

DIFFERENTIAL WHEAT PRICES
IN THE STATE OF KANSAS AND RAIL RATES
TO TERMINAL AND SUBTERMINAL MARKETS

by

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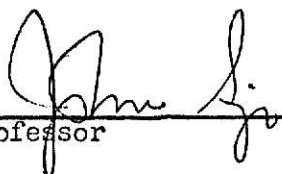
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INTRODUCTION

It is of interest to find out why prices received by farmers for the same quality of a given commodity at different locations are not the same at a given point in time. Economic theory immediately suggests that the main governing cause of any such differences is the transportation charge between the various points. Specifically in this thesis the variation in prices paid by grain elevator managers for wheat in the state of Kansas was investigated. Since a large part of the wheat is transported by rail, the rates charged by the railroad companies for this service should be a major factor in the pricing policies of the local elevator managers. The rates that are applicable depends upon the destination of the wheat grain.

Since terminal and sub-terminal markets are the major centers of buying and selling of grains, it is reasonable to assume that such central markets are the basing points of grain elevator managers. Hence the main hypothesis of this thesis is that rail rates to central markets are the chief causes of price differences among the various locations for wheat.

This problem is of interest to the people of the state of Kansas since wheat is the major crop of the farmers in the area and thus ties in with the farmers' income. As a foreign student the significance of the problem arises from similarities between wheat and the main cash crop of the people in Northern Nigeria which is peanuts. Wheat is used for food, so also is peanuts in Northern Nigeria. Both are produced for home consumption and export. Railroads are employed in moving a major part of these products to export ports and both have major gathering centers. Finally both are similarly graded.

When it comes to determining the prices for these two products however,

entirely two different systems are used. Ordinarily, the farmer delivers his wheat by truck to the local elevator where it is sampled for quality characteristics and weighed. The farmer may then take the price offered by the elevator manager or may decide to pay for the storage of his grain to be sold at a later date. In Nigeria peanuts like other farm produce entering export trade is purchased only by the legal monopsonist, Marketing Boards. The boards pay the same price for the same grade no matter where the purchase is made. The price which is fixed by the boards is paid promptly upon purchase and no speculation is allowed.

The Nigerian Federal Government has set aside a substantial sum of money to encourage cooperative marketing of food products throughout the country and it is of interest to know what pricing policies such a body and the existing Marketing Boards should use. The question of pricing policies arise from equity considerations and from the need of policies to encourage efficient allocation of resources from the comparative advantage point of view. Another reason for interest is this type of problem results from the belief that one of the easiest ways of improving the income of farmers is to open up the rural areas to good transportation. This method is considered easier because it is a far simpler matter to build a road or a railway to an area than to bring about a change in technology or a significant development of new varieties of plants and animal breeds.

During trips to get the necessary data, grain dealers were often asked how they determine the price of the wheat they purchase. All had a ready made answer to the question which often took the form "Kansas City minus freight charge." It would be of interest if such answers can be sustained by empirical evidence and to see which other factors if any are significant in equilibrating locational prices.

From an administrative point, this type of study could be used in predicting what type of relationships to expect with a new policy or structural rate changes. However, these practical considerations are not the only reasons for this type of study. The appeal to satisfy the academic appetite by discovering the functional or structural relationship of interrelated factors could be another reason.

The variable to be analysed in this study is the wheat price differential defined broadly as the difference between the relevant central market wheat price and the quoted wheat price of other locations. The precise definition for the respective central markets will be given later.

In the thesis three main hypotheses are tested, namely:

1. There is a correlation between the wheat price differential of a given central market and rail rates from the relevant locations. (The relevant locations are the points that send their wheat grain to a particular central market).

2. The rail rate factor is the most significant independent variable in the price differential function.

3. The relative influence of rail rates on the differentials of the various central markets vary over space and time.

Hypothesis number one is meant to discover the degree and direction of any association between the wheat price differential of any central market and the rail freight rates to such markets.

The second hypothesis is designed to give an idea of the most significant independent variable in the explanation of the differentials and to give structure to such relationships.

The third hypothesis is meant to test the stability of the functional structure over space between central markets and over time for each central

market.

The study was limited to the state of Kansas for the period July 1958 to June 1970, a total of twelve crop years. One crop year covering the period July of one year through June of the next year. Terminal and subterminal markets considered are Kansas City, Salina, Hutchinson, Wichita and Enid, Oklahoma. The Kansas City terminal market is the largest among them. Enid, Oklahoma is the only out-of-state subterminal included in the study because it was thought to be sufficiently close to the southern part of the state of Kansas to have a significant influence. Moreover, Enid, Oklahoma is a subterminal on the rail route to the gulf export ports. Other subterminal markets which should ideally have been considered are Atchison and Topeka both in Kansas and Denver, Colorado. It was also recognized that other transportation rates which should have been ideal to include in the study are barge freight rates and truck rates, the last becoming significant in recent years.

In carrying out this study certain assumptions were made, namely:

- a) Farmers and elevator managers are adequately informed about wheat prices in the central markets and the rail rates to such markets.
- b) Rail rates are a good measure of the distances between the various points and central markets.
- c) Railroads ship most of the wheat grain from the various locations to the central markets.
- d) Rail rates are set competitively against other transportation rates.

LITERATURE REVIEW

There is abundant published literature on location theory but published works on empirical investigations are more scarce. Classical writers on the theory of location often cited include Von Thunen, Weber, Losch, Hoover and Isard.¹ Von Thunen's theory emphasized the non-institutional factors of location. His formulations revolve on the cost of transportation and the rent of land which explains why a particular agricultural product is grown on a given piece of land. Weber's theory of location is procedurally the opposite of von Thunen's. In his theory, the branch of industry is given and the place of location is sought. Weber's theory is based upon three general factors of location: transportation cost, labor cost and agglomerating forces. Hoover's approach suggests demand determinants as well as cost factors. He separates the cost factors of location into transportation factors and the production factors.

However, the interest of this study is not on location theory as such, but on the relationship between rail rates and the price of wheat in different locations in the state of Kansas. Interest in the effect of rail rates has deep origins. In a 1915 article in which Meeker urged a reorganization of rail rates, he charged that "rates were fixed in other cases on a mileage basis, on the most-favored-community basis, on the basing-point basis, on no

¹Richard A. King and William R. Henry, "Transportation Models in Studies of Interregional Competition," Journal of Farm Economics, Volume XLI, December 1959 No. 5 P. 997; citing Johann Heinrich von Thunen, The Isolated State (1826); Alfred Weber, Manufacturing Industry Within the Economic System (1909); August Losch, The Economics of Location (New Haven: Yale University Press, 1954); Walter Isard, Location and Space Economy (New York: MIT Press and John Wiley and Sons, Inc., 1956); Edgar M. Hoover, Jr., The Location of Economic Activity (New York: McGraw-Hill Book Co. Inc., 1948).

basis at all."¹ Later in another article, Hibbard questioned the truth of the general assumption that the farmer pays the freight rate both ways. He said claims such as the price of wheat to the farmer is the central market price minus the cost of getting there are only partly correct.² As the director of the Bureau of Railway Economics, Washington, D. C., Parmelee in 1922 commented on the general complaint at that time that prices were too high. He asserted that there was no way of determining whether wages, prices and freight rates are at any time in a state of exact equilibrium. Adjustments in freight rates would not benefit everybody alike and moreover he asked who can say that what existed before the changes is the optimum which must be maintained? His advice to the farmer was that he should increase his productivity to meet his new cost.³

Concerning the general problem of the market, Marshall summarized the difficulties when he wrote "The difficulties of the problem depend on variations in the area of space, and the period of time over which the market in question extends; the influence of time being more important than that of space."⁴ Fetter stated the law of market areas and illustrated the idea of the extent and shape of the market tributary territory as related to any given levels of prices and freight rates. In the case of buying markets with decentralized producing points, the higher the price relative to its competitor,

¹Royal Meeker, "Market Distribution," American Economic Review, Supplement to Vol. V, March 1915, P. 120.

²B. H. Hibbard, "The Effect of Freight Rates on Agricultural Geography," Journal of Farm Economics, Vol. IV, July 1922.

³Julius H. Parmelee, "Farm Prices and Railway Rates," Journal of Farm Economics, Vol. IV, July 1922, PP. 144-49.

⁴Alfred Marshall, Principles of Economics (9th Edition, London: McMillan and Co. 1961) P. 496.

the larger the area from which it can attract sellers to it. The price indifference curves surrounding each market given two markets, is hyperbolic.¹ In search for a natural and spatial order of things, Lösch showed that the hexagon is the most economical shape for trading areas. However such shapes are difficult to find in the real world. Geographical and cultural regions, he claimed are artificial units of reference from an economic point of view and their aggregates such as their balance of payments and their price levels are entirely arbitrary and accidental.² Writing later in 1950 C. D. Hyson and W. P. Hyson generalized Fetter's law for two competing markets for like goods without assuming equal transportation rates or equal prices. The boundry line between the territories tributary to the two competing markets they said, is a hypercircle.³ Though the theory of value does not commonly include considerations of space, nevertheless Enke thought that it is probable that spatial elements alone are sufficient in all save a few special cases to prevent pure competition in demand and supply schedules of goods considered homogeneous. Though there are infinite variety of ways in which the producers and consumers may be located relative to one another, preliminary assumptions regarding the relative locations may determine the conclusions of economic analysis. For example von Thunen's theory of concentric agricultural zones around the city state can only apply to a case where all producers are scattered indiscriminately but all consumers are concentrated at one point.

¹Frank A. Fetter "The Economic Law of Market Areas" Quarterly Journal of Economics, Vol. XXXVIII, PP. 520-29, May 1924.

²August Lösch "The Nature of Economic Regions", Southern Economic Journal, Vol. V, July 1938, PP. 71-78.

³C. D. Hyson and W. P. Hyson "The Economic Law of Market Areas" Quarterly Journal of Economics, Vol. LXIV, PP. 319-27, May 1950.

This same assumption was made by Chamberlin in his analysis.¹

Many attempts have been made and are being made to subject spatial problems to mathematical analysis and in this regard Enke has this to say: "One class of problems in economics that has long resisted attack concerns the effect of transportation costs upon local price and commodity movements when traders are located at many different points."² Enke further noted that if there are only three such regions, the problem is easily solved given certain unknowns but for more than three regions, though mathematically soluble by method of iteration, the proper method of solution was not apparent to the mathematicians who were consulted. For a three region case, Enke derived a formula for the local price.³ Samuelson showed that the problem posed by Enke could be given an explicit mathematical formulation as a standard problem in linear programming.⁴ Later Takayama and Judge were able to show how this spatial equilibrium formulation of Samuelson can be converted to a quadratic programming problem.⁵

Bawden warned that care must be taken in using models when it comes to interpreting the results because error could arise from three sources, namely inefficient market, an incorrect model and inaccurate data. He also noted that price predictions by equilibrium or activity analysis models are not

¹Stephen Enke, "Space and Value" Quarterly Journal of Economics, Vol. LVI, No. 4, August 1942, PP. 627-637 citing Chamberlin, Theory of Monopolistic Competition; (Harvard University Press, 4th edition 1939) Appendix D.

²Stephen Enke, "Equilibrium Among Spatially Separated Markets: Solution by Electric Analogue," Econometrica, Vol. XIX, PP. 40-47, Jan. 1951, P. 40.

³Stephen Enke, "Equilibrium Among Spatially Separated Markets."

⁴Paul A. Samuelson, "Spatial Price Equilibrium and Linear Programming," American Economic Review, Vol. XLII, PP. 282-303, June 1952.

⁵T. Takayama and G. G. Judge "Spatial Equilibrium and Quadratic Programming," Journal of Farm Economics, Vol. XLVI No. 1 February 1964 PP. 67-93.

expected to possess high degree of accuracy because of the errors noted. Moreover he further noted that deterrents in increasing empirical effectiveness of spatial models are lack of reliable disaggregated data, computational complexity and lack of adequate theories to describe market behavior.¹ As further reasons that may lead to inaccuracy of results, Day noted that empirical spatial models have too often utilized flat rail rates which because of transit privileges do not accurately reflect the cost of shipments from one point to another. The situation is made worse by the lack of information on truck hauling and truck and barge rates. Truck rates are further complicated by the differing prevalence of back-haul opportunities between areas.² Nevertheless King and Henry pointed out how the transportation model can be used to indicate the likely direction of future adjustments to existing market conditions. The authors also discussed how the transportation model could be modified to handle the problems of space, space-form, space-time and space-form-time.³

The question of who pays the freight charges is always of interest. Trumbower discussing the general assumption of farmers who claim they pay the complete freight charges on products they sell and on products they buy said this can only be true in special cases. The incidence of freight depends upon the elasticities of demand of the products, the more inelastic the higher the incidence of any freight increase and vice versa for a given supply.⁴ This

¹Lee D. Bawden "An Evaluation of Alternative Spatial Models," Journal of Farm Economics, Vol. XLVI December 1964, PP. 1372-79.

²Lee M. Day, Discussion: Spatial Economics; Journal of Farm Economics, Vol. XLVI, No. 5, December 1964, PP. 1386-1390.

³Richard A. King and William R. Henry "Transportation Models in Studies of Interregional Competition," Journal of Farm Economics, Vol. XLI December 1959, PP. 997-1011.

⁴Henry R. Trumbower, "The Incidence of Freight Charges on Agricultural Products," Journal of Political Economy, Vol. XXXIII, June 1925, PP. 340-53.

same problem of the incidence of freight charges was discussed by Barton who noted Locklin's statement that the farmer cannot be right unless one economic law determines the price of manufactured goods and a different law determines the price of farm commodities. He cited the conclusions of a United States Department of Agriculture (USDA) study of why farmers are interested in freight rates. The study came to two conclusions namely that the price in an area of surplus production is approximately equal to the central (primary) market prices minus the cost of moving the product to the market; and secondly that the price in a deficit area is roughly equal to the price in the most distant area of surplus production from which the supply is drawn plus the cost of transportation and handling.¹

Ownership of the country elevators does not seem to make much difference in their pricing practices. Stokes came to this conclusion in a study done for the USDA and noted "Outright purchase at the time the grain is delivered is the most widely used method. The country elevator receives frequent quotations from grain buyers and is also in constant contact with the grain traders by telephone and radio. The local elevator operator bases his price to the farmer upon the terminal market price at that time, taking into consideration freight charges to the terminal market, the terminal market handling costs and his own cost and profit."² However, Farris writing in 1958

¹Frank L. Barton, "Length of Haul and Farm Commodity Prices," Journal of Farm Economics, Vol. XXIII, No. 2, May 1941 citing U. S. Department of Agriculture, "Prices of Farm Products Received by Producers," Stat. Bul. 17, and "Reliability and Adequacy of Farm Price Data," Dept. Bul. 1480 (Washington Government Printing Office, 1927).

²Donald R. Stokes "Marketing Margins and Costs for Grains, Grain Products, and Dry Edible Beans," U. S. Department of Agriculture, Bureau of Agricultural Economics, Technical Bul. No. 934, August 1947, P. 10.

noted in a study of the country elevator pricing process for wheat in Illinois that prices vary between elevators located in the same town depending upon the percentage of the business taken up by the wheat handling. Those handling higher volumes tend to pay higher prices than those handling less volume or for whom wheat handling is a side business. He also found differences in freight rates depended upon elevator location. Influence of carrier and shipment destination was overshadowed by the effects of other variables such as factors affecting margins and local competitive situations. He also found that lags in the transfer of information resulted in fluctuating prices. Prices paid is often for wheat and something else which often includes subjective feelings.¹ In a similar study of Missouri farmers, Yager found farmers attached varying importance to such things as price, distance, speed of unloading, proper grading and sideline services in determining the elevator to which to deliver their grain. The elevator operators also attach varying weight to these factors.²

If there is any sense at all in studying location economics it must be as Isard puts it because there are certain regularities in the variations of costs and prices over space. These regularities arise primarily because transport cost is some function of distance. If this were not so, if transport costs were completely irregular and their changes unpredictable, there would be little sense in searching for a general economics of spatial activities.

¹Paul L. Farris, "The Pricing Structure for Wheat at the Country Elevator Level," Journal of Farm Economics, Vol. LX, No. 3, August 1958, PP. 607-24.

²Francis P. Yager "What Influences Off-farm Grain Sales in Missouri?" U. S. Department of Agriculture, Farmer Cooperative Service, General Report No. 91, July 1961 (Washington, D. C.).

Since it is the distance factor that is the heart of locational analysis, there is every reason to take transportation rates into consideration.¹ Earliest formal work concerning location theory and the influence of transportation was by Johann Heinrich von Thunen in the early nineteenth century. Assuming a given transportation rate for a given weight and distance, von Thunen hypothesized that "the value of produce at the place of production decreases with the distance of the place of production from the market place."² In contrast to von Thunen's one center of consumption, Alfred Weber expanded his theoretical system to include an endless number of consuming points distributed over an area with constant weight-distance transportation costs.³ The striking characteristic of transportation rates is that they are tapered. That means as the distance of the haul increases, a given weight is charged smaller increments per mile. This characteristic coupled with transit privileges may cancel out any advantages or disadvantages of any particular point. Transit privileges enable shippers to divert or stop goods on the way to their final destination at special rates which are not the sum of the separate rates.⁴ In a study of geographical freight rate distributions from certain chosen centers called "nodal regions" in the U. S., Alexander, Brown and Dahlberg noted that there is no reason to believe that nice uniform concentric circles will result but the general less erroneous idea that rates increase with distance but always at a diminishing rate can be crudely

¹Walter Isard, Location and Space Economy, P. 35.

²J. L. Heskett, Robert M. Ivie, Nicholas A. Glaskowsky, Jr., Business Logistics: Management of Physical Supply and Distribution (The Ronald Press Company, New York: 1964), P. 122.

³J. L. Heskett et al., Business Logistics, Chapter 6.

⁴Ibid.

demonstrated.¹

As a passing reference, Benedict noted that since transportation rates are relatively stable as compared to commodity prices, they take the nature of other semi-fixed charges and are a larger percentage of low prices than high prices. Hence producers in areas paying a larger freight charge to reach their markets are subject to larger percentage variations in the prices paid to farmers.² In a study of differential price behavior between three major wheat markets of Chicago, Winnipeg and Liverpool, Working concluded that price movement in any of the market is made up of a primary movement made during its own session plus a secondary movement made in response to movements in other markets plus a contemporary movement involving all three. There is a lag of overnight in secondary response because of time differences.³

Warntz estimated the geographical variation of prices for wheat, potatoes, onions and strawberries by the method of multiple regression analysis for the U. S. covering the period 1940 to 1949 using state average prices for the commodities involved. His independent variables were gross economic population potential which is a measure of aggregate proximity of people to a point weighted by their incomes, product supply space potential which is a measure of the proximity of the supply area to a point and product supply time

¹John W. Alexander, S. Earl Brown and Richard E. Dahlberg "Freight Rates: Selected Aspects of Uniform and Nodal Regions" in G. J. Karaska and D. F. Bramhall, editors, Locational Analysis for Manufacturing Chapter 6 (Cambridge: Mass., M.I.T. Press, 1969).

²M. R. Benedict, "The Significance of Transportation Rate Policies in the Marketing Problem," Journal of Farm Economics, Vol. XIII, PP. 401-409, July 1931.

³Holbrook Working, "Differential Price Behavior As a Subject For Commodity Price Analysis," Econometrica, Vol. III, October 1935, PP. 416-27.

potential which is the nearness in time of all the production of a product to that instant of time.¹ We are interested in studying price differentials because they assist in explaining and forecasting prices of specific commodities in individual markets. This was the reason given by Working when he presented the results of a study of price comparisons for potatoes in St. Paul-Minneapolis, Chicago, Kansas City, Philadelphia and New York City. He listed three elements influencing the differential namely freight rate, quality difference and dealer margin. He ranked freight rate as the most important and dealers margin as probably small in influence. He expressed the normal differential (DN), as the sum of freight charges differential (Da) and quality differential (Db) (which included the dealers margin).

$$DN = Da + Db$$

He further expressed the quality differential as a function of time to allow for a trend if any exists

$$Db = L(a+bt),$$

where L is the index number of wholesale price level. He also expressed the freight charge differential as an index of freight rates.

$$Da = cF$$

$$\text{Hence } DN = L(a+bt) + cF$$

$$\text{or } DN = aL + btL + cF$$

Taking his origin for t as 1913, he obtained the function

$$DN = 0.0909L + 0.00325tL + 0.8909F$$

as the value for November differential between St. Paul-Minneapolis and New York City. A similar solution was obtained for October

¹William Warntz, Toward A Geography of Prices; A Study in Geo-Econometrics (Philadelphia: University of Pennsylvania Press, 1959) Chapters 2 and 3.

$$DN = 0.0716L - 0.00416tL + 0.877F$$

with freight charges appearing to have practically the same effects for the two months.¹

In an empirical investigation of beef marketing for the U. S. divided into twenty one regions, Judge and Wallace used the model

$$C_{ij} = B_1 M_{ij} + B_2 M_{ij}^{\frac{1}{2}} + e$$

to reflect transportation rates, where C_{ij} represents costs in cents of shipping a pound of beef from point i to point j ; M_{ij} is the mileage between i and j and where B_1 and B_2 are unknown parameters and e is the random error term.

By method of least squares, sample data was used to estimate the unknown parameters and the following

$$C_{ij} = 0.008 M_{ij} + 0.0464 M_{ij}^{\frac{1}{2}} \quad R^2 = 0.970$$

was obtained for the rail transportation cost.²

This concludes the review of literature. It was attempted to review the ordinary statements in the first paragraphs, theoretical statements in the middle paragraphs and ending with explicit mathematical formulations. Attempts were made to incorporate some of these literature findings into the investigations of this paper.

¹Holbrook Working, "Factors Influencing Price Differentials Between Potato Markets," Journal of Farm Economics, Vol. VII, No. 4, October 1925, PP. 377-398.

²G. G. Judge and T. D. Wallace, "Estimation of Spatial Price Equilibrium Models," Journal of Farm Economics, Vol. LX : No. 4, November 1958, PP. 801-20.

DATA COLLECTION AND PREPARATION

To test the hypotheses proposed earlier, it was necessary to get wheat prices at different locations within the state of Kansas covering the period July 1958 to June 1970. It was thought too tedious and long to collect daily price information from as many locations as possible, hence mid-month prices were collected from the different locations. The locations were from the towns that have had daily newspapers reporting local wheat prices over the period, this came to a total of twenty nine in all. To get more distribution of the locations involved, two more towns with weekly newspapers reporting local wheat prices were added thus bringing to a total of thirty one all the points for which mid-month local price of wheat was obtained. The newspapers used are listed in Appendix A. The price on the fifteenth of the month was obtained or the closest possible day to the fifteenth. The mid-month price for eleven percent ordinary protein for Kansas City over the period was obtained from a weekly summary release, "Grain Market News" published by Grain Division, Agricultural Marketing Service, USDA, Washington, D. C. The prices are listed in Appendix B.

The wheat quality data for the various locations were taken to be that of the county in which the town is located. The quality aspects for which information was available for the period under consideration were in terms of protein content and test weight (weight per bushel). The wheat quality data were obtained from survey reports done every year during the harvest season of the new crop published as "Wheat Quality Survey." The survey was done by the Kansas Crop and Livestock Reporting Service jointly carried out by the USDA, Statistical Reporting Service and the Kansas Department of Agriculture, Statistical Division. The protein content and test weight for

the points are listed in Appendix C.

The rail rates in effect over the period from the various locations to the central markets in Kansas City, Salina, Hutchinson, Wichita and Enid were obtained from many sources cited in the acknowledgements section. The rates to Kansas City from 1958 to 1964 were obtained from the Santa Fe Railroad Company in Topeka and from the Kansas City Board of Trade rate book for the rest of the period. In order to find out for which locations to obtain the rail rates to the other central markets, the various companies cited in the acknowledgements were asked to supply the places they normally get their wheat from and the rail rates for the points at any time within the period under consideration. This was then used as a base in forming the rates in effect for the rest of the period for the various points in respect of the central market under consideration. The principle used in forming the rest of the rates was that if the rates were equal at any time, then they ought to be equal at all other times. This is true for the state of Kansas during the period under consideration. By looking through the Kansas City Board of Trade Rate Book, the necessary conversions were made for the rest of the period. Since the rate book only contains the rail rates in effect since October 24, 1960, the only one change prior to that date and the magnitude of the change was obtained from Mr. Henry J. Yunck, Director of Transportation, FAR-MAR-Co., INC., Hutchinson. That change which brought the previous rates to the level of that listed in the rate book, involved the following increases: previous rates of one to sixty-five cents per hundredweight were increased by half a cent and rates over sixty-five cents were increased by one cent. Since no rates under consideration exceeded sixty-five cents per hundredweight, any error therefore is small or negligible. Thus the relevant points for each central market and their effective rates were determined. The rail rates for

all the locations to Kansas City during the period are listed in Appendix D. The effective rail rates to Salina, Hutchinson, Wichita all in Kansas and to Enid, Oklahoma are listed in Appendixes E, F, G and H respectively.

In addition to the price data listed in Appendix A, county mid-month prices of Hard Red grade one wheat was obtained from the State Statistician, Mr. J. E. Pallesen which was for the period July 1967 to June 1970 only. In addition to protein content and test weight, other quality characteristics for which data were available for the period were in terms of moisture content and dockage. Because this contains more observations per given year (105 counties), it was hoped, using this set of data would give better results. In using this set of data, the effective rail rates for the counties were taken to be the same as the rail rates from the towns located in the centers of the counties. Any errors arising from this is small because rail rates for various other towns not centrally located compare almost equally with rail rates from central towns, usually if any the difference is of the order half a cent per hundred-weight.

Figure 1 shows the points included in this study.

**THIS BOOK
CONTAINS
NUMEROUS PAGES
WITH DIAGRAMS
THAT ARE CROOKED
COMPARED TO THE
REST OF THE
INFORMATION ON
THE PAGE.**

**THIS IS AS
RECEIVED FROM
CUSTOMER.**

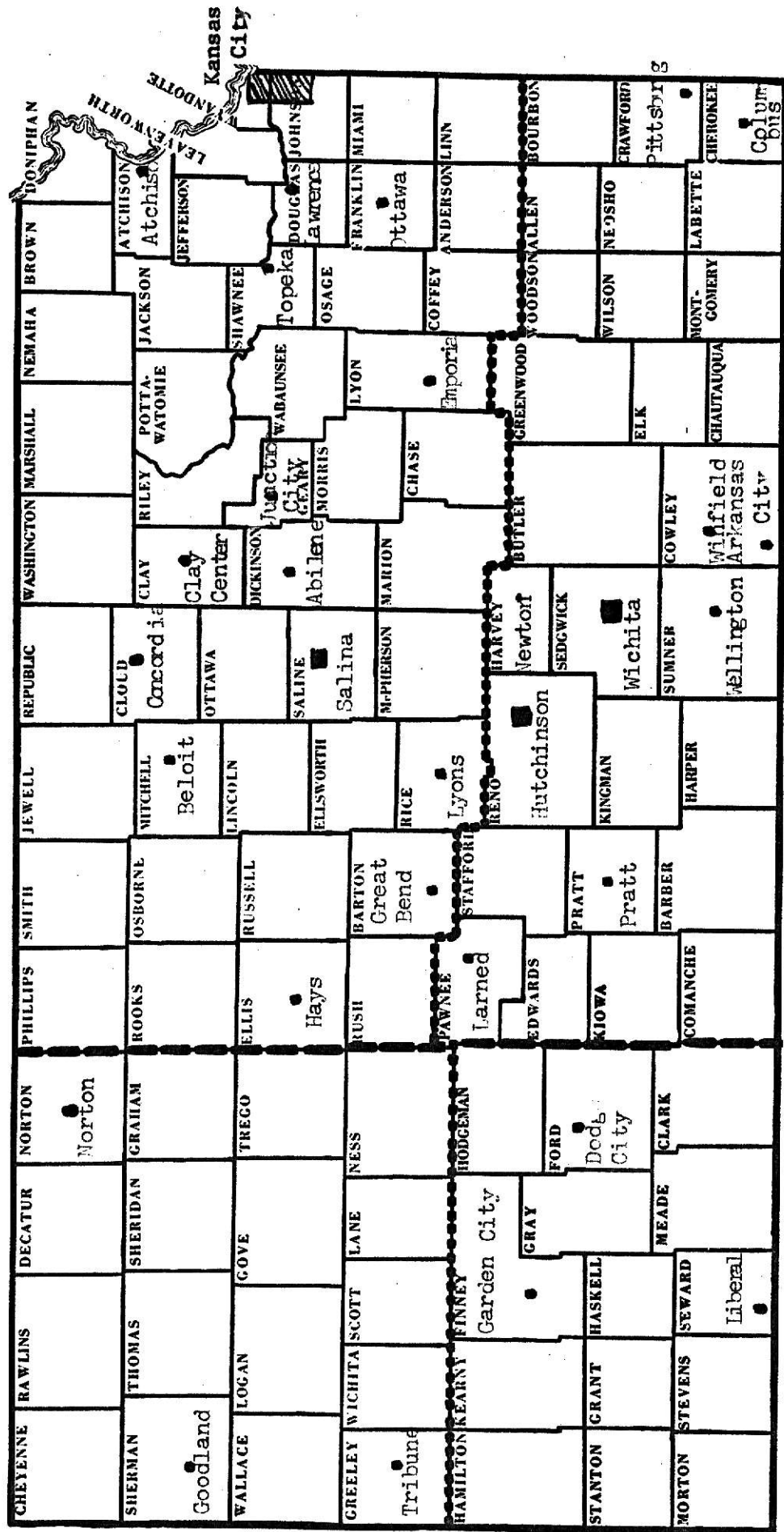


Fig. 1. Map of Kansas showing points and counties included in this study.

ANALYTICAL THEORY

It was thought that the differential price between the central market and any other location is a function of three elements namely elevator manager's margin, transportation charges and quality difference. Therefore we could write:

$$P_{d_{kitj}} = f(A, T, Q) + e$$

where e = error term

where $P_{d_{kitj}}$ = price differential for central market k and place i for mid-month t and year j defined more precisely for the various central markets below.

Kansas City (K.C.) central market wheat price differential before July 1962	=	Price in cents per bushel of number two ordinary protein wheat at K. C. in mid-month t of year j	-	farmers price for average bushel of wheat sold at relevant location i in mid-month t of crop-year j
K. C. central market wheat price differential after July 1962	=	price in cents per bushel of number one ordinary protein wheat at K. C. in mid-month t of year j	-	farmers price for average bushel of wheat sold at relevant location i in mid-month t of crop-year j

For the other central markets, the respective price differential has the following meaning:

price in cents per bushel of average grade and quality of wheat at central market k at a given mid-month t for crop- year j	-	price in cents per bushel of average grade and quality of wheat at the relevant location i at a given mid-month t for crop-year j
---	---	--

k = 1, 2, 3, 4, 5

t = mid-July, mid-August, mid-September,, mid-June

j = July 1958 through June 1970

The relevant locations are the locations that send wheat grain to a given central market.

A = elevator manager's margin for his services in cents per bushel

$$\begin{array}{rcl}
 \begin{array}{l} A \\ \text{in cents per} \\ \text{bushel} \end{array} & = & \begin{array}{l} \text{price received in cents per} \\ \text{bushel at a given central market} \\ k \text{ for a given grade and quality} \\ \text{of wheat} \end{array} - \begin{array}{l} \text{total costs} \\ \text{incurred in} \\ \text{delivering a} \\ \text{bushel of the same} \\ \text{grade and quality} \\ \text{of wheat to the} \\ \text{given central} \\ \text{market } k \text{ in cents} \\ \text{per bushel} \end{array}
 \end{array}$$

This margin is assumed constant in the short-run period for all relevant days and for all grades of wheat at all locations i because the various components of the elevator managers costs (wages, depreciation of plant and equipment etc.) can be considered unchanged in the short-run.

T = total transportation charges from location i to the relevant central market k in cents per hundredweight

Total transportation charges consist of two main elements namely terminal or handling charge and line or delivery charge. Handling charge is considered constant in the short-run period for all places and for all grades of wheat handled and for all relevant days. Delivery charge is some function of distance. Transportation rates can be taken as the measure of distance since these are the costs per unit weight incurred when shipment is made from one point to another. In this paper only rail rates are considered. Therefore total transportation charges can be expressed as:

$$T = C + bR$$

where C = handling charge in cents per bushel

R = rail rates in cents per hundredweight

b = unknown coefficient

Q = quality factors in terms of average percentage by weight of protein content (P) of wheat at location i in year j , average test weight (W) in pounds per bushel of wheat at location i in year j , average percentage by weight of dockage (D) (broken and shrunken kernels, foreign material etc.) of wheat at location i in year j and average percentage by weight of moisture content (M) at location i in year j .

These quality factors are measured at the time of the new wheat crop each year and are taken to be unchanged for the rest of the crop-year. This obviously is not true since foreign material content, moisture content and other factors likely change during the course of the crop-year. This therefore is a source of error.

Before we express the theoretical relationship between the various factors, we could first state the approximate relationships between them.

The higher is any of the components of total transportation costs, the higher the cost of making delivery to the central markets and therefore the lower the price the farmer is likely to receive and hence we can expect the differential to increase with increase in any of these costs. Since we assumed handling charge to be a constant, we could write this relationship in terms of the partial differentiation of price differential and rail rates:

$$\frac{\partial Pd}{\partial R} > 0$$

As for the quality characteristics, the higher the protein content, the higher the price the farmer is likely to receive and hence we can expect the price differential to decrease with an increase in protein content, or more precisely

$$\frac{\partial Pd}{\partial P} < 0$$

High test weight is valued and therefore we can expect the higher the test weight, the higher the price paid to the farmer and hence we can expect the price differential to decrease with an increase in test weight. This is more precisely expressed as:

$$\frac{\partial Pd}{\partial W} < 0$$

Moisture content and dockage material are not valuable factors and hence we can expect the price paid to the farmer to decrease with increase in either percent dockage and/or percent moisture and therefore we expect the

price idfferential to increase with increase in either of them.

$$\frac{\partial Pd}{\partial M} > 0$$

and

$$\frac{\partial Pd}{\partial D} > 0$$

In general as the locational wheat quality rises we expect the price differential to decrease or more generally

$$\frac{\partial Pd}{\partial Q} < 0$$

Without offering any proof at this time, the model used in all the analyses for the various central markets was taken to be the following:

$$Pd = Bo + B_1R - B_2P - B_3W + B_4M + B_5D + e$$

This followed the approximate relationships discussed above. The accuracy of this model is discussed at the end of this paper under the heading "Model Derivation" where the theoretical model is also derived. The symbols mean the same as in above definitions, e is the error term and Bi are unknown coefficients.

Since the measurements for the terms percent moisture content (M) and percent dockage (D) were not available from the beginning of the period covered by this study, they were not included in the analysis for the town data, but were included in the analysis using county mid-month prices. Therefore the model used for all the analyses using town mid-month prices was:

$$Pd = Bo + B_1R - B_2P - B_3W + e$$

Since the appropriate signs of the coefficients would be in the computer output of results, the model was generally written as:

$$Pd = Bo + B_1R + B_2P + B_3W + e \quad (1)$$

Since grains that are high in protein content tend to have low test weights, it was thought appropriate to add an interaction term involving P and W. Two forms of the interaction term were tried in the regression equation using the same data to see which gave a higher coefficient of determination namely PW and P+W. Also in the light of the results obtained by Judge and Wallace¹ cited earlier in the literature review, it was thought appropriate to add another term for the rail rate effect in terms of the square root of the rates. Rewriting the regression equation for the price differential separately with the interaction terms involving P and W, we have:

$$Pd = B_0 + B_1R + B_2P + B_3W + B_4PW + B_5R^{\frac{1}{2}} + e \quad (2)$$

and

$$Pd = B_0 + B_1R + B_2P + B_3W + B_4PW + B_5R^{\frac{1}{2}} + B_6(P+W) + e \quad (3)$$

Preliminary test runs were made using the same data and models (1), (2) and (3). The coefficient of determination values were:

$$\text{model (1) } R^2 = 0.377$$

$$\text{model (2) } R^2 = 0.373$$

$$\text{model (3) } R^2 = 0.386$$

These values were obtained from the computer output using stepwise regression program. For the sake of simplicity and for identifying the significant variables, only model (1) was used for the rest of the analyses.

In using this linear regression model, the standard assumptions hold true, namely:

- 1) The independent variables are fixed or nonstochastic
- 2) No two or more than two of the independent variables are perfect linear

¹G. G. Judge and T. D. Wallace, "Estimation of Spatial Price Equilibrium Models," Journal of Farm Economics, Vol. LX, No. 4, November 1958, PP. 801-20.

combinations of one another

- 3) The disturbances e have an identical distribution with mean zero, variance σ^2 and among them, zero covariances.

Before starting the main analysis, the scatter diagram of the various central markets was plotted to give an idea of what the differential relationship and rail rates look like. These scatter diagrams are shown in Figures 2 to 6. As these Figures show, rail rates alone do not tell us much about the wheat price differential of the various central markets and the trend seems to have a negative slope which seems contradictory, hence the justification of including other variables in the analyses. The only comment that can be made here is that it is worthy of note that though the rail rates for all the central markets are in about the same range, the points for Kansas City and Enid (the ones that are geographically further than the others) are all to the right of the origin while the points for the others tend to group around the rail rate axes. This gives the impression that the further geographical markets, not necessarily economically further, tend to command higher wheat prices and hence higher price differentials and it looks like rail rates have no effect on the differentials of Salina and Hutchinson.

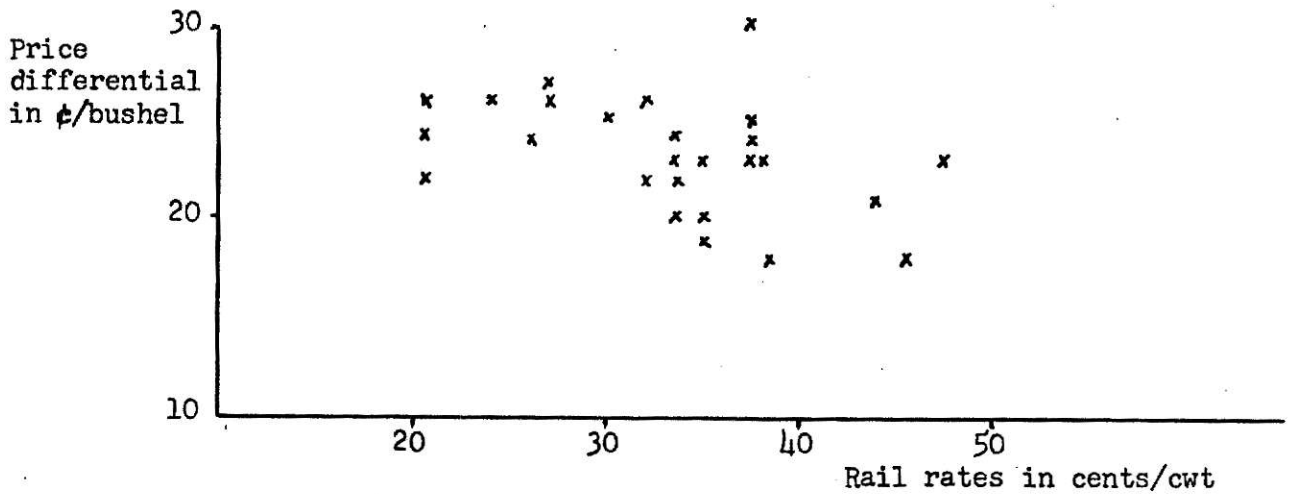


Fig. 2. Kansas City wheat price differential and effective rail rates for the relevant locations in mid-November 1958-59 crop year.

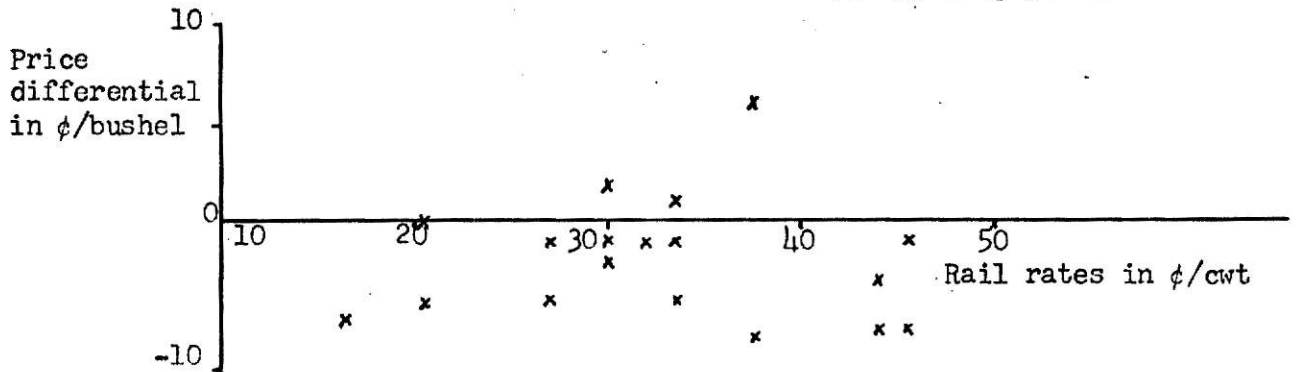


Fig. 3. Salina wheat price differential and effective rail rates for the relevant locations in mid-November 1958-59 crop-year.

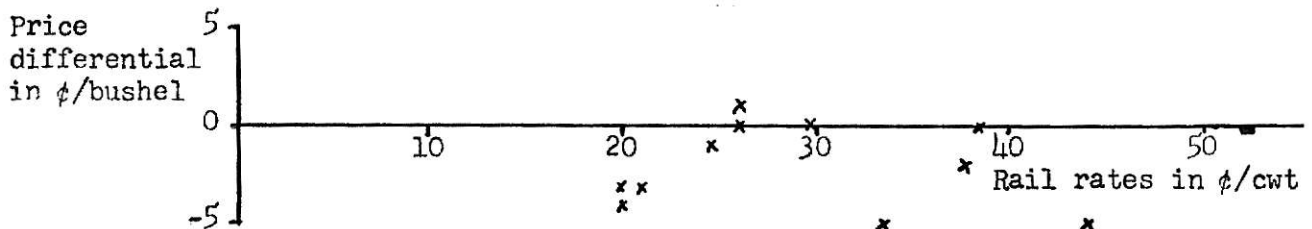


Fig. 4. Hutchinson wheat price differential and effective rail rates for the relevant locations in mid-November 1958-59 crop year.

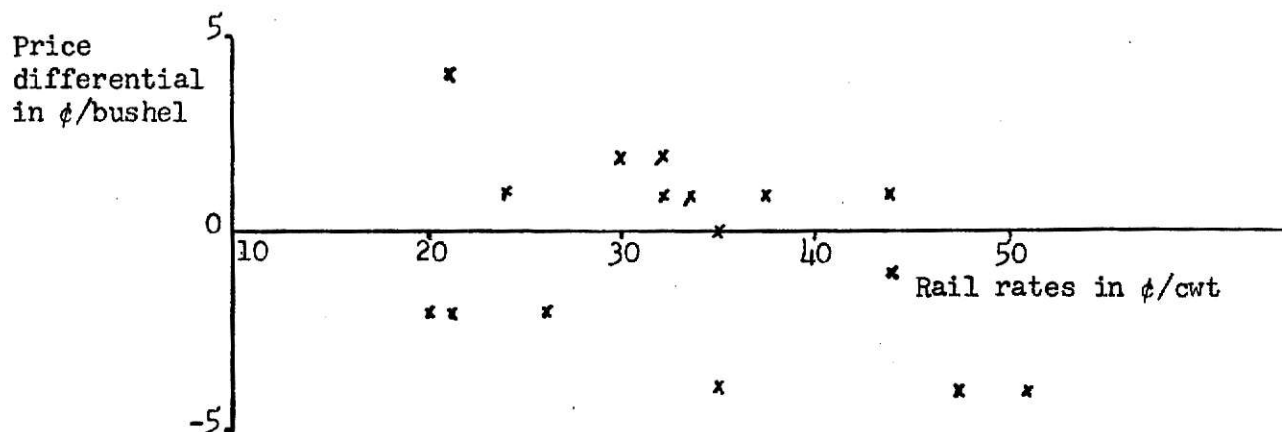


Fig. 5. Wichita price differential and effective rail rates for the relevant locations in mid-November 1958-59 crop year.

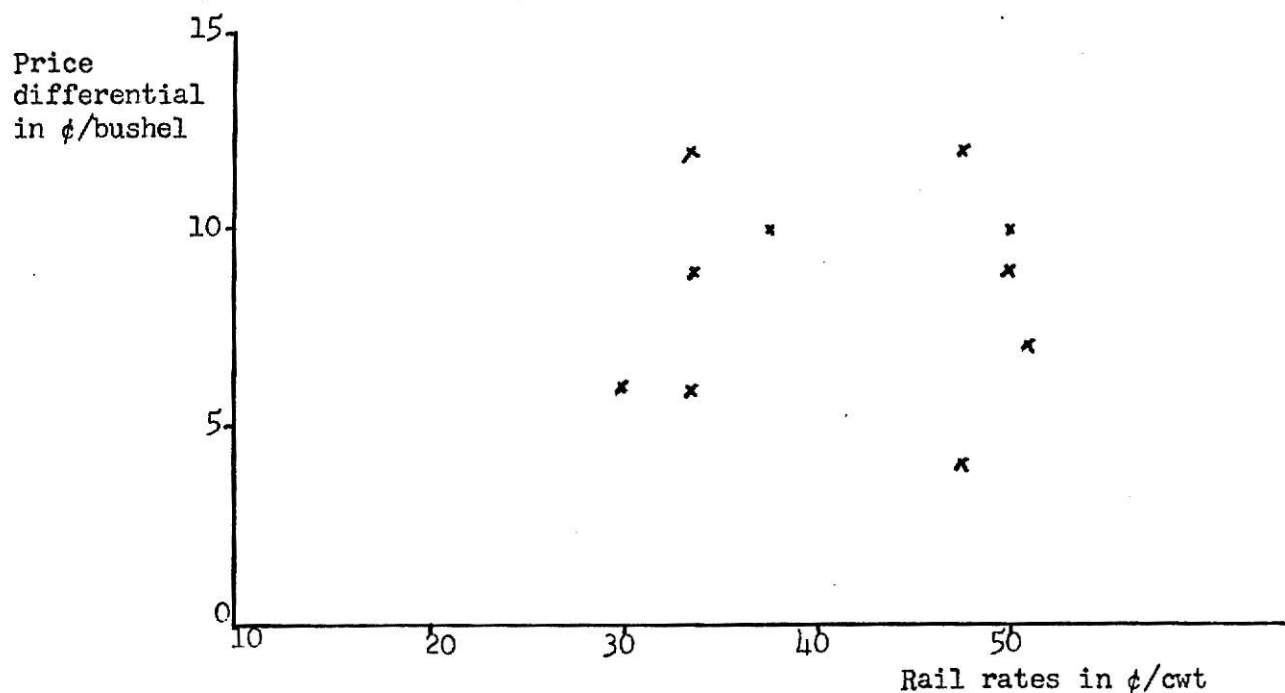


Fig. 6. Enid wheat price differential and effective rail rates for the relevant locations in mid-November 1958-59 crop year.

METHOD OF ANALYSIS

As already described, the model chosen for the regression analysis is:

$$Pd = B_0 + B_1R + B_2P + B_3W + e$$

The price differential which is the dependent variable was obtained by subtracting the various locational prices from the respective central market price.

To determine which level of the dependent variable to use in the analyses, four preliminary analyses were made using the following level of price differentials:

$$Pd_{kitj}$$

where k = central market

i = relevant locations

t = mid-month

j = crop year

(a) A mid-month cross section for Kansas City price differential for November 1958

k = Kansas City

i.e. t = mid-November

j = 1958-59

(b) a crop-year average mid-month price differential for Kansas City for the period July 1958 to June 1959

k = Kansas City

i.e. t = mid-July, mid-August,, mid-June

j = 1958-59

(c) a period average mid-month price differential for Kansas City covering a period rail rates were unchanged from July 1958 to October 1960

k = Kansas City

i.e.

t = mid-July 1958 to mid-October 1960

(d) same month same period mid-month average price differential for Kansas City using the average of November 1958 and November 1959 mid-month differentials.

i.e.

t = mid-November 1958, mid-November 1959

The results given by stepwise regression program (KSU-13.6.002) which is an IBM-contributed program, revised by Doug Crank showed the following values for the coefficient of determination R^2 for each, corrected to three decimal places:

(a) $R^2 = 0.386$

(b) $R^2 = 0.291$

(c) $R^2 = 0.127$

(d) $R^2 = 0.107$

Since R^2 is a measure of the goodness of fit between alternative sets of independent variables, the simple mid-month price differentials were used for the rest of the analyses.

As has already been referred to, the multiple regression analysis was done by Kansas State University Computer using STEPWISE which is a canned IBM-contributed, KSU-revised (KSU-13.6.002) program written to perform a stepwise multiple regression on a set of variables, which are entered as input by observation. The program computes and prints averages, standard deviations, and correlation coefficients for all the variables, and for each step of the regression, reports the variable entered, the multiple correlation coefficient, the constant term, and the coefficient for each variable currently in the regression, in addition to several other useful statistics. A table of residuals may optionally be printed, as well as a listing of the input data.

The user may change existing variables or create new ones by transformations of the input data.

By looking at appendix D, it is noted that seven different rail rates were in effect during the period under study i.e. from July 1958 to June 1970. Also it must be remembered that the terminal markets under consideration were Kansas City, Salina, Hutchinson, Wichita all in Kansas and Enid, Oklahoma. In the light of the hypotheses one to three, it is desirable to have the results for a few points in time for each terminal so that the necessary tests can be made.

Since it has been decided to use a mid-month price differential, which month shall we use? It is desirable to use the same mid-month differential for all the analyses so that any comparisons over space and time would be more meaningful as any seasonal effect would be eliminated. It was decided to use mid-November differential for all the analyses for the following reason which may not be too important. It was reasoned that since the new wheat crop comes in each year between June and July, it was decided not to use either of these months or any close to them as this period presents uncertainty as to what the situation really is concerning total production, quality of the new crop, storage and transportation capacity to handle the new crop. This reason may not be too important because by looking at the differentials for each location, the figures are pretty much stable over any given year, for example a few random sample locations gave the following standard deviations of the differentials for Kansas City.

<u>Location</u>	<u>Crop year</u>	<u>Differential mean</u>	<u>Standard deviation</u>
Wellington	1959-60	21.92	2.07
Abilene	1960-61	22.50	1.67
Hutchinson	1961-62	28.17	2.12
Hays	1962-63	27.66	2.06

However other terminal differentials are not as consistent for a given year as that for Kansas City for example:

<u>Terminal</u>	<u>Location</u>	<u>Crop Year</u>	<u>Differential mean</u>	<u>Standard deviation</u>
Salina	Abilene	1958-59	-0.92	2.54
	Liberal	1965-66	-2.00	2.04
	Norton	1969-70	1.67	1.30
Hutchinson	Great Bend	1958-59	0.00	1.04
	McPherson	1965-66	-3.00	1.47
	Larned	1968-69	-3.42	2.84
Wichita	Emporia	1958-59	5.33	1.15
	Goodland	1964-65	-0.83	2.37
	Tribune	1969-70	-6.50	2.78
Enid, Oklahoma	Dodge City	1959-60	2.00	2.52
	Arkansas City	1964-65	2.16	3.16
	Pratt	1969-70	5.42	1.08

Deciding the relevant points for Kansas City was not as easy as it was for the other terminals where the grain dealers in these terminal markets were simply asked to supply the list of where they normally get their wheat grains from.

Consequently, the following method was used in deciding the relevant locations to use in regards to Kansas City differential regression. First, all the thirty one points were used in running the regression using mid-November 1958-59 crop year.

Southern District points (13) within the state were then eliminated from the regression as these were more likely to send their wheat to other terminal markets and to the gulf ports. After reading the results of the study by Wright in which he noted the increasing importance of wheat shipment by trucks and how twice as much wheat was trucked in the gulf ports direction

as was trucked to Kansas City from western Kansas in 1963,¹ it was decided to eliminate the three western district points from the regression as well. Here are the results of these test-runs.

<u>Number of Points</u>	<u>R²</u>
All 31 points	0.377
18 northern points (excluding 13 southern points)	0.427
15 remaining points (excluding 16 southern and western points)	0.173

On the basis of these results, it was decided to exclude the southern thirteen points from the regression to be run for the rest of the analyses for Kansas City. However in case trucking from western Kansas increased over time, it was decided to run the same regressions excluding the three western points as well. Judging by the criterion of the value of R^2 (the coefficient of determination) the eighteen point analyses gave better results on the whole than by using fifteen points in the analyses. The exceptions were in the analyses for mid-November of 1960-61, 1965-66 and 1969-70. Hence only the eighteen point results for Kansas City will be used in testing the hypotheses of the thesis.

It was mentioned at the beginning that mid-month wheat price information for all the counties was made available by the State Statistical Office and that it was hoped, these data would give better results because of the many more observations made. Counties in the southern districts were omitted

¹Bruce H. Wright, "Changes in Transportation Used by Country Grain Elevators in the North Central Region 1958-1963," Marketing Research Report No. 724, USDA, Economic Research Service, July 1965, Washington, D. C.

also before using this set of data for Kansas City differential analyses. The results from these two sets of data will be presented for each central market as A and B, B being the county data results. To minimize any confusion that may arise, the central markets are identified with the counties in which they are located, thus part B results which are actually county differential results are given the name of the respective central market located in it. It should be noted that part B results contain extra two variables in terms of moisture content (M) and dockage (D) which were not included in part A results because these were only available since the 1964 crop year. To maintain uniformity and to enhance the significance of any comparisons, these two terms were left out of part A results. The results for each terminal market will be presented separately and discussed separately before a final intermarket comparison is made.

RESULTS AND TESTS

The results and tests for the central markets are presented in the following order, Kansas City, Salina, Hutchinson, Wichita and Enid. Each result is in two parts, A and B. Part A contains the results of using town data and part B contains the results of using county data. Because Kansas City is the biggest eriminal market among them, analyses for many more crop years were done for it than for others. Consequently, for the Kansas City terminal there are eight results while for the others there are only four results. Because there was an across-the-board reduction of ten cents per hundredweight in October, 1964, results for November of that year and the following year were included in all the results to see if any differences exist for just a month after rate reductions and a year after rate reductions.

In testing hypothesis number one which says that there is a correlation between the wheat price differential of a given central market and the rail rates from the various locations, the following standard test given by books on statistics and econometrics¹ for testing the significance of an estimated simple correlation coefficient is used.

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

where t is the T-variate with n-2 degrees of freedom

r = estimate of simple correlation coefficient

n = number of observations

The test of hypothesis number two which asserts that the rail rate

¹For example see J. Johnston, Econometric Methods (New York: McGraw-Hill Book Company, 1960) P. 33 or see H. C. Fryer, Concepts and Methods of Experimental Statistics (Boston: Allyn and Bacon, Inc., 1966) P. 226.

factor is the most significant independent variable in the function is by testing the significance of rail rate coefficients in the regression equations and how it compares to the significance of other independent variables included in the regression. The test criterion is how the T-values calculated with the coefficients compare with critical T-values from the tables. The critical T-values have $n-k-1$ degrees of freedom¹ where they are n observations and k independent variables. This is for separate tests of the coefficients.

The joint test for the coefficients of all the independent variables taken together is by comparing the "goodness of fit F" values shown with critical F values from tables. The critical F test statistic has $(k, n-k-1)$ degrees of freedom.² This test statistic should tell us, how significant the independent variables included in the regression equations are.

Test of hypothesis number three which asserts that the relative influence of rail rates vary over time and space is divided into two parts. We will defer the spatial part till we have considered the results of all the other markets. The test for the intertemporal part is by comparing the coefficients of rail rates for the different regressions for the same market to see how much they differ. The spatial part which will be tested at the end, will be by comparing the results of one market with another for the same period of time.

¹For example see David S. Huang, Regression and Econometric Methods (New York: John Wiley and Sons, Inc., 1970) P. 91 or J. Johnston, Econometric Methods (New York: McGraw-Hill Book Company, 1960) P. 118.

²See David S. Huang, Regression and Econometric Methods (New York: John Wiley and Sons, Inc., 1970) P. 103 or see J. Johnston, Econometric Methods (New York: McGraw-Hill Book Company, 1960) P. 122.

Kansas City Differential Tests and Results

The results for Kansas City market differentials are summarized in Tables 1A and 1B. Table 1A contains the results of using eighteen points for the regression while Table 1B contains the results of using county data.

1. Test of hypothesis number one:

For mid-November 1958-59 regression, the correlation coefficient between the price difference and rail rates is -0.455 , $n = 18$

$$\begin{aligned}\therefore t &= \frac{-0.455 \sqrt{18-2}}{\sqrt{1-(0.455)^2}} \\ &= -2.044\end{aligned}$$

From tables, $t_{.05}(16) = 2.120$

Hence we conclude that the sample correlation coefficient is not significant at 5 percent level, but it is significant at 10 percent level because $t_{.01}(16) = 1.746$.

With the same method, those simple correlation coefficients found significant at $\alpha = 0.05$ are marked with an "a" while those found significant at $\alpha = 0.02$ have the "b" marks. By looking at Table 1A, we can therefore conclude that half of the years analyzed showed significant correlation between the price difference and rail rates. Since the price differential for Kansas City was always positive, and the signs of all the significant simple correlations are positive, we can say that as rail rates increase, so does the differential. It is worthy of note that the significant correlations only started after the rail rate reduction of ten cents took place on October 15, 1964. The correlation for 1968-69 is strikingly very small and insignificant. This could be attributed to the fact that between June and August 1968, there were two or three rate changes and this period was one of uncertainty (see note

TABLE 1A
Summary of Results for Kansas City Terminal Using the Model $Pd = B_0 + B_1Rr + B_2P + W + e$
(T-Values are in parentheses)

Mid-November Crop Year	Date of Effective Rail Rate	Constant Term	Rr	P	W	R ²	Se	Goodness of Fit F	Simple Correlation of For Pd & Rr Obser- vations	Number
1958-59	not known	5.880	-0.089 (-0.863)	-1.856 (-1.426)	0.694 (0.735)	0.427	2.688	(3,14)=3.476	-0.455	18
1960-61	October 24 1960	-18.861	0.240 (1.588)	-1.401 (-0.786)	0.820 (1.044)	0.241	4.031	(3,14)=1.483	0.378	18
1963-64	October 24 1960	46.914	0.207 (1.581)	-0.573 (-0.449)	-0.343 (-0.251)	0.171	3.446	(3,14)=0.961	0.398	18
1964-65	October 15 1964	-115.678	0.047 (0.357)	1.989 (1.475)	1.848 ^a (2.416)	0.610	2.249	(3,14)=7.306	0.667 ^b	18
1965-66	October 15 1964	48.823	0.217 ^a (2.353)	0.066 (0.065)	-0.546 (-0.798)	0.334	2.693	(3,14)=2.341	0.551 ^b	18
1967-68	October 15 1964	99.500	0.675 ^b (7.151)	-0.641 (-0.899)	-1.401 (-1.840)	0.807	2.319	(3,14)=19.568	0.870 ^b	18
1968-69	July 1 1968	13.359	0.434 ^a (2.471)	-4.891 ^b (-3.259)	0.828 ^b (3.188)	0.433	3.580	(3,14)=3.562	0.032	18
1969-70	April 1 1969	160.403	0.773 ^b (5.173)	-5.720 ^b (-2.784)	-1.527 (-1.719)	0.664	3.437	(3,14)=9.208	0.666 ^b	18

where Pd = price difference in cents per bushel
Rr = rail rates in cents per cwt
P = percent protein content
W = test weight in pounds per bushel
R² = coefficient of determination

Se = standard error of estimate
a indicates significance at $\alpha = 0.05$
b indicates significance at $\alpha = 0.02$

TABLE 1B

Summary of Results for Kansas City Terminal Using County Data for the Model $Pd = B_0 + B_1Rr + B_2P + B_3W + B_4M + B_5D + e$

(T-values are in parentheses)

Mid-Nov. Crop Year	Date of Rail Rate Effective	Constant Term	P	W	M	D	R ²	Se	Goodness of Fit for Pd and Rr	Simple Corre- lation of Pd and Rr	Number of Obser- vations
1967-68	October 15 1964	36.488	0.633 ^b (11.518)	-0.343 (-0.759)	0.454 (0.460)	-0.099 (-0.130)	0.786	2.563	(5,58)=42.595	0.880 ^b	64
1968-69	July 1 1968	151.987	-5.832 ^b (-7.976)	-0.447 (-0.485)	-2.292 ^a (-2.058)	-3.159 ^b (-3.534)	0.728	3.165	(5,53)=28.415	-0.337 ^b	59
1969-70	April 1 1969	135.355	0.464 ^b (6.610)	-0.992 ^a (-2.366)	-1.684 (-1.395)	-0.745 (-0.686)	0.540	2.795	(5,54)=12.700	0.531 ^b	60

where Pd = price difference in cents per bushel

Rr = rail rates in cents per cwt

P = percent protein content

W = test weight in pounds per bushel

M = percent moisture content

D = percent dockage

R² = coefficient of multiple determination

Se = standard error of estimate

^a indicates significance at $\alpha = 0.05$

^b indicates significance at $\alpha = 0.02$

attached to Nebraska portion, Kansas City Board of Trade Rate Book No. 31).

The second part of hypothesis number one states that the relevant central market gives the better correlation. The only way to test this portion is to recall the value of the simple correlation (r) between P_d and R_r from the preliminary analysis for Kansas City which used all the thirty one points before points in southern counties were eliminated to leave eighteen points. The value of r from that first analysis (not recorded in this paper) was -0.442 which is smaller in absolute value than the value of r given in Table 1A for 1958-59 (-0.455) which used 18 of the 31 points from the same set of data. Also in using the county data, using all the 105 counties in the Kansas City differential an r value of 0.767 was obtained and when southern counties thought not relevant were dropped from the differential, r value of 0.880 was obtained. The first value is not recorded in this paper but the second which used 64 of the remaining counties after the southern counties were dropped is that listed in Table 1B for 1967-68 result. From these two results, we can surmise if not conclude, that the relevant central market gives the better correlation between the wheat price differential and rail rates.

2. Test of hypothesis number two:

In testing the second hypothesis which states that the rail rate factor is the most significant independent variable in the function, we could examine how significant the rail rate coefficient is relative to other variables. By looking at Table 1A, we could rank the regressors (independent variables) in the order of their significance for each result using the absolute T -value criterion. Ranking the regressors R_r , P and W as first, second and third and by using the numerals 1, 2 and 3 to represent the ranks accordingly, we have the following result:

<u>Crop-Year</u>	<u>Ranks of</u>		
	<u>Rr</u>	<u>P</u>	<u>W</u>
1958-59	2	1	3
1960-61	1	3	2
1963-64	1	2	3
1964-65	3	2	1
1965-66	1	3	2
1967-68	1	3	2
1968-69	3	1	2
1969-70	<u>1</u>	<u>2</u>	<u>3</u>
Total	13	17	18

By totalling the scores of each regressor, the one with the least total is most significant on the average. Hence rail rates were selected as being the most significant on the average while protein content is second most significant on the average but its position over that of the test weight is doubtful (compare 17 against 18). If the same ranking test were done for Table 1B, the order would be Rr, P, W, M and D where M is moisture content and D is dockage. If we want to know the significance of each independent variable at any particular time, all we need to do is to compare the calculated T-values for each with table T-values with $n-k-1$ degrees of freedom. The level of significance of each at any time is indicated by the symbols "a" and "b". For example since $n = 18$ in Table 1A, and $k = 3$, $t_{.05}(14) = 2.145$ from tables. If the absolute value of calculated T statistic is greater than this, we say it is significant at 5 percent level. Taking our level of significance at 5 percent ($\alpha = 0.05$) we notice that rail rates become significant for the first time in 1965-66 in Table 1A and continued being significant to the end of the analysis. Rail rates were significant for all the three results of Table 1B.

Protein content was significant only for the last two years of Table 1A while dockage was significant only in 1964-65 and 1968-69. Once again, rail rates show up as being the most significant in Tables 1A and 1B.

Protein content shows up as the second most significant in Table 1B while no definite decision can be made concerning the position of moisture content, test weight and dockage.

The joint test of the significance of all the variables taken together is by using the F ratio values listed as "Goodness of Fit F." This F statistic has the degrees of freedom (k, n-k-1). From tables, the critical $F_{.05}(3,14) = 3.34$. By comparing this value with the calculated values, we notice that in Table 1A, the regressors were significant for all the years except in 1960-61, 1963-64 and 1965-66. Similarly by comparing the F values in Table 1B with the appropriate critical F values, we notice that the regressors were all highly significant for all the three years even at one percent level.

To summarize, whatever criterion we use either by ranking or separate tests, the rail rate variable show up as being the most significant among the variables in both Tables 1A and 1B.

3. The third hypothesis is divided into two parts, the spatial part and the intertemporal part. We defer the spatial part till we have considered the results of the other central markets.

To see if the relative influence of rail rates remain the same over any period rates stayed the same, we compare the regressions for 1960-61 and 1963-64 because these two had the same rate level. We note that there is not much difference between the coefficients of rail rates 0.240 in 1960-61 and 0.207 in 1963-64. If we had more points in time for this period, we could

have concluded that the relative effects of rail rates stayed the same over this period more especially so since the T-values are almost identical.

In October 1964, an across-the-board rate reduction of ten cents per hundredweight took place and we notice that the rate coefficient dropped drastically also and was not statistically significant. A year later, rail rates coefficient increased from 0.047 to 0.217, almost what it used to be before the rate reduction in 1964. By 1967-68, the coefficient has risen substantially to 0.675 and was very highly significant but this time we notice that though the same rate level prevailed from October 1964 to June 1969, the rate coefficient rose from 0.047 to 0.675 and from being statistically insignificant to very significant. This period is a marked contrast to the immediate preceding period when the rate coefficients stayed almost the same from 1960-61 to 1963-64. It is likely that the people involved became more sensitive to rate levels and therefore gave more attention to it than in the past or it could be that when the railroad companies decreased their rates in 1964-65 to meet competition from trucks, they gradually gained back more of the market and hence the increasing importance of rail rates in the price difference.

We notice that when rates were lowered slightly in 1968-69, the coefficient of R_r dropped from 0.675 to 0.434 and when rates were increased in 1969-70 rail rate coefficient again rose to 0.773.

To bring out the contrast of rail rate coefficient fluctuations with the coefficients of the other regressors and the constant term, graphs 7 and 8 were plotted. The graphs show that the coefficients of rail rates are more stable than that of the other regressors with the constant term coefficient fluctuating most wildly.

In addition to the regressions considered above for Kansas City, a

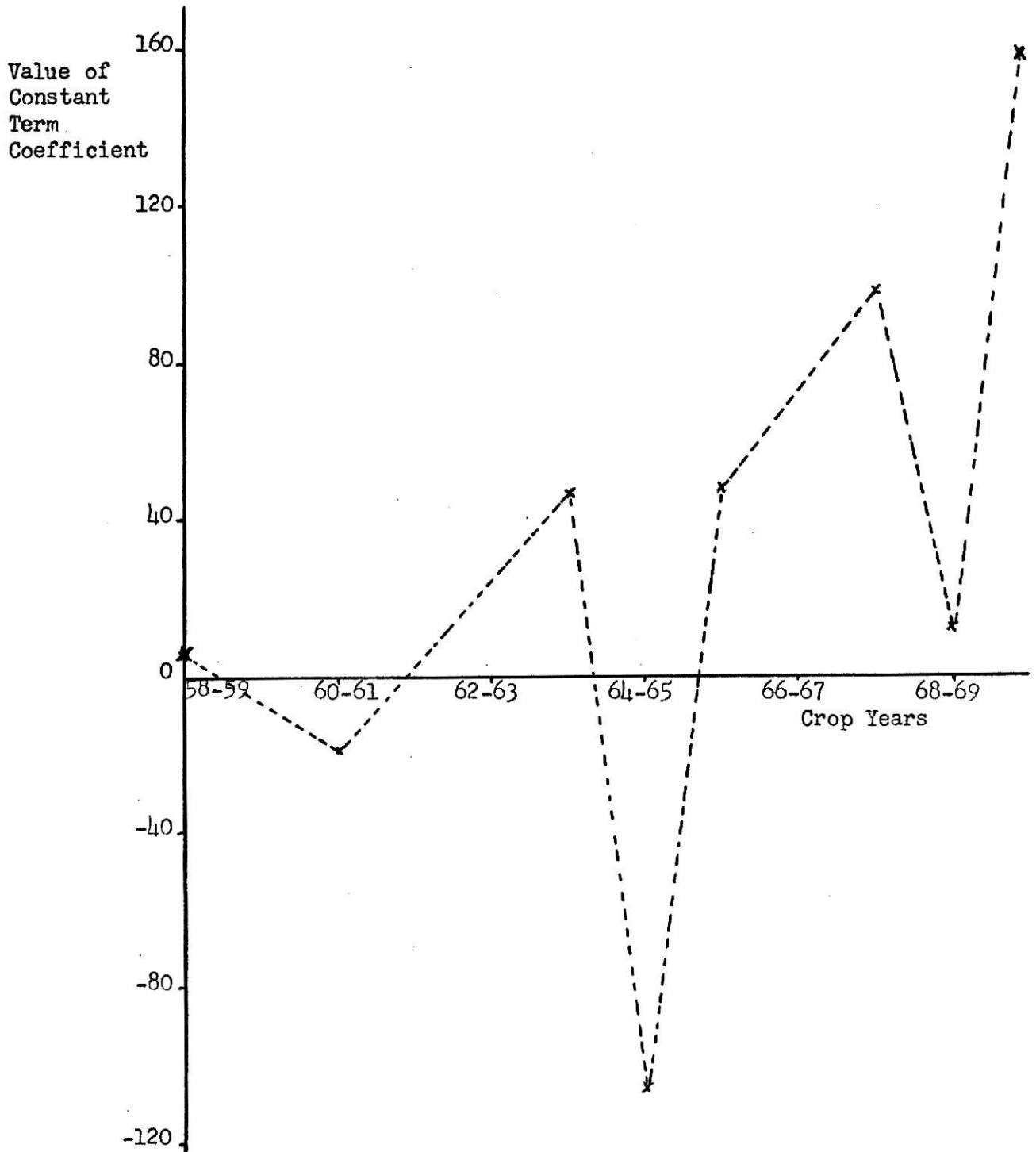


Fig. 7. Graph showing fluctuating value of the constant term coefficient in Kansas City differential regression over the crop years.

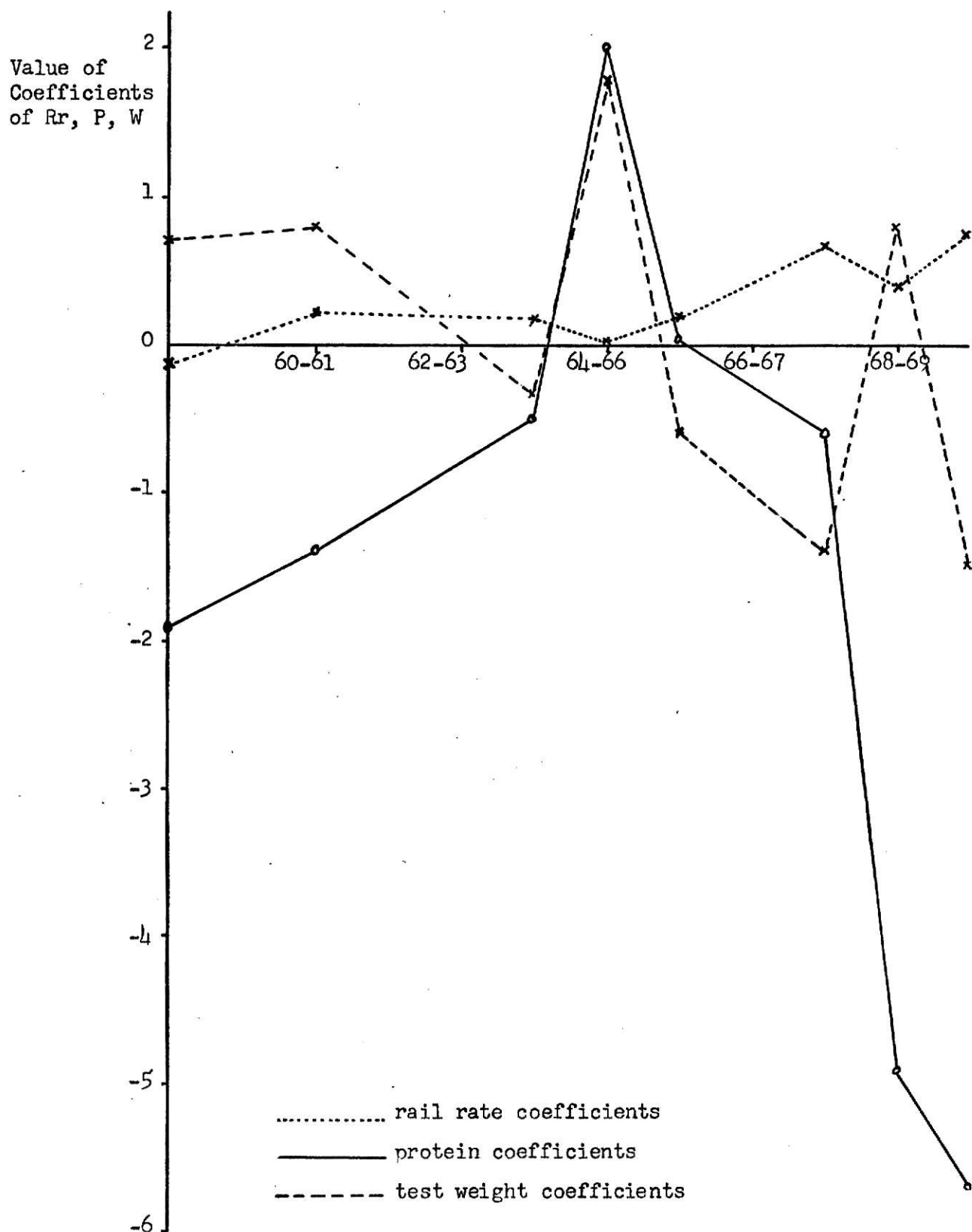


Fig. 8. Values of coefficients of independent variables for Kansas City differential over the crop years.

kind of mid-November cross-sectional analysis over the entire period was made by combining all the mid-November data for the eighteen points over the twelve year period. The summary of results from the computer output for this analysis is given below.

$$Pd = 65.658 + 0.207 Rr + 0.199 P - 0.337 W$$

$$(T\text{-values}) \quad (5.973) \quad (2.221) \quad (-10.830)$$

$$Se = 4.366$$

$$R^2 = 0.418$$

$$\text{Goodness of Fit } F(3,212) = 50.724$$

$$n = 216$$

The symbols have the same meaning as listed in Table 1A.

The coefficients of Rr and W are highly significant judging by their T -values while surprisingly that of protein content is only significant at 5 percent level. This could mean that over time, the test weight is more important in reducing the differential than the protein content. Rail rates without any surprise has a positive coefficient. It seems that the advantage derived from a high test weight is bigger in the long run than the advantage due to a higher protein content. This result is all the more surprising when we consider the simple mid-month regressions of Tables 1A and 1B where the protein content tend to come ahead of test weight in being more significant and tends to have an opposite sign to the constant term thus seeming to decrease the differential more than test weight does.

Salina Differential Results and Tests

The points whose differentials were included in the regression for the Salina subterminal market were obtained by simply asking the grain dealers in Salina to supply the list of the places from which they normally get their wheat. The results for Salina are presented in Tables 2A and 2B. Table 2A shows the results of using the town data, while 2B shows the result of using county data. Once again, Table 2B contains two extra variables, moisture content (M) and dockage (D). These terms were not included in 2A analyses because they were not available from the beginning of the period covered by those analyses. All the analyses used the mid-November differentials for the year listed. Here only four regressions were given structure namely those for 1958, 1964, 1965 and 1969.

Since the same routine tests as were done for the Kansas City results were followed here, only the highlights in this market will be pointed out with respect to the three hypotheses.

1. With respect to hypothesis number one, t-test was used to test the significance of the simple correlation between the differential and rail rates. The only significant correlation in Table 2A was in 1969-70 while Table 2B result shows significant correlation in 1967-68 only. This set of results confirm the deductions from earlier scatter diagrams which show almost no relationship between the differential and rail rates taken alone without considering other factors as well.

2. In testing hypothesis number two, the significance of the rail rate coefficients in the regression equations was considered. The T-values in Table 2A show that rail rates were significant in the regression at 5 percent level only in 1969-70. Prior to this date, we may infer that rail rates

TABLE 2A
Summary of Results for Salina Terminal Market Obtained from the Computer Output for the Model
 $Pd = B_0 + B_1Rr + B_2P + B_3W + e$

(T-Values are in parentheses)

Mid-November Crop Year	Date of Effective Rail Rate Term	Constant	Rr	P	Coefficients of		R ²	Se	Goodness of Fit F	Simple Correlation For Pd & Rr Obser- vations	Number of Observations
1958-59	July 1 1958	23.460	0.105 (0.979)	-2.029 (-1.441)	W	-0.072 (-0.078)	0.164	3.209	(3,14)=0.918	0.020	18
1964-65	October 15 1964	-97.032	-0.060 (-0.421)	1.621 (1.126)	W	1.255 (1.050)	0.145	2.544	(3,14)=0.792	0.245	18
1965-66	October 15 1964	70.553	-0.010 (-0.110)	-0.136 (-0.159)	W	-1.157 ^a (-2.301)	0.279	2.298	(3,14)=1.804	0.072	18
1969-70	April 1 1969	188.271	0.483 ^a (2.538)	-4.252 (-1.494)	W	-2.511 (-1.035)	0.344	4.582	(3,14)=2.452	0.490 ^a	18

where Pd = price differential

Rr = rail rates

P = % protein content

W = weight per bushel (test weight)

R² = coefficient of determination

Se = standard error of the estimate

^a indicates significance at $\alpha = 0.05$ by conventional tests.

^b indicates significance at $\alpha = 0.02$ by conventional tests.

From tables $t_{.05}(14) = 2.145$
 $t_{.02}(14) = 2.624$

TABLE 2B
Summary of Results for Salina Terminal for the Model $Pd = B_0 + B_1Rr + B_2P + B_3W + B_4D + B_5e$
(T-values are in parentheses)

Mid-Nov. Crop Year	Using County Data Date of Rail Rate Effective	Constant Term	Rr	P	W	M	D	R ²	Se	Goodness of Fit for Pd and Rr	Simple Correlation for Pd and Rr	Number of Observations
1967-68	October 15 1964	34.932	0.101 (1.012)	-0.991 (-0.787)	0.453 (0.397)	-3.752 (-1.682)	-0.245 (-0.245)	0.518	2.868	(5,13)=2.792	0.609 ^b	19
1968-69	July 1 1968	282.072	0.006 (0.095)	-6.425 ^b (-8.453)	-2.654 ^b (-8.612)	-4.038 ^b (-5.248)	1.443 (1.742)	0.971	1.667	(5,13)=86.917	-0.116	19
1969-70	April 1 1969	152.124	0.246 ^a (2.472)	-5.161 ^b (-3.211)	-1.684 (-1.253)	0.139 (0.129)	0.362 (0.462)	0.527	2.507	(5,13)=2.895	0.313	19

where Pd = price differential
Rr = rail rates in cents per cwt
P = percent protein content
W = test weight (weight per bushel)
M = percent moisture content
D = dockage (percent)
B_i = unknown coefficients

R² = coefficient of determination
Se = standard error of estimate

^a indicates significance at $\alpha = 0.05$
^b indicates significance at $\alpha = 0.02$

From tables $t_{.05(13)} = 2.160$
 $t_{.02(13)} = 2.650$

did not play a significant role in the Salina differential during the period covered by this study. The same result for rail rates hold when we consider Table 2B results. If rail rates were not significant, which factors were significant? The significance of the other factors are indicated by the symbols "a" and "b". In Table 2A, test weight was significant only in 1965-66 regression. In Table 2B, protein was significant in 1968-69 and 1969-70 while the factors test weight and moisture content were significant in 1968-69. The dockage factor did not show any significance at any time during the period.

3. With respect to hypothesis number three, we only note the changes in rail rate coefficients over time here. Rail rate coefficients showed a decrease from 1958-59 to 1964-65 and a slight increase in 1965-66 and what may be considered a big jump in 1969-70 which also became statistically significant.

To be able to compare the changes in rail rate coefficients with changes in the coefficients of other variables, graphs of the four points were made and are shown in Figures 9 and 10. Here again the stable, though small effect of rail rates is again demonstrated in contrast to the volatile coefficients of the other factors. Here as in Kansas City results, we note the rising positive coefficient value of rail rates toward the end of the period covered by this study.

Since not many of the coefficients were significant at any time except in Table 2B 1968-69, the question of how well the independent variables fit the regression can be decided by comparing the "Goodness of Fit F" values calculated with the appropriate critical table values. If this is done, it would be found that the regressors in Table 2A were not

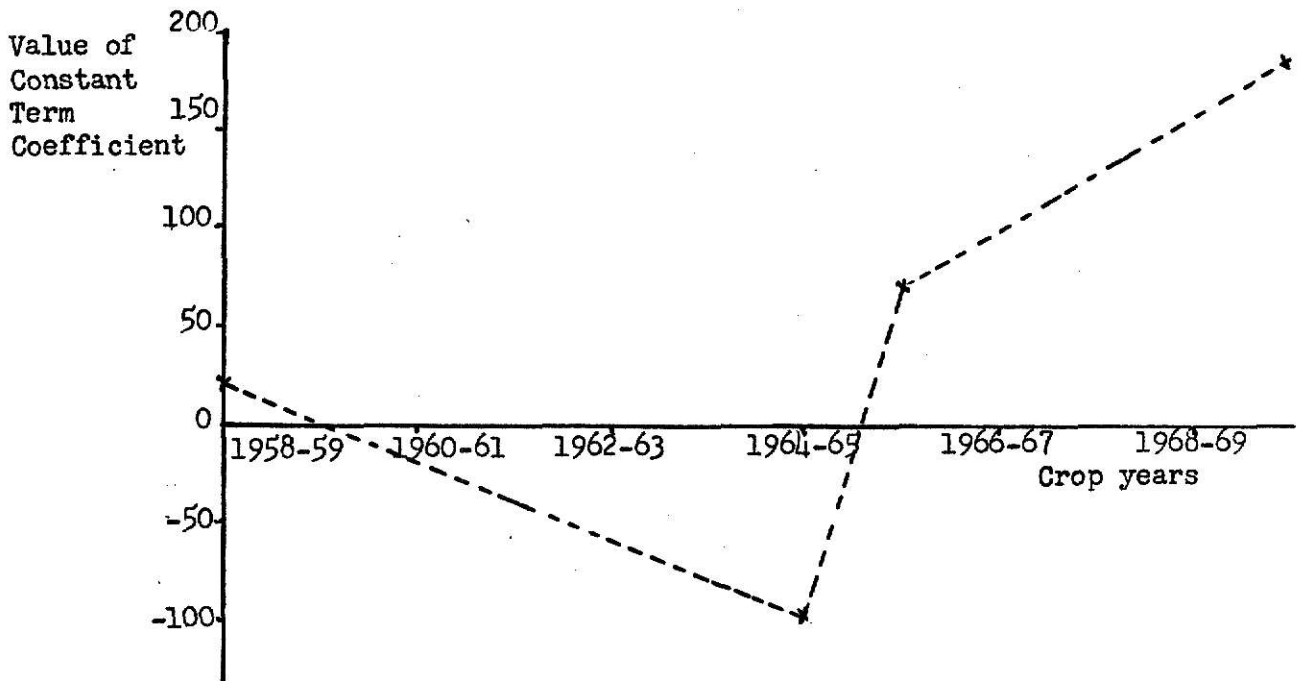


Fig. 9. Salina constant term coefficient values over the crop years.

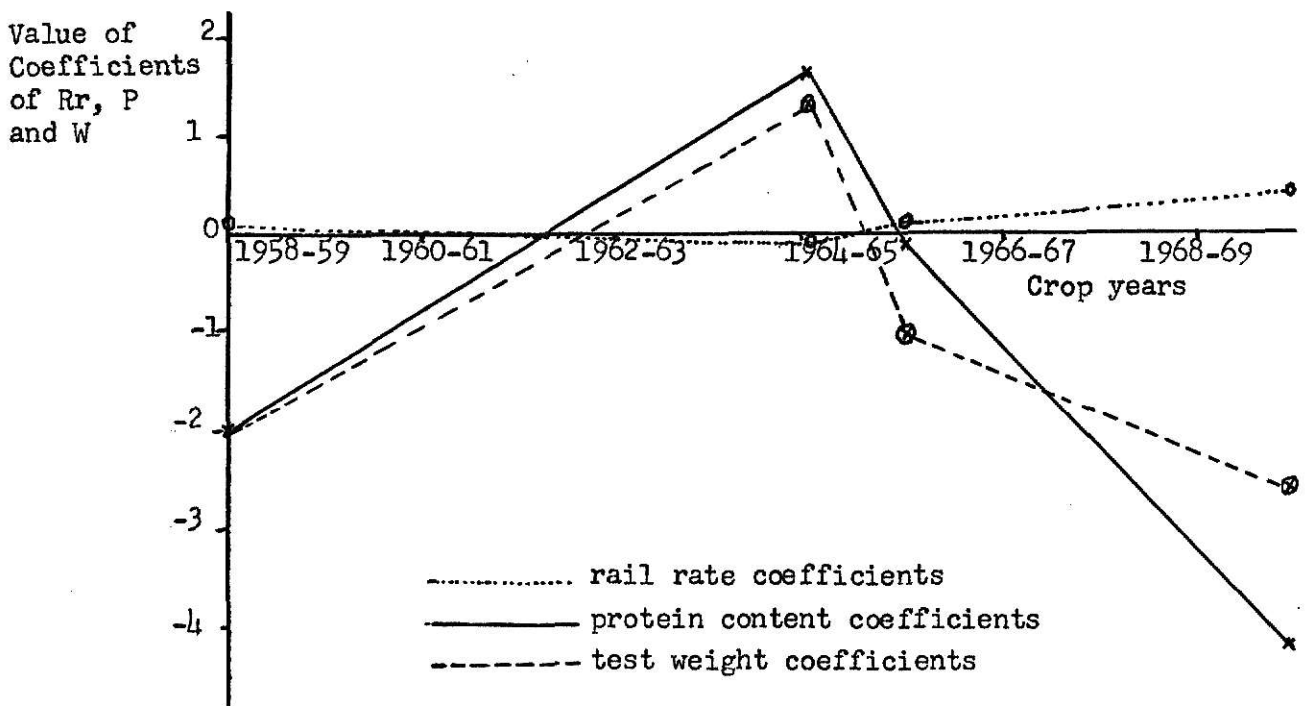


Fig. 10. Salina coefficients of regression of various factors over the crop years.

significant at 5 percent level. A similar test for Table 2B would show that the regressors were highly significant in 1968-69 Salina result. These results may mean that Salina central market differential has other factors which are important in determining the differentials which are not included in these regressions, or it may mean that there is not much pricing of wheat using Salina as the basing point, or it could mean that the places used in the regression price their wheat in respect to Salina in an arbitrary manner and therefore not very suited to this type of analysis for explanation or that the true rates are transit rates, not the flat rates used in the analyses.

Hutchinson Differential Results

The points included in the regression for this terminal market were determined similarly to the Salina case by asking the grain dealers in Hutchinson. Similar steps were taken in the analyses and the results are summarized in Tables 3A and 3B. Table 3B contains the result of using county data.

1. Test of hypothesis number one:

By using the t-test mentioned earlier, it is found that none of the simple correlation coefficient between the price differential and rail rates in Table 3A is significant while those for 1967-68 and 1968-69 results in Table 3B are found to be very significant even at two percent level. Left to Table 3A results alone, it would have been concluded that rail rates did not play a significant role in the Hutchinson wheat price differential during the years of the period included in the analyses. However the results of the years 1967-68 and 1968-69 in Table 3B show high correlation and hence we can say rail rates played a significant role in the differential of those two years. Since the correlations take the same sign as the average differential, (not shown) we can say that the average differential increases as the rail rates increase.

2. Test of hypothesis number two:

Here again the T-values for the coefficients of rail rates show that rail rates were not significant as explanatory variable in the regressions of Tables 3A and 3B. If rail rates were not significant explanatory variables, which other factors were significant? The T-values for the other regressors show that protein content and test weight were significant in 1958-59 regression equation and in 1969-70, only protein content was significant

TABLE 3A
Summary of Results for Hutchinson Terminal Market for the Model $Pd = B_0 + B_1Rr + B_2P + B_3W + e$
(T-values are in parentheses)

Mid-November Crop Year	Date of Effective Rail Rate Term	Constant	Rr	P	Coefficients of W	R ²	Se	Goodness of Fit F	Simple Correlation For Pd & Rr	Number of Observations
1958-59	July 1 1958	76.702	0.070 (0.740)	-3.263 ^a (-2.680)	-0.700 ^b (-3.199)	0.691	1.710	(3,7)=5.2078	0.468	11
1964-65	October 15 1964	-76.692	-0.109 (-0.539)	0.239 (0.157)	1.207 (0.696)	0.083	2.774	(3,7)=0.212	-0.106	11
1965-66	October 15 1964	-43.099	-0.053 (-0.413)	-0.256 (-0.130)	0.725 (0.534)	0.262	2.109	(3,8)=0.949	-0.430	12
1969-70	April 1 1969	113.687	0.335 (1.854)	-6.499 ^a (-2.841)	-0.746 (-0.357)	0.784	2.362	(3,7)=8.460	0.273	11

where Pd = price difference in cents per bushel
Rr = rail rates in cents per cwt
P = percent protein content
W = test weight in pounds per bushel
R² = coefficient of determination
Se = standard error or estimate
^a indicates significance at $\alpha = 0.05$
^b indicates significance at $\alpha = 0.02$

TABLE 3B
Summary of Results for Hutchinson Terminal Market Using County Data for the Model
 $Pd = B_0 + B_1Rr + B_2P + B_3W + B_4M + B_5D + e$
(T-values are in parentheses)

Mid-Nov. Crop Year	Date of Rail Rate	Constant Term	Rr	P	Coefficients of			D	R ²	Se	Goodness of Fit for Pd F	Simple Corre- lation of Pd and Rr	Number of Obser- vations
1967-68	October 15 1964	-43.950	0.0130 (0.155)	0.965 (0.968)	0.321 (0.430)	-0.258 (-1.027)	6.705 ^b (4.172)	0.654 2.354	0.530 ^b	6.798	(5,18)	0.530 ^b	24
1968-69	July 1 1968	257.937	-0.046 (-0.581)	-4.788 ^b (-5.799)	-2.601 ^a (-2.134)	-3.297 ^a (-2.529)	-0.499 (-0.532)	0.847 2.181	0.591 ^b	19.954	(5,18)	-0.591 ^b	24
1969-70	April 1 1969	-56.255	0.105 (1.145)	-0.586 (-0.483)	1.086 (0.896)	-0.676 (-0.639)	1.089 (1.146)	0.343 2.110	0.394	1.878	(5,18)	0.394	24

where Pd = price differential
Rr = rail rates in cents/cwt
P = percent protein content
W = test weight in lbs.
M = % moisture content
D = % dockage

R² = coefficient of determination
Se = standard error of estimate

a indicates significance at $\alpha = 0.05$
b indicates significance at $\alpha = 0.02$

(Table A). The results of 1964-65 and 1965-66 show that none of the explanatory variables was significant in those two years of Table 3A. When we turn to Table 3B, we find that only the dockage variable was significant in the 1967-68 regression equation and was highly significant. In the 1968-69 regression, protein content, test weight and moisture content were significant while none showed any significance in 1969-70 regression.

The question then arises, how good are the fits of the regression independent variables in explaining the price differential for Hutchinson? The judgement criterion here are the computed "Goodness of Fit F" values. These show that the regressors were significant at 5 percent level in 1958-59 and at 2.5 percent level in 1969-70 of Table 3A. Results of Table 3B show that the regressors were significant even at one percent level in 1967-68 and in 1968-69 regression equations, while there was no significance in 1969-70 result.

To summarize, rail rates were not significant explanatory variables for Hutchinson at 5 percent level in any of the years while some of the other factors show some significance some of the time. The goodness of fit of the regressors were significant in two out of four years for Table 3A and two out of three years for Table 3B.

3. Test of trend of the relative effect of rail rates:

The purpose of this hypothesis was to detect any trend in the sizes of the coefficients of the regressors. Except for moisture content coefficient which was always negative in Table 3B, nothing definite can be said about the signs of the others, which are sometimes positive and sometimes negative in both Table 3A and 3B. About the relative absolute values of the coefficients, it was noted again that the constant term is always large while that of rail rates is always the smallest. Nothing definite can

be said about the relative values of the coefficients of the other regressors. The trends here are as unpredictable as for the other markets we have considered.

Wichita Differential Results

The results of the multiple regression analysis done for Wichita terminal market wheat price differential are summarized in Tables 4A and 4B. Examination of these results with respect to the three hypotheses earlier proposed is discussed below.

1. The simple correlation between the price difference and rail rates shown in Table 4A was not significant at any time when examined at 5 percent level. Examination of the same hypothesis using the results of Table 4B show significant correlation between the price difference and rail rates in 1967-68 and 1969-70 results. Both correlations take the same sign as the average differential indicating that as rail rates increase, so does the price difference. This is reasonable because you can expect the price difference between two points to rise as the cost of shipping rises. However because this correlation never showed as significant in Table 4A at any time, it may not always be so.

2. Hypothesis number two states that the rail rate factor is the most significant independent variable in the function. Examining the rail rate coefficients in Table 4A and comparing their calculated T-values with the critical T-values from tables show that rail rates were significant in 1958-59 and 1969-70 regressions but were far from being significant at the appropriate significance levels at other times. Rail rates were significant for all the three years of Table 4B. For an over all conclusion we may say that rail rates were significant in the differential price of Wichita at least towards the end of the period.

Examination of the significance of the other factors shows protein content to be almost as equally significant as rail rates sometimes exceeding

TABLE 4A
Summary of Results for Wichita Terminal Market for the Model $Pd = B_0 + B_1Rr + B_2P + B_3W + e$
(T-values are in parentheses)

Mid-November Crop Year	Date of Effective Rail Rate	Constant Term	Rr	P	Coefficients of		R ²	Se	Goodness of Fit F	Simple Correlation For Pd & Rr	Number of Observations
					W	P					
1958-59	Not known	26.385	0.160 ^b (3.323)	-3.422 ^b (-5.211)	0.136 (0.264)		0.707	1.704	(3,16)=12.872	0.108	20
1964-65	October 15 1964	0.688	0.003 (0.328)	0.027 (0.193)	-0.023 (-0.204)		0.048	0.267	(3,11)= 0.219	0.188	15
1965-66	October 15 1964	47.055	0.065 (0.480)	-0.986 (-0.440)	-0.655 (-0.461)		0.034	2.879	(3,12)= 0.140	0.115	16
1969-70	April 1 1969	47.830	0.508 ^b (3.069)	-5.463 ^a (-2.227)	-0.025 (-0.278)		0.478	4.806	(3,11)= 3.360	0.470	15

where Pd = price difference in cents per bushel
Rr = rail rates in cents per cwt
P = percent protein content
W = weight per bushel in pounds
B_i = regression coefficients
R² = coefficient of determination
Se = standard error of estimate

^a indicates significance at $\alpha = 0.05$
^b indicates significance at $\alpha = 0.02$

TABLE 4B
Summary of Results for Wichita Terminal Market Using County Data for the Model
 $Pd = B_0 + B_1Rr + B_2P + B_3W + B_4M + B_5D + e$

(T-values are in parentheses)

Mid-Nov. Crop Year	Date of Rail Rate Effective	Constant Term	Rr	P	Coefficients of			D	R ²	Se	Goodness of Fit for Pd and Rr	Simple Corre- lation of Obser- vations
					W	M				F		
1967-68	October 15 1964	-14.449	0.170 ^a (2.450)	0.238 (0.306)	0.017 (0.294)	0.199 (0.128)	2.869 ^a (2.302)	0.643	2.432	(5,23)=8.278	0.737 ^b	29
1968-69	July 1 1968	170.395	0.135 ^a (2.395)	-6.143 ^b (-10.402)	-1.119 (-1.381)	-2.858 ^b (-3.966)	0.836 (1.261)	0.955	1.280	(5,13)=55.360	-0.308	19
1969-70	April 1 1969	97.564	0.295 ^b (6.710)	-4.956 ^b (-5.373)	-0.750 (-1.235)	0.263 (0.367)	-1.177 (-1.392)	0.823	1.590	(5,13)=12.099	0.524 ^a	19

where Pd = price difference in cents per bushel
Rr = rail rates in cents per cwt
P = percent protein content
W = weight in pounds per bushel
M = percent moisture content
D = percent dockage
B_i = regression coefficients
R² = coefficient of determination
Se = standard error of estimate

^a indicates significance at $\alpha = 0.05$
^b indicates significance at $\alpha = 0.02$

rail rate significance, for example 1958-59 of Table 4A and 1968-69 of Table 4B. Test weight was not found significant at any time in either table. The dockage factor was significant only in 1967-68 regression and moisture content factor was only significant in 1968-69 in Table 4B. We may conclude that though rail rates are significant in the differential pricing of Wichita wheat, other factors may at times be equally or more important.

3. With regards to hypothesis, number three, the coefficients of rail rates decreased from its value in 1958-59 (0.160) to its value in 1964-65 (0.003) and subsequently rose in its 1965-66 value and still rose to its 1969-70 value (0.508). This pattern seems to follow the pattern of rail rate changes (see any of the Appendices to note when rates changed). It is noteworthy here that the signs of the coefficients of rail rates were always positive in both results of Table 4A and 4B and nearly always the smallest in magnitude. This means that though the relative effect of rail rates on the differential is small, it is definitely positive. The signs and magnitudes of the coefficients of the other factors are as volatile as ever.

Enid Differential Results

As has been alluded to, Enid, Oklahoma, is a sub-terminal market on the railroad lines going to the gulf ports and is sufficiently close to draw some of its wheat from the southern parts of the state of Kansas. The analyses results for this terminal market are discussed below in the light of the proposed hypotheses. Tables 5A and 5B contain the summary of the analyses with 5A containing the results for town data while 5B contains the results of using county data.

Test of hypotheses:

1. The simple correlation between the price differential and rail rates are not significant at 5 percent level as can be seen by the values tabulated in Table 5A. However the values of the same simple correlation in Table 5B are all significant with some significant even at 2 percent level. Since the simple correlations take the same sign as the average differential, (not shown) we see here again that as rail rates increase, so does the differential.
2. In testing the significance of rail rate variable in the regression equations, the T-values accompanying it were compared with the critical table values and by doing so it was found that none of the coefficients of rail rates in Table 5A is significant at 5 percent level but was significant at 10 percent level in 1969-70 only. In turning to Table 5B, two out of three rail rates coefficients were significant at 2 percent. If rail rates were not significant, which factors were significant? In Table 5A, protein content is significant in 1958-59 and none of the other factors at any other time showed significance at 5 percent level. This conclusion is confirmed by observing "goodness of fit F" values shown which none turn out to be

TABLE 5A
Summary of Results for Enid Terminal Market for the Model $Pd = B_0 + B_1Rr + B_2P + B_3W + e$
(T-values are in parentheses)

Mid-November Crop Year	Date of Effective Rail Rate Term	Constant	Rr	P	Coefficients of W	R ²	Se	Goodness of Fit F	Simple Correlation For Pd & Rr	Number of Obs- ervations
1958-59	Not available	63.191	0.030 (0.304)	-2.547 ^a (-2.847)	-0.439 (-0.513)	0.590	2.099	(3,6)=2.873	0.075	10
1964-65	October 15 1964	47.147	0.005 (0.403)	-0.410 (-0.397)	-0.602 (-0.569)	0.086	2.604	(3,6)=0.188	0.035	10
1965-66	October 15 1964	-101.323	0.145 (1.530)	-2.089 (-1.776)	1.947 (1.442)	0.417	1.718	(3,6)=1.433	0.040	10
1969-70	April 1 1969	-195.951	0.358 ^c (2.046)	3.721 (0.891)	2.439 (1.264)	0.644	3.957	(3,6)=3.621	0.582	10
where	Pd = price difference in cents per bushel Rr = rail rates in cents per cwt P = percent protein content W = weight per bushel in pounds Bi = regression coefficients R^2 = coefficient of determination Se = standard error of estimate ^a indicates significance at $\alpha = 0.05$ ^b indicates significance at $\alpha = 0.02$ ^c indicates significance at $\alpha = 0.10$									

TABLE 5B
Summary of Results for Enid Terminal Market Using County Data for the Model
 $Pd = B_0 + B_1Rr + B_2P + B_3W + B_4M + B_5D + e$
(T-values are in parentheses)

Mid-Nov. Crop Year	Date of Rail Rate	Constant Term	Rr	P	Coefficients of			D	R ²	Se	Goodness of Fit for Pd F	Simple Corre- lation of Pd and Rr Observations
1967-68	October 15 1964	75.488	0.371 ^b (4.599)	0.920 (1.343)	-1.537 (-1.711)	0.090 (0.058)	1.095 (0.973)	0.845	1.872	(5,10)=10.900	0.719 ^b	16
1968-69	July 1 1968	133.196	-0.004 ^b (-0.049)	-4.461 ^b (-5.272)	-0.621 (-0.756)	-3.427 ^b (-2.773)	-0.213 (-0.145)	0.961	1.427	(5,10)=48.700	-0.575 ^b	16
1969-70	April 1 1969	-92.642	0.294 ^b (2.778)	0.268 (0.173)	1.862 ^c (2.042)	-2.067 (-1.756)	-2.181 (-1.173)	0.804	1.680	(5,10)= 8.227	0.569 ^a	16

where Pd = price difference in cents per bushel
Rr = rail rates in cents per cwt
P = percent protein content
W = weight per bushel in pounds
M = percent moisture content
D = percent dockage
R² = coefficient of determination
Se = standard error of estimate

a indicates significance at $\alpha = 0.05$
b indicates significance at $\alpha = 0.02$
c indicates significance at $\alpha = 0.10$

significant at 5 percent level. In short this means that the explanatory variables were not accounting very well for the differential. This might have been due to the too few observations used. From Table 5B we note that the F-values were all significant even at 2 percent level and R^2 values were particularly good compared to other previous results. The explanatory variables in Table 5B account for as much as 80 to 96 percent (highest $R^2 = 0.961$ and lowest $R^2 = 0.804$) of the variation occurring in the price difference. Individually protein and moisture content were highly significant ($\alpha = 0.02$) in 1968-69, but showed no significance in any of the two remaining years.

To summarize this portion we note that rail rates were significant in 2 out of 3 years of Table 5B. Though the regression equation showed significant fits in all of Table 5B results, none of the fits was significant in Table 5A results.

3. In testing hypotheses number three, we examine the signs and magnitudes of the rail rate coefficients in Tables 5A and 5B. In discovering any trend in the relative effect of rail rates, it was noted that the signs of all the rail rate coefficients in Table 5A are positive and relatively small compared to the coefficients of the other variables. Similarly in Table 5B, the rail rate coefficients are relatively small and has a negative coefficient in 1968-69 which is the same as the sign of the average differential. As for the signs of magnitudes of the coefficients of the others, nothing definite can be said except to repeat that they are as volatile in sign and magnitude as has been observed for the others. This concludes the individual market examination of the results. We now turn to intermarket comparison in order to test the second part of hypothesis number three which asserts that the

relative rail rate effect has a trend over space as well as in time. The spatial trend has been postponed till we have the results of all the markets.

Intermarket Comparisons

Since the B part of all the results tend to give better results in terms of R^2 , Goodness of Fit F, and the corresponding T-values of the coefficients, it was decided to use these for intermarket comparisons to test the spatial part of hypothesis number three. For easier comparison of rail rate and other factor significance for the various central markets, the necessary results have been extracted from the B part of all the results and are arranged below in Table 6.

The results summarized in Table 6 have some outstanding features which can be pointed out. First it was noted that except for Salina and Hutchinson, rail rates were significant explanatory variables in the other market differentials in 1967-68 results. The dockage factor was only important in Wichita and Hutchinson markets in the same year. All the markets showed significant simple correlation between rail rates and price differentials in the same year. It is noteworthy that the signs of both rail rates coefficients and simple correlation coefficients are all positive. There is no contradiction here, rail rates and price difference tend to move in the same direction. Also it was noted that protein content, test weight and moisture content were not significant explanatory variables in 1967-68 in any of the markets. The values of R^2 show that the variables included in the regression could account from as low as 62 percent to a high of almost 85 percent of the variation in price difference in 1967-68.

By 1968-69 however emphasis has shifted from rail rates to protein content and moisture content as the significant explanatory variables in all the markets. Only Kansas City and Wichita markets have rail rates as significant explanatory variable in 1968-69. In addition to protein content and moisture content, Salina and Hutchinson markets show that test weight

TABLE 6

Summary of Results for Intermarket Comparisons Using the County Data Results for the Model

$$Pd = B_0 + B_1Rr + B_2P + B_3W + B_4M + B_5D + e$$

(T-values are in parentheses)

Mid-Nov. Crop Year	Market	Constant Term	Rr	P	W	Coefficients of		D	R ²	r	Number of Obs- er- vations
1967-68	Kansas City	36.486	0.633 ^b (11.518)	-0.535 (-1.489)	-0.343 (-0.759)	0.454 (0.460)		-0.099 (-0.130)	0.786	0.880 ^b	64
	Salina	34.932	0.101 (1.012)	-0.991 (-0.787)	0.453 (0.397)	-3.752 (-1.682)		-0.245 (-0.245)	0.518	0.609 ^b	19
	Hutchinson	-43.950	0.013 (0.155)	0.965 (0.968)	0.321 (0.430)	-0.258 (-1.027)		6.705 ^b (4.172)	0.654	0.530 ^b	24
	Wichita	-14.449	0.170 ^a (2.450)	0.238 (0.306)	0.017 (0.294)	0.199 (0.128)		2.869 ^a (2.302)	0.643	0.737 ^b	29
	Enid	75.488	0.371 ^b (4.599)	0.920 (1.343)	-1.537 (-1.711)	0.090 (0.058)		1.095 (0.973)	0.845	0.719 ^b	16
1968-69	Kansas City	151.987	0.347 ^b (4.291)	-5.832 ^b (-7.976)	-0.447 (-0.485)	-2.292 ^a (-2.058)		-3.159 ^b (-3.534)	0.728	-0.337 ^b	59
	Salina	282.072	0.006 (0.095)	-6.425 ^b (-8.453)	-2.654 ^b (-8.612)	-4.038 ^b (-5.248)		1.443 (1.742)	0.971	-0.116	19
	Hutchinson	257.937	-0.046 (-0.581)	-4.788 ^b (-5.799)	-2.601 ^a (-2.134)	-3.297 ^a (-2.529)		-0.499 (-0.532)	0.847	-0.591 ^b	24
	Wichita	170.395	0.135 ^a (2.395)	-6.143 ^b (-10.402)	-1.119 (-1.381)	-2.858 ^b (-3.966)		0.836 (1.261)	0.955	-0.308	19
	Enid	133.196	-0.004 (-0.049)	-4.461 ^b (-5.272)	-0.621 (-0.756)	-3.427 ^b (-2.773)		-0.213 (-0.145)	0.961	-0.575 ^b	16

TABLE 6 (continued)

Mid-Nov. Crop Year	Market	Constant Term	Rr	P	W	M	D	R ²	r	Number of Observations
1969-70	Kansas City	135.355	0.464 ^b (6.610)	-4.464 ^b (-4.717)	-0.992 ^a (-2.366)	-1.684 (-1.395)	-0.745 (-0.686)	0.540	0.531 ^b	60
	Salina	152.124	0.246 ^a (2.472)	-5.161 ^b (-3.211)	-1.684 (-1.253)	0.139 (0.129)	0.362 (0.462)	0.527	0.313	19
	Hutchinson	-56.255	0.105 (1.445)	-0.586 (-0.483)	1.086 (0.896)	-0.676 (-0.639)	1.089 (1.146)	0.343	0.394	24
	Wichita	97.564	0.295 ^b (6.710)	-4.956 ^b (-5.373)	-0.750 (-1.235)	0.263 (0.367)	-1.177 (-1.392)	0.823	0.524 ^a	19
	Enid	-92.642	0.294 ^b (2.778)	0.268 (0.173)	1.862 ^c (2.042)	-2.067 (-1.756)	-2.181 (-1.173)	0.804	0.569 ^a	16

where

Pd = price difference in cents per bushel

Rr = rail rates in cents per cwt

P = percent protein content

W = weight per bushel in pounds

M = percent moisture content

D = percent dockage

Bj = regression coefficients

R² = coefficient of determination

r = simple correlation between Pd and Rr

a indicates significance at $\alpha = 0.05$ b indicates significance at $\alpha = 0.02$ c indicates significance at $\alpha = 0.10$

was significant for those markets. Kansas City market also showed dockage factor to be significant for it in 1968-69. How good are the regressions in 1968-69 in fitting the data well? The values of R^2 show that the variables included in the regression could account for 72 to 96 percent of the variations observed in the price differential. This being the case, the model selected was quite a good fit for the data of that year.

By 1969-70, emphasis on significant factors has shifted to rail rates and protein content while moisture content which was significant for all the markets in the previous year is no longer significant for any market. Also in 1969-70, test weight which has not been significant in Kansas City regression for the previous two years is now significant.

It is remarkable that the Hutchinson market never showed rail rates to be significant at any time during the period included in the analyses. Rail rates became significant for Salina in 1969-70, but did not appear so in the previous two years.

The values of R^2 in 1969-70 show that the model was not as a good fit as it was in the previous two years. The simple correlation values between the price difference and rail rates are not as significant in 1969-70 as they were in the previous two years.

Nothing definite can be said about the values of the constant term which was lowest for Hutchinson in 1967-68 and highest for Hutchinson in 1968-69 and almost the lowest again in 1969-70 for Hutchinson. The large relative value of the constant term deserves some comment. It could be that because we are dealing with rail rates and elevators, the fixed components involved are high but why it reverses its signs for the same town over the period, is not definite.

From these results, it seems the various central markets tend to

emphasize the same factors in a given crop year. Rail rates were never important factor in Hutchinson differential while it was important only in 1969-70 for Salina. These two markets are located between the bigger central markets of Wichita and Kansas City geographically and it could be that these two markets are not used as basing points but only transit points in which case the appropriate rail rates would be transit rates and not flat rates as used.

So it can be concluded that rail rate effects and for that matter the effects of any other factors vary over space between the different markets and over time for the same market.

MODEL DERIVATION

In discovering the theoretical relationship between the various factors, the variables used are defined below.

Grade of wheat depends upon test weight and percentage dockage with protein content undefined. Assume handling charge C and margin A are constant per bushel.

Let the dockage fraction by weight = D and let the moisture content fraction by weight = M. Then for a given bushel of wheat, weight W pounds, the weight of usable material in a bushel of wheat with D, M and W is:

$$(1-D)(1-M)W$$

When this given weight of wheat is purchased in a central market k at a price P_k , only the usable material is being paid for. Therefore we could write

$$P_k = \text{constant } (1-D)(1-M)W$$

where P_k is price in cents per bushel at central market k and the constant is the price of one pound of usable material.

Wheat of average grade and quality of a given location i will sell in the central market k in mid-month t for P_{kit}

or
$$P_{kit} = \text{constant } (1-D_i)(1-M_i)W_i$$

By definition, $Pd_{kit} = P_{kt} - P_{it}$

where Pd_{kit} = price differential for central market k and location i for mid-month t

P_{kt} = central market price per bushel for the defined grade and quality of wheat in the central market k for mid-month t

P_{it} = quoted price per bushel of average quality for location i in mid-month t at location i.

Assuming that the price paid for wheat is linearly related to the protein content in the form

$$P_w = a + bN$$

where P_w = wheat price

N = percent protein content

a and b are regression coefficients

Assuming the wheat at location i has protein content N_i , then this locational wheat will sell in the central market k in mid-month t for PN_{kit}

$$\text{or } PN_{kit} = \text{constant} (1-D_i)(1-M_i)W_i(a+bN_i)$$

$$= K_o(1-D_i)(1-M_i)W_i(a+bN_i)$$

where K_o = constant

$$P_{it} = P_{kit} - A - C - R_iW_i$$

where P_{it} = quoted price per bushel at location i for average quality and grade of wheat in mid-month t

P_{kit} = central market k price for wheat from location i in mid-month t

A = elevator manager's margin (assumed constant per bushel)

C = handling charge (assumed constant per bushel)

R_i = rail rate per hundredweight from location i

W_i = weight of a bushel of wheat from location i

but

$$Pd_{kit} = P_{kt} - P_{it}$$

Therefore we could rewrite Pd_{kit} as:

$$Pd_{kit} = P_{kt} - (P_{kit} - A - C - R_iW_i)$$

$$\text{but } P_{kit} = K_o(1-D_i)(1-M_i)W_i$$

for protein content N_i , price at central market k is given by

$$PN_{kit} = K_o(1-D_i)(1-M_i)W_i(a+bN_i)$$

Therefore:

$$\begin{aligned}
 Pd_{kit} &= P_{kt} - [K_o(1-D_i)(1-M_i)W_i(a+bNi) - A - C - R_iW_i] \\
 &= P_{kt} - [K_o(1-M_i-D_i+D_iM_i)W_i(a+bNi) - A - C - R_iW_i] \\
 &= P_{kt} - [(K_oW_i - K_oW_iM_i - K_oW_iD_i + K_oW_iD_iM_i)(a+bNi) - A - C - R_iW_i] \\
 &= P_{kt} - [K_oaW_i + K_obW_iNi - K_oaW_iM_i - K_obW_iM_iNi - K_oaW_iD_i - K_obW_iD_iNi \\
 &\quad + K_oaW_iD_iM_i + K_obW_iD_iM_iNi - A - C - R_iW_i]
 \end{aligned}$$

Average values of protein content, M, W and D for the state of Kansas over the years 1964-70 were:

$$\begin{aligned}
 \text{protein content (Ni)} &= 11.84, \text{ approximately } 12\% \\
 \text{test weight} &= 61.37, \text{ approximately } 61.0 \\
 \text{moisture content} &= 12.0 \text{ percent} \\
 \text{dockage} &= 2.0 \text{ percent.}
 \end{aligned}$$

Substituting these values in the following products, gives:

$$\begin{aligned}
 W_iM_iNi &= 0.854 \\
 W_iD_i &= 1.22 \\
 W_iD_iNi &= 0.120 \\
 W_iD_iM_i &= 0.120 \\
 W_iD_iM_iNi &= 0.016
 \end{aligned}$$

The values of a and b in the protein regression were estimated by using the mid-November prices for number one Hard Red Winter wheat 11 percent protein and 13 percent protein in Kansas City for the years 1962-63 through 1969-70.

$$a = 175.25, \quad b = 6.31$$

K_o was estimated by taking a price for number one Hard Red Winter wheat, 11 percent protein and substituting it in the equation:

$$PN_{kit} = K_o(1-D_i)(1-M_i)W_i(a+bNi)$$

$$\begin{aligned}\text{Therefore } K_o &= \frac{PN_{kit}}{(1-D_i)(1-M_i)W_i(a+bN_i)} \\ &= \frac{PN_{kit}}{W_i(1-D_i)(1-M_i)(175+6x11/100)}\end{aligned}$$

and was found to be very small.

Therefore where K_o appears in a term and the estimated values of the other terms were substituted and found very small, the whole term was neglected.

Now,

$$\begin{aligned}Pd_{kit} &= P_{kt} - K_o a W_i - K_o b W_i N_i + K_o a W_i M_i + K_o b W_i M_i N_i + K_o a W_i D_i \\ &\quad + K_o b W_i D_i N_i - K_o a W_i D_i M_i - K_o b W_i D_i M_i N_i + A + C + R_i W_i\end{aligned}$$

Following above reasoning and estimation,

$$Pd_{kit} = P_{kt} - K_o a W_i - K_o b W_i N_i + K_o a W_i M_i + K_o a W_i D_i + A + C + R_i W_i$$

was selected as the significant terms in the equation for price differential.

Collecting the constants together, we could rewrite the equation as:

$$Pd_{kit} = B_o - B_1 W_i - B_2 W_i N_i + B_3 W_i M_i + B_4 W_i D_i + B_5 R_i W_i$$

Dividing the equation by W_i would give:

$$\frac{Pd_{kit}}{W} = \frac{B_o}{W} - B_1 - B_2 N_i + B_3 M_i + B_4 D_i + B_5 R_i$$

by dropping the subscripts and replacing N_i with P for protein, we could write:

$$\frac{Pd}{W} = \frac{B_o}{W} - B_1 - B_2 P + B_3 M + B_4 D + B_5 R$$

The model used in the analysis of this thesis was

$$Pd = B_o + B_1 R - B_2 P - B_3 W + B_4 M + B_5 D + e$$

Compared with the theoretical model, the model used in the analysis of this paper should have had the price differential and the constant term coefficient divided by the test weight and eliminating the test weight term from the right hand side of the equation to approach a better approximation of the theoretical model. This makes sense since the derivation was based on the

fraction of usable material per bushel of wheat, the price differential also should have been based on a fraction especially more so since the other factors are measured in fractions (e.g. percent P, M and D and rail rates per given weight).

The complete theoretical model could not have been used because it is much too complicated and the linear postulated effect of protein content may be compounded by real market forces.

SUMMARY AND CONCLUSION

The results of this study though not unequivocal show that rail rates are important in causing the differences of wheat price between different points in the state of Kansas and are more significantly so when the differentials are based on the Kansas City terminal market. When the differentials are based on Salina and Hutchinson, rail rates seem not to be an important variable and this could be that because these two points are in between the bigger terminals at Kansas City and Wichita, they mainly act as transit points and the applicable rail rates may not be the flat rates used in the analyses but transit rates. The general notion that as rail rates increase, so does the price difference when based on a particular point is demonstrated in this study. The study also points out that other factors are important in explaining the differentials of various points. High protein content and test weight tend to lower the differentials. Protein content is more important in lowering the differential in the short run or at a given moment of time while test weight seems to be more important in the long-run.

This means that farmers located far from the central markets may overcome their disadvantage by growing high quality wheat. This conclusion is attested to by the fact that farmers in Western Kansas received higher prices for their wheat in most of the years than farmers located near Salina or Hutchinson and the main reason seems to be that the protein content in that area is higher than the average level for the state. (Compare Fig. 1. and Appendixes B and C). The relatively small coefficients of rail rates compared to that of protein content and test weight mean that advantages due to protein content and test weight are reflected back to the farmers more than advantages resulting from rail rates.

The implication of this for Nigeria, in answering the earlier questions raised concerning the pricing policies of the Marketing Boards would seem to be that the Boards are in the right direction in emphasizing quality as the only cause of price differences. However, this study shows that in undominated purchasing situations, private buyers do consider transportation rates to the final destination of their commodities hence if the Boards are to encourage production according to comparative advantages of the areas, they ought to consider including transportation costs in their pricing policies. The same thing can be said of the pricing policies which the cooperative network that the Federal Government of Nigeria intends to set up should use in undertaking the marketing of food products within the country.

The direct application of the findings to the Nigerian situation must be with caution since there are so many other factors that enter the picture. For example price information dissemination is not particularly efficient and fast. Already, farmers are not receiving the correct prices ordered by the Marketing Boards and any official declaration or sanction of varying prices may only worsen the situation.

This paper will not be complete if the shortcomings of this study are not pointed out. The first problem is that of clustering of observations. The points considered did not have a large enough rail rates range, few points with low rates and few points with relatively high rates were observed. This clustering affects the other variables as well namely protein content which normally only ranged from 10 to 13 percent and test weight which also normally ranged from 58 to 61 pounds per bushel. Because of this, analysis of residual estimates was undertaken by plotting the residual estimates (ûi) for Kansas City 1958-59 result against different variables. The residual values are listed in Appendix I. The results are shown in Figures 11 to 14.

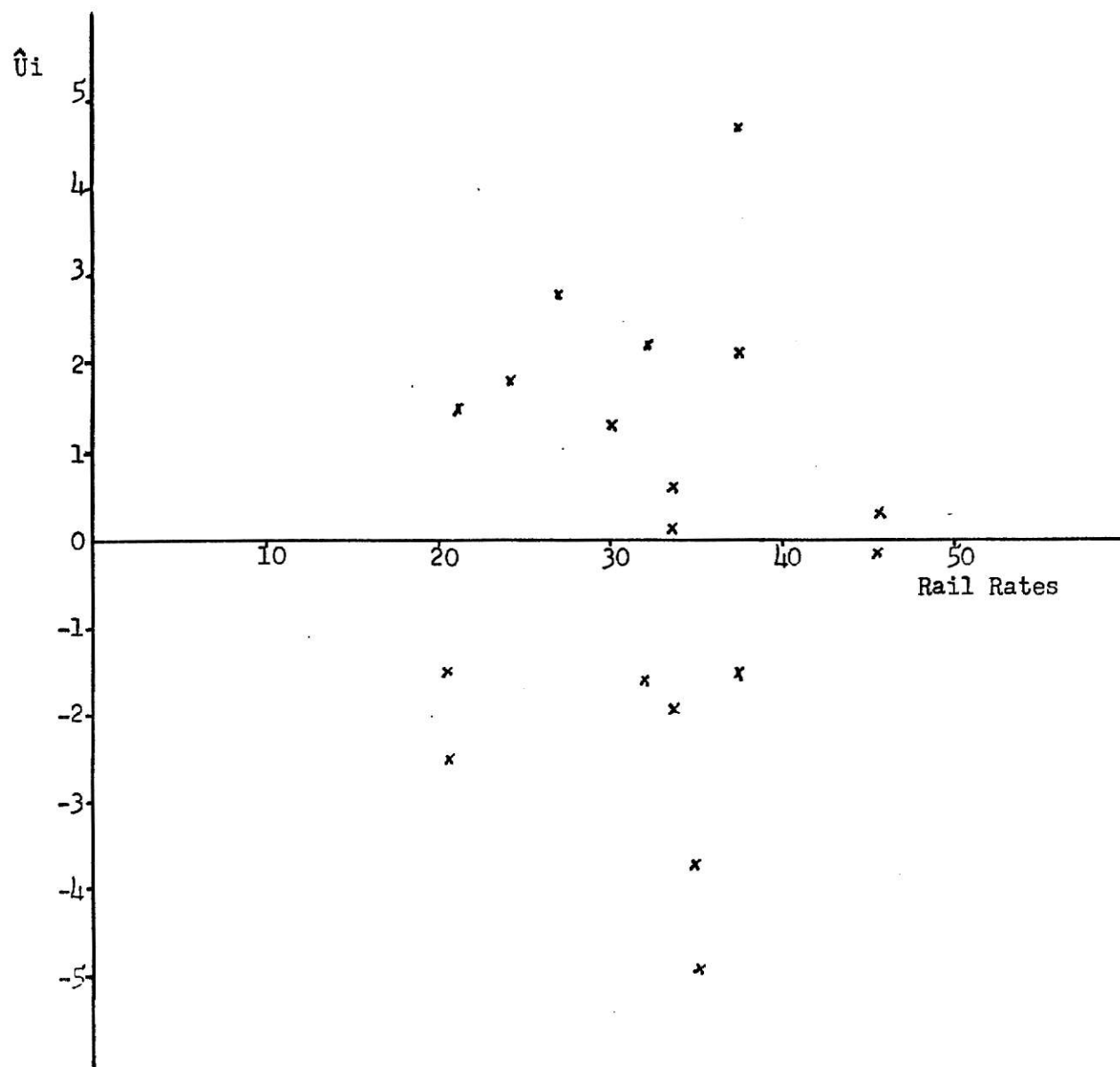


Fig. 11. Residuals ($\hat{U}_i$) for Kansas City results for mid-November 1958 plotted against rail rates.

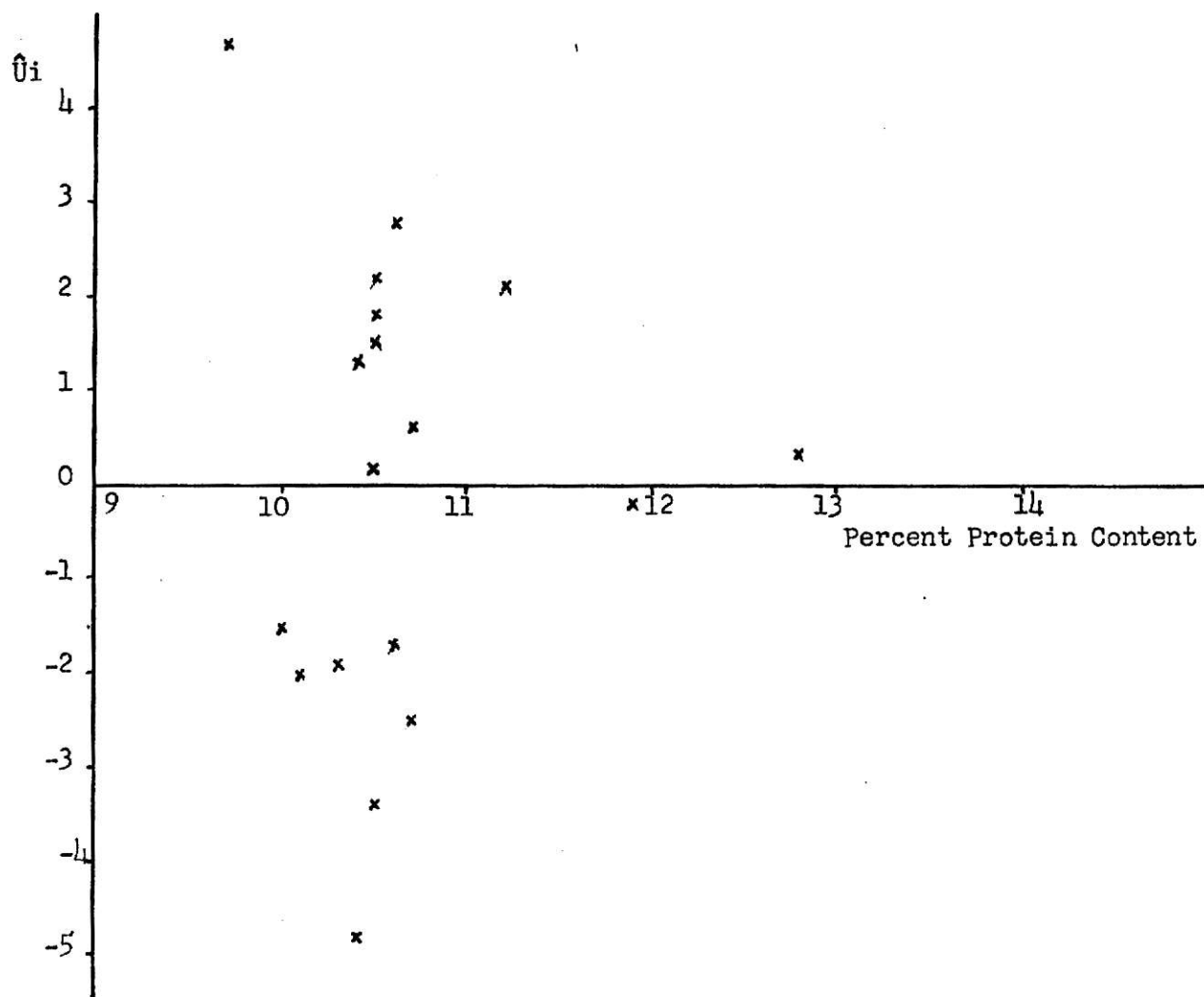


Fig. 12. Residuals ($\hat{U}_i$) of Kansas City results for mid-November 1958 plotted against percentage protein content.

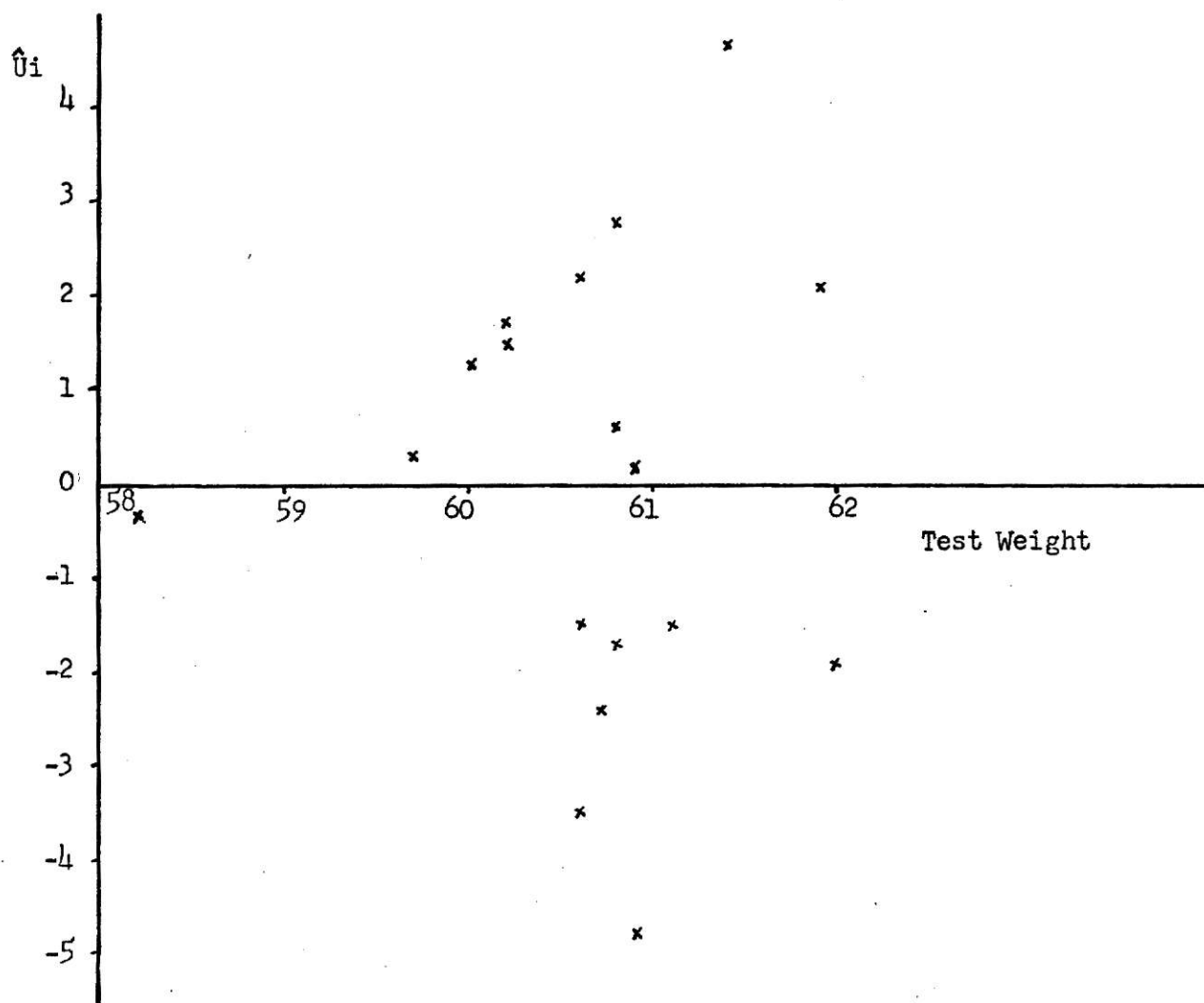


Fig. 13. Residuals ($\hat{U}_i$) of Kansas City results for mid-November 1958 plotted against test weight.

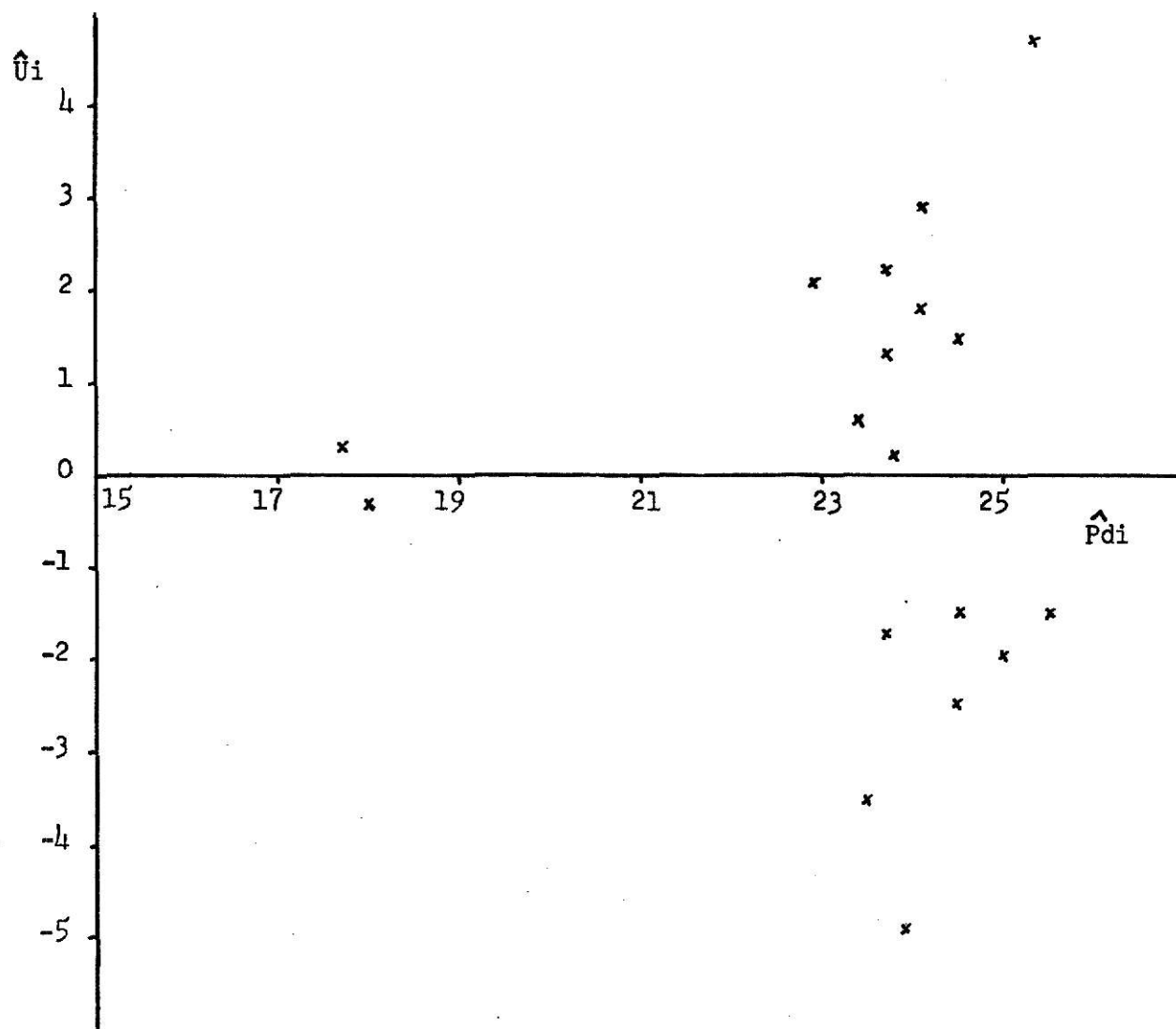


Fig. 14. Residuals ($\hat{U}_i$) of Kansas City results for 1958 plotted against estimated price differential ($\hat{P}_{di}$)

Though we do not have many points, the presence of heteroskedasticity can be clearly seen.¹ In Fig. 11, the value of the residuals ($\hat{u}_i$) increases with increasing rail rates. In Fig. 12 the opposite result holds as the residuals diminish as the protein content rises. Figure 13 illustrates again the rising value of residuals as test weight rises. In Fig. 14 we see again that as the estimated value of price difference increases, the residual value also rises. This presence of heteroskedasticity (heterogeneous variance) nullifys one of the assumptions of the method of linear regression analysis which assumes that the disturbances have the same distribution.

Other errors arise because the effective rail rates may not be the flat rates but transit rates. The increasing shipment of wheat by trucks for within and out of the state also is another source of error² because then the real rates are truck rates not the rail rates used. Often pricing of wheat is not just for the commodity alone, "It is for wheat and something else."³ Also errors might arise because what was considered fixed for example marketing margins and handling charges, may not be fixed. Nevertheless, the model used sometimes showed a high value for the coefficient of determination which means that at least the major variables are included in the regression equations.

¹See David S. Huang, Regression and Econometric Methods (New York: John Wiley & Sons, Inc., 1970) Chapter 6.2.

²Bruce H. Wright, "Changes in Transportation Used by Country Grain Elevators in the North Central Region 1958-63," Marketing Research Report No. 724 USDA, Economic Research Service, July 1965, Washington, D. C.

³Paul L. Farris, "The Pricing Structure for Wheat at the Country Elevator Level," Journal of Farm Economics Vol. LX, August 1958, P. 623.

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APPENDIX A

<u>Towns</u>	<u>Newspapers</u>
Abilene	Abilene Reflector-Chronicle
Atchison	Atchison Daily Globe
Arkansas City	Arkansas City Daily Traveler
Beloit	The Beloit Daily Call
Clay Center	The Clay Center Dispatch
Columbus	Columbus Daily Advocate
Concordia	Concordia Blade-Empire
Emporia	The Emporia Gazette
Garden City	Garden City Telegram
Great Bend	Great Bend Daily Tribune
Hays	The Hays Daily News
Hutchinson	The Hutchinson News
Larned	The Tiller and Toiler
Liberal	The Southwest Daily Times
Lyons	The Lyons Daily News
McPherson	The McPherson Sentinel
Newton	The Newton Kansan
Lawrence	Lawrence Daily Journal-World
Pratt	Pratt Daily Tribune
Salina	The Salina Journal
Topeka	The Topeka Daily Capital
Wichita	The Wichita Eagle
Dodge City	Dodge City Daily Globe
Norton	The Norton Daily Telegram
Ottawa	Ottawa Herald
Junction City	The Junction City Union
Wellington	Wellington Daily News
Pittsburg	The Pittsburg Headlight
Winfield	Winfield Daily Courier
Goodland (weekly)	Sherman County Herald
Tribune (weekly)	Greeley County Republican

APPENDIX B

Wheat Price in Cents per Bushel July 1958 ~ June 1959

	July 1958	Aug.	Sep.	Oct.	Nov.	Dec. 1958	Jan. 1959	Feb.	March	April	May	June 1959
Abilene	162	158	170	172	170	174	173	176	179	179	182	164
Arkansas City	162	160	171	170	172	173	171	177	178	177	175	164
Atchison	160	159	169	172	174	173	172	178	183	180	180	166
Beloit	161	158	169	171	173	171	171	173	177	175	175	164
Clay Center	150	154	168	168	170	174	171	175	177	178	178	161
Columbus	160	167	168	168	170	173	172	175	177	188	180	165
Concordia	162	158	170	173	174	174	173	178	180	178	179	170
Dodge City	167	162	173	174	178	175	174	178	181	180	178	169
Emporia	158	153	166	165	169	168	167	172	173	172	171	158
Enid (Okla.)	166	168	177	180	182	179	180	186	186	186	182	170
Garden City	162	162	172	175	175	171	171	174	177	174	173	164
Goodland	168	161	174	175	178	176	176	180	180	177	179	172
Great Bend	162	158	171	170	173	173	170	174	176	174	175	164
Hays	160	156	167	169	171	169	167	173	177	175	175	165
Hutchinson	159	158	171	171	173	173	171	174	176	175	175	164
Junction City	159	156	166	168	171	170	171	174	179	183	178	164
Kansas City (No.2. O.P.HRW)	185	180	190	193	196	195	193	199	204	202	201	190
Larned	162	158	171	170	173	172	170	174	177	174	175	163
Lawrence	159	162	167	174	170	176	177	176	178	184	180	165
Liberal	162	162	168	172	173	172	174	176	178	184	183	165
Lyons	168	163	174	175	177	177	175	178	180	181	179	168
McPherson	164	160	173	172	176	175	172	179	180	179	177	168
Newton	164	160	173	174	176	175	173	179	181	179	177	164
Norton	152	150	165	166	166	168	168	171	175	174	173	158
Ottawa	161	157	167	170	172	172	172	175	177	184	178	165
Pittsburg	160	164	173	172	172	172	170	177	183	184	180	167
Pratt	158	158	171	170	172	173	173	176	175	178	174	166
Tribune	170	161	174	175	178	178	177	181	182	181	182	170
Salina	159	158	170	171	172	172	171	174	177	175	180	170
Topeka	155	154	157	175	170	172	170	174	178	180	177	163
Wellington	164	160	173	172	176	175	173	179	180	180	177	164
Wichita	162	158	171	170	174	173	171	177	178	179	177	165
Winfield	164	173	170	172	176	175	175	173	180	180	177	167

APPENDIX B (continued)
July 1959 - June 1960

	July 1959	Aug.	Sept.	Oct.	Nov.	Dec. 1959	Jan. 1960	Feb.	March	April	May	June 1960
Abilene	170	173	176	178	179	179	182	184	189	184	177	172
Arkansas City	167	172	178	185	185	188	181	185	188	184	177	167
Atchison	180	184	188	193	193	189	195	197	202	197	187	182
Beloit	170	172	176	179	179	181	180	182	186	182	176	168
Clay Center	167	169	172	175	177	177	180	180	185	184	177	170
Columbus	170	174	176	177	180	180	180	182	191	190	185	175
Concordia	169	172	177	178	179	182	179	182	187	183	173	166
Dodge City	170	174	179	179	180	183	180	183	188	185	176	163
Emporia	163	169	174	174	176	177	174	178	182	177	168	160
Enid (Okla.)	170	174	177	182	183	183	180	188	193	191	177	166
Garden City	168	173	177	178	177	179	179	181	187	183	175	169
Goodland	175	178	180	181	180	183	182	184	188	185	173	172
Great Bend	165	169	178	180	180	182	180	183	187	181	173	175
Hays	170	174	179	182	183	184	181	183	187	183	175	170
Hutchinson	165	169	178	179	180	181	180	183	187	181	174	170
Junction City	166	169	173	174	180	180	182	182	182	185	180	170
Kansas City (No.2. O.P.H.R.W.)	189	193	197	202	202	202	203	209	213	207	200	192
Larned	165	169	178	180	180	182	180	183	189	182	173	165
Lawrence	171	171	175	176	182	182	185	184	188	189	182	177
Liberal	168	174	175	180	182	182	183	186	189	189	179	162
Lyons	174	177	182	183	184	184	184	186	193	187	180	171
McPherson	168	175	179	181	182	185	182	185	190	185	178	167
Newton	167	172	178	180	181	184	180	185	189	184	177	167
Norton	170	175	179	178	178	181	182	183	188	186	173	166
Ottawa	168	173	175	180	180	182	182	182	187	186	180	175
Pittsburg	170	174	175	177	180	178	180	185	192	190	180	172
Pratt	165	170	178	178	180	181	181	181	187	181	175	171
Tribune	170	175	179	178	181	182	180	184	187	186	180	173
Salina	174	175	180	181	182	182	182	184	190	184	177	172
Topeka	165	170	174	176	180	182	180	182	189	183	175	173
Wellington	166	172	178	181	181	184	181	185	189	184	175	170
Wichita	160	170	176	179	179	181	179	183	187	182	175	165
Winfield	169	179	185	188	189	191	187	191	196	195	186	171

APPENDIX B (continued)
July 1960 - June 1961

	July 1960	Aug.	Sept.	Oct.	Nov.	Dec. 1960	June 1961	Feb.	March	April	May	June
Abilene	169	169	172	173	176	179	180	180	180	177	175	176
Arkansas City	170	170	174	181	184	184	182	182	182	178	174	173
Atchison	182	184	187	187	190	191	194	194	192	189	183	184
Beloit	162	168	171	172	175	176	175	177	176	170	163	165
Clay Center	164	165	169	170	173	173	178	178	178	175	170	168
Columbus	168	172	180	178	178	180	184	188	185	182	173	170
Concordia	166	168	172	172	174	176	178	178	176	172	168	168
Dodge City	166	168	173	172	176	176	175	178	176	173	171	170
Emporia	163	166	171	170	172	173	173	176	176	168	166	166
Enid (Okla.)	170	173	179	177	179	180	183	187	184	175	176	171
Garden City	162	164	169	168	171	173	172	174	175	170	168	168
Goodland	168	167	171	172	175	175	176	175	175	173	170	171
Great Bend	165	167	172	172	176	176	175	177	176	169	169	167
Hays	161	163	169	168	172	172	173	174	171	169	165	167
Hutchinson	165	167	172	172	175	176	175	177	176	169	169	167
Junction City	163	170	172	174	174	175	181	181	180	175	172	169
Kansas City (No.2. O.P.HRW)	189	193	197	197	199	201	203	204	202	199	195	197
Larned	165	167	172	172	---	176	175	177	178	170	168	167
Lawrence	171	170	175	176	180	182	182	182	180	179	179	175
Liberal	166	168	175	175	176	177	178	183	182	174	173	169
Lyons	169	172	176	175	179	180	180	180	181	176	173	171
McPherson	168	170	175	175	179	180	181	182	184	176	174	172
Newton	167	169	173	173	179	177	177	179	179	172	171	169
Norton	160	164	169	168	172	175	175	177	174	171	167	166
Ottawa	170	172	175	175	175	177	180	182	185	180	173	175
Pittsburg	168	170	179	176	177	180	184	187	185	184	177	185
Pratt	161	164	172	172	177	177	175	177	178	172	166	168
Tribune	166	167	173	173	176	177	177	176	174	170	169	169
Salina	170	171	175	173	177	178	178	180	179	175	171	171
Topeka	179	170	175	173	175	177	182	182	180	177	173	176
Wellington	168	169	174	174	179	177	177	179	178	174	171	172
Wichita	164	167	172	171	176	175	175	177	176	172	168	167
Winfield	170	170	180	183	186	188	182	182	182	178	174	173

APPENDIX B (continued)
July 1961 - June 1962

	July 1961	Aug.	Sept.	Oct.	Nov.	Dec. 1961	Jan. 1962	Feb.	March	April	May	June 1962
Abilene	171	176	177	180	182	184	182	183	185	187	192	193
Arkansas City	176	183	188	191	191	191	187	190	190	190	197	200
Atchison	185	195	194	195	198	199	197	198	201	204	207	208
Beloit	169	176	177	178	180	180	180	180	180	183	190	190
Clay Center	---	173	173	177	180	183	183	183	183	187	187	191
Columbus	174	184	188	186	186	186	187	190	193	196	197	198
Concordia	170	178	179	179	183	184	180	181	185	190	196	191
Dodge City	171	183	182	182	185	185	181	183	185	188	195	192
Emporia	170	173	175	175	177	178	176	177	179	180	183	192
Enid (Okla.)	174	183	184	185	188	187	184	187	191	195	198	199
Garden City	171	182	179	180	185	186	182	183	186	188	195	194
Goodland	167	169	173	176	175	177	176	176	179	180	189	187
Great Bend	167	177	177	177	181	180	175	177	179	181	187	197
Hays	169	179	178	178	182	183	179	180	183	184	190	191
Hutchinson	167	176	177	177	180	180	176	177	179	181	186	195
Junction City	171	180	183	181	183	183	183	187	186	191	194	196
Kansas City (No.2. O.P.HRW)	196	202	206	205	207	208	204	206	209	212	216	218
Larned	161	177	176	178	182	182	179	181	183	---	192	194
Lawrence	179	185	186	186	186	186	188	188	188	188	196	200
Liberal	174	183	184	185	186	187	186	186	188	191	194	198
Lyons	171	179	181	180	184	185	181	184	185	187	193	198
McPherson	171	182	183	182	185	184	182	185	186	189	193	198
Newton	171	179	180	180	183	183	179	181	184	186	193	195
Norton	170	179	180	178	182	184	179	181	183	184	191	189
Ottawa	177	183	184	183	183	185	184	188	190	194	198	200
Pittsburg	172	174	188	186	186	188	188	193	193	195	198	197
Pratt	168	176	177	178	181	182	177	181	184	186	190	193
Tribune	178	185	185	184	186	187	182	184	186	189	195	193
Salina	171	178	179	179	184	183	179	181	184	187	191	192
Topeka	179	181	185	184	187	187	190	190	191	193	199	205
Wellington	169	177	180	180	183	182	179	184	184	190	193	195
Wichita	168	175	178	178	181	180	177	179	181	184	190	193
Winfield	176	182	188	191	191	191	187	190	190	191	200	196

APPENDIX B (continued)

July 1962 - June 1963

	July 1962	Aug.	Sept.	Oct.	Nov.	Dec. 1962	Jan. 1963	Feb.	March	April	May	June 1963
Abilene	195	195	196	193	204	207	205	210	209	220	198	188
Arkansas City	201	205	207	207	207	207	207	208	209	215	192	181
Atchison	207	205	209	208	210	212	213	217	219	228	206	196
Beloit	198	198	198	198	200	201	201	204	207	210	195	178
Clay Center	195	191	193	193	195	197	198	203	204	213	187	179
Columbus	202	200	202	200	200	204	205	210	212	220	190	201
Concordia	198	203	202	201	203	206	202	207	207	213	190	182
Dodge City	194	195	196	195	198	201	200	203	204	208	191	179
Emporia	193	191	192	191	194	197	196	201	200	211	190	172
Enid (Okla.)	201	200	200	199	202	204	203	210	211	219	191	183
Garden City	197	199	200	199	203	204	202	206	206	215	190	181
Goodland	196	196	200	200	202	204	203	206	207	207	190	177
Great Bend	195	193	197	198	200	202	200	206	206	209	189	180
Hays	192	190	192	191	196	197	197	200	202	212	188	178
Hutchinson	196	193	197	195	201	202	200	206	206	209	189	178
Independence												
Junction City	197	194	197	196	197	200	199	206	207	215	190	180
Kansas City (No. 1 HRW O.P.)	220	216	217	219	220	225	226	228	232	236	221	207
Larned	197	199	200	199	203	205	204	208	207	215	190	180
Lawrence	206	200	196	196	196	202	204	207	208	220	194	189
Liberal	200	201	201	199	203	204	205	209	209	216	190	182
Lyons	200	198	198	200	202	204	202	208	207	215	196	185
McPherson	199	198	202	202	203	205	203	208	207	213	192	183
Neodesha												
Newton	195	198	198	192	202	205	202	206	207	214	198	177
Norton	193	189	189	190	192	196	196	200	202	---	---	171
Ottawa	202	202	198	198	198	203	203	206	206	213	192	187
Pittsburg	203	199	197	199	199	206	207	212	212	218	202	191
Pratt	196	193	196	194	201	203	199	205	206	216	209	176
Tribune	198	199	204	202	206	205	202	205	205	209	189	180
Salina	196	193	193	193	195	199	197	203	203	211	194	181
Topeka	199	198	199	202	204	204	204	204	204	211	195	178
Wellington	194	193	193	195	198	201	200	205	207	220	192	183
Wichita	192	193	192	192	196	199	197	203	205	210	190	183
Winfield	201	207	207	207	208	208	208	211	212	221	204	183

APPENDIX B (continued)
July 1963 - June 1964

	July 1963	Aug.	Sept.	Oct.	Nov.	Dec. 1963	Jan. 1964	Feb.	March	April	May	June 1964
Abilene	179	182	186	195	196	200	204	202	188	197	202	147
Arkansas City	185	185	190	192	203	198	200	200	187	202	204	135
Atchison	187	190	193	200	204	205	210	210	200	206	200	147
Beloit	173	177	181	190	190	193	196	195	182	194	194	135
Clay Center	174	176	180	190	193	197	200	200	187	197	196	130
Columbus	190	190	190	200	201	205	209	209	200	206	198	150
Concordia	175	178	183	195	196	196	198	199	187	198	195	137
Dodge City	173	178	183	190	191	194	196	196	181	196	194	131
Emporia	175	178	180	188	195	191	194	195	182	191	195	133
Enid (Okla.)	181	182	185	198	201	203	206	207	191	207	200	139
Garden City	177	181	184	192	192	194	196	196	182	195	195	126
Goodland	177	181	185	193	194	191	195	194	184	196	202	131
Great Bend	175	178	182	190	192	194	196	197	182	198	197	138
Hays	182	187	186	200	200	201	200	200	190	198	200	130
Hutchinson	173	178	182	190	192	194	196	197	182	198	197	138
Junction City	173	178	181	192	196	194	202	201	183	194	191	135
Kansas City (No. 1 HRW O.P.)	198	203	205	220	221	222	224	224	210	227	226	159
Larned	175	179	182	191	190	194	196	197	184	198	195	136
Lawrence	180	185	186	196	197	200	204	203	187	199	199	144
Liberal	185	183	185	192	198	198	198	200	180	198	190	138
Lyons	180	183	185	194	198	199	200	200	188	200	197	135
McPherson	176	180	186	195	197	199	202	200	185	204	197	140
Newton	172	176	183	190	192	196	198	197	185	198	196	135
Norton	173	177	180	192	192	194	196	196	188	196	194	127
Ottawa	183	185	187	191	196	196	202	204	187	198	200	140
Pittsburg	190	191	191	202	204	207	209	210	185	201	198	150
Pratt	174	178	181	190	192	193	196	196	180	197	193	135
Tribune	177	184	185	192	195	194	193	194	179	196	191	126
Salina	173	175	179	189	190	191	196	195	182	196	197	134
Topeka	179	181	182	195	---	200	204	204	189	201	200	143
Wellington	181	181	184	193	195	196	197	200	185	201	198	135
Wichita	171	175	181	189	192	194	195	195	181	196	198	133
Winfield	188	188	190	201	200	198	203	203	185	207	193	135

APPENDIX B (continued)
July 1964 - June 1965

	July 1964	Aug.	Sept.	Oct.	Nov.	Dec. 1964	Jan. 1965	Feb.	March	April	May	June 1965
Abilene	137	140	140	144	148	146	143	143	140	134	131	124
Arkansas City	131	135	137	145	147	145	144	144	140	136	130	122
Atchison	143	145	149	150	153	152	147	150	145	143	139	136
Beloit	130	132	137	141	143	144	140	138	136	133	128	124
Clay Center	124	136	138	141	145	144	141	142	138	135	127	125
Columbus	138	141	142	143	145	144	140	145	142	135	130	127
Concordia	128	134	140	143	146	145	142	141	138	136	130	125
Dodge City	131	135	141	142	144	143	140	138	133	132	128	123
Emporia	130	132	135	138	141	144	139	142	136	133	130	124
Enid (Okla.)	138	139	142	149	151	149	145	145	138	133	128	125
Garden City	132	132	136	139	145	141	140	139	132	132	128	123
Goodland	127	130	135	140	140	139	139	138	130	132	125	126
Great Bend	128	132	134	139	142	140	136	134	131	127	123	122
Hays	127	130	137	138	144	142	139	139	136	135	129	126
Hutchinson	128	132	134	139	142	140	136	134	131	127	123	122
Junction City	133	132	138	141	146	145	143	142	139	135	131	126
Kansas City (No.1 HRW O.P.)	157	160	165	167	167	165	162	160	153	156	150	146
Larned	129	138	139	143	144	142	140	139	135	138	132	123
Lawrence	138	139	142	144	148	148	144	145	139	139	135	130
Liberal	137	139	142	145	149	148	143	143	137	130	127	122
Lyons	134	136	139	141	144	145	145	145	140	138	---	126
McPherson	132	136	139	145	149	147	146	145	140	137	135	---
Newton	132	132	136	144	144	144	142	142	138	134	130	126
Norton	131	135	139	140	144	143	140	138	134	133	127	123
Ottawa	138	140	142	142	148	146	142	145	141	138	133	126
Pittsburg	138	141	142	143	145	144	140	140	140	133	128	127
Pratt	130	130	134	139	143	142	140	138	136	131	127	121
Tribune	131	133	139	137	143	140	138	137	132	131	128	123
Salina	130	133	134	138	143	141	139	137	132	134	127	123
Topeka	136	139	142	145	148	147	143	144	140	137	134	128
Wellington	132	135	138	140	148	148	143	143	139	136	130	122
Wichita	126	130	132	139	142	140	139	137	134	131	125	120
Winfield	131	133	136	144	147	145	144	143	139	137	130	122

APPENDIX B (continued)
July 1965 - June 1966

	July 1965	Aug.	Sept.	Oct.	Nov.	Dec. 1965	Jan. 1966	Feb.	March	April	May	June 1966
Abilene	127	138	136	138	141	142	143	141	142	144	150	164
Arkansas City	126	136	139	139	144	145	146	144	146	145	151	161
Atchison	143	154	150	151	153	154	155	155	152	152	156	174
Beloit	130	138	138	139	142	143	144	142	143	143	147	163
Clay Center	126	139	137	138	140	142	144	141	144	142	147	162
Columbus	131	140	140	139	142	148	146	148	147	146	152	165
Concordia	129	139	138	139	141	143	145	144	144	143	150	163
Dodge City	130	141	139	140	144	145	141	140	141	140	147	163
Emporia	130	140	139	139	142	143	144	142	142	142	151	157
Enid (Okla.)	130	142	138	141	143	144	146	146	146	147	152	165
Garden City	129	139	140	141	142	146	142	141	141	139	148	163
Goodland	126	134	134	134	136	139	134	137	135	135	147	157
Great Bend	126	140	141	142	145	146	147	146	144	146	154	166
Hays	129	136	140	140	142	143	144	150	150	149	155	165
Hutchinson	126	135	136	137	140	143	142	141	142	141	146	163
Junction City	126	136	137	140	143	141	145	143	141	141	150	162
Kansas City(No.1 HRW O.P.)	149	159	157	158	160	160	164	163	162	164	168	188
Larned	126	135	135	137	140	140	142	140	141	142	149	164
Lawrence	---	---	---	---	---	---	---	---	---	---	---	---
Liberal	129	139	135	139	143	141	142	143	144	143	147	161
Lyons	128	137	138	139	142	145	144	143	144	143	151	166
McPherson	128	137	138	139	144	146	145	146	146	145	151	163
Newton	128	138	138	141	143	143	146	145	144	144	148	166
Norton	126	133	134	134	138	140	141	139	139	138	---	---
Ottawa	133	143	142	145	147	147	158	150	148	151	155	168
Parsons												
Pttisburg	131	141	140	139	142	147	148	147	147	146	152	166
Pratt	123	133	134	136	140	142	141	140	141	141	145	161
Tribune	130	140	137	140	145	142	141	139	140	140	149	160
Salina	125	132	134	137	140	142	142	141	142	141	146	160
Topeka	123	145	142	145	148	147	144	143	144	144	149	158
Wellington	126	135	138	141	145	142	145	145	145	146	151	163
Wichita	123	133	133	135	139	141	142	140	141	141	146	162
Winfield	126	137	139	139	143	145	145	144	145	145	149	164

APPENDIX B (continued)
July 1966 - June 1967

	July 1966	Aug.	Sept.	Oct.	Nov.	Dec. 1966	Jan. 1967	Feb.	March	April	May	June 1967
Abilene	179	175	176	160	162	165	157	147	165	154	156	142
Arkansas City	181	179	182	166	160	171	164	151	169	158	160	145
Atchison	191	191	192	172	174	176	164	161	178	166	168	158
Beloit	177	175	176	161	164	166	155	148	169	153	154	143
Clay Center	175	---	179	163	164	168	159	150	168	156	160	146
Columbus	182	183	182	163	164	171	157	152	168	158	159	147
Concordia	178	175	176	161	165	168	156	149	167	155	159	146
Dodge City	175	176	178	159	163	164	155	145	158	151	163	141
Emporia	178	178	179	162	164	167	155	149	167	156	158	146
Enid (Okla.)	182	180	180	163	167	171	162	153	171	160	160	155
Garden City	176	175	178	175	162	164	151	143	149	146	151	140
Goodland	167	170	172	150	160	---	147	140	159	145	146	140
Great Bend	183	183	185	168	170	170	158	152	167	156	159	143
Hays	178	179	178	158	165	167	157	159	165	153	157	145
Hutchinson	179	176	180	160	162	166	159	146	165	154	157	143
Junction City	176	176	178	161	162	165	160	149	163	153	156	143
Kansas City(No.1 HRW O.P.)	199	196	199	179	186	188	180	172	191	175	175	166
Larned	177	178	177	161	164	165	165	147	165	152	156	144
Lawrence	185	183	185	169	171	173	163	156	174	162	163	152
Liberal	177	174	175	157	163	169	159	147	165	152	152	142
Lyons	181	179	181	162	166	167	159	148	164	155	158	144
McPherson	183	182	185	167	170	170	162	149	168	156	157	146
Newton	180	178	182	165	168	170	164	150	168	157	159	146
Norton	174	173	174	159	162	162	157	146	161	152	153	142
Ottawa	183	179	185	165	171	172	---	154	170	158	162	---
Pittsburg	182	183	182	163	166	---	157	153	166	158	159	147
Pratt	179	177	178	157	164	165	157	146	162	153	156	144
Tribune	177	175	179	156	163	161	---	141	160	145	151	140
Salina	176	174	175	159	162	164	156	146	161	153	155	141
Topeka	183	181	182	166	169	171	161	152	166	158	160	150
Wellington	181	179	182	166	167	171	159	151	169	158	159	146
Wichita	176	175	178	161	164	166	155	148	166	155	156	142
Winfield	181	181	185	168	172	---	163	147	171	154	151	145

APPENDIX B (continued)
July 1967 - June 1968

	July 1967	Aug.	Sept.	Oct.	Nov.	Dec. 1967	Jan. 1968	Feb.	March	April	May	June 1968
Abilene	138	133	133	136	133	136	138	140	141	129	132	121
Arkansas City	143	139	137	140	138	139	142	145	142	127	131	123
Atchison	151	147	145	150	146	148	148	151	152	140	144	134
Beloit	139	133	133	136	135	137	140	138	136	127	130	121
Clay Center	137	135	135	137	134	137	139	137	137	126	129	121
Columbus	141	136	136	140	137	141	141	143	143	134	137	125
Concordia	137	133	135	139	135	138	140	139	140	129	131	122
Dodge City	136	132	134	136	130	134	137	135	137	127	131	124
Emporia	138	136	136	141	135	137	139	140	138	129	133	121
Enid (Okla.)	147	145	145	148	145	149	151	150	149	131	127	123
Garden City	135	132	133	134	127	132	133	132	135	122	127	120
Goodland	136	128	128	130	126	130	133	---	130	127	125	119
Great Bend	139	135	135	137	132	136	139	138	140	130	133	121
Hays	140	136	136	140	135	139	140	138	139	128	131	123
Hutchinson	143	140	137	140	139	140	141	140	144	131	133	125
Junction City	141	136	135	138	134	136	140	139	142	130	132	122
Kansas City (No. 1 HRW O.P.)	162	156	157	160	158	158	161	161	165	155	154	143
Larned	137	135	135	137	131	137	139	137	141	129	130	125
Lawrence	145	142	142	147	142	144	146	148	149	137	140	130
Liberal	135	132	131	135	131	133	136	138	137	123	126	120
Lyons	141	139	136	141	138	140	140	140	142	130	137	128
McPherson	140	138	137	138	136	141	141	140	144	132	134	129
Newton	140	136	133	137	134	136	139	137	137	123	135	123
Norton	132	129	130	134	130	133	137	135	136	124	126	115
Ottawa	---	142	141	145	141	142	145	144	148	136	137	126
Pittsburg	141	138	136	141	139	140	141	143	144	134	137	125
Pratt	135	135	133	136	134	135	138	137	140	128	133	123
Tribune	137	131	130	132	129	131	134	131	135	125	126	117
Salina	135	133	132	135	132	134	139	137	140	126	129	120
Topeka	142	138	140	143	138	141	142	141	147	133	135	126
Wellington	139	138	138	145	139	142	145	143	142	130	133	129
Wichita	134	133	131	135	133	133	138	135	135	121	124	121
Winfield	139	137	136	140	137	140	141	143	144	127	133	121

APPENDIX B (continued)
July 1968 - June 1969

	July 1968	Aug.	Sept.	Oct.	Nov.	Dec. 1968	Jan. 1969	Feb.	March	April	May	June 1969
Abilene	118	115	113	120	123	119	121	182	122	119	117	113
Arkansas City	122	120	120	125	128	124	127	123	123	122	121	117
Atchison	128	126	125	130	133	132	133	133	133	130	130	125
Beloit	115	115	116	122	126	123	125	124	126	126	125	123
Clay Center	115	114	113	119	121	118	120	118	120	117	115	115
Columbus	120	117	115	122	126	124	125	123	122	122	124	117
Concordia	118	117	102	121	127	124	126	125	124	120	121	117
Dodge City	127	127	130	136	140	136	137	135	137	135	132	125
Emporia	118	116	114	119	123	121	123	123	122	119	119	115
Enid (Okla.)	121	119	118	125	127	124	125	123	123	120	120	115
Garden City	121	120	126	128	135	131	133	130	132	131	129	127
Goodland	107	112	113	122	124	120	119	117	119	118	117	---
Great Bend	117	116	116	120	123	120	122	119	119	116	115	111
Hays	120	120	125	130	133	128	129	128	128	126	125	122
Hutchinson	116	118	119	121	126	122	123	121	121	117	118	116
Junction City	118	115	113	120	123	---	121	119	120	116	118	114
Kansas City (No. 1 HRW O.P.)	138	136	135	141	144	140	143	142	141	139	139	137
Larned	124	117	120	119	129	127	127	125	125	123	123	120
Lawrence	123	121	120	124	128	127	128	128	127	123	122	119
Liberal	122	120	123	126	134	131	130	128	130	127	126	118
Lyons	118	119	118	121	125	122	125	122	121	118	119	117
McPherson	121	120	121	125	127	125	125	124	124	119	121	117
Newton	118	116	115	121	124	121	124	121	120	119	118	114
Norton	110	111	110	115	119	116	119	117	117	113	116	109
Ottawa	123	120	118	122	126	128	123	125	124	121	122	119
Pittsburg	122	118	117	122	125	123	123	123	124	122	122	119
Pratt	119	116	119	124	126	123	125	123	123	121	122	120
Tribune	123	122	123	133	134	132	131	129	131	131	127	128
Salina	113	112	111	117	120	117	118	116	118	115	114	113
Topeka	122	119	117	122	125	123	123	124	123	122	122	118
Wellington	---	---	---	128	132	128	131	127	129	128	127	122
Wichita	115	114	113	119	123	119	122	118	118	117	116	111
Winfield	120	118	117	123	126	123	123	123	123	122	121	117

APPENDIX B (continued)
July 1969 - June 1970

	July 1969	Aug.	Sept.	Oct.	Nov.	Dec. 1969	Jan. 1970	Feb.	March	April	May	June 1970
Abilene	108	103	118	118	122	123	123	121	121	121	120	115
Arkansas City	113	113	122	126	126	127	128	127	126	129	122	118
Atchison	122	124	131	136	136	138	138	138	135	140	132	129
Beloit	105	110	117	122	122	122	123	122	121	124	117	114
Clay Center	107	109	117	122	123	122	122	121	121	123	117	114
Columbus	112	114	120	123	126	130	128	128	126	126	126	115
Concordia	108	109	118	125	125	125	124	125	122	125	120	115
Dodge City	106	107	113	119	118	120	121	119	118	120	114	111
Emporia	106	109	117	123	122	125	124	125	123	127	121	114
Enid (Okla.)	111	112	121	127	127	127	128	127	127	128	123	120
Garden City	108	107	112	118	118	121	120	118	118	121	114	109
Goodland	114	---	---	108	109	111	112	112	112	112	107	102
Great Bend	106	107	116	118	121	122	121	122	120	123	118	113
Hays	104	107	114	119	120	120	119	120	118	120	116	114
Hutchinson	111	110	118*	125*	125*	125*	125*	123*	122*	125*	117*	113*
Junction City	109	108	118	124	123	122	123	123	121	122	118	114
Kansas City(No.1 HRW O.P.)	129	131	141	144	146	145	147	146	145	148	141	139
Larned	109	106	116	119	122	123	122	124	121	123	117	111
Lawrence	114	113	123	128	129	130	130	130	128	131	126	124
Liberal	108	105	110	114	113	115	117	117	117	119	114	109
Lyons	109	111	115	122	122	122	121	125	124	127	119	116
McPherson	113	110	119	121	124	125	125	125	123	125	122	117
Newton	108	110	120	123	126	126	127	125	124	126	122	116
Norton	103	103	111	117	119	119	119	120	118	119	115	111
Ottawa	111	---	---	125	127	127	---	128	---	---	---	---
Pittsburg	113	114	118	122	126	127	127	127	128	127	127	120
Pratt	107	105	117	120	121	123	122	122	121	123	118	114
Tribune	118	115	124	129	128	130	131	124	122	129	120	118
Salina	105	107	115	119	121	120	120	120	119	121	115	112
Topeka	111	112	120	124	126	128	126	125	125	126	122	121
Wellington	115	115	125	132	131	131	132	130	128	132	124	122
Wichita	106	106	116	123	121	122	123	121	120	123	116	113
Winfield	111	111	121	128	127	126	127	126	125	128	121	118

*Hutchinson Board of Trade quotations, not necessarily elevator prices

APPENDIX C
Wheat Quality Data *

Towns	Counties	1958-59		1959-60		1960-61		1961-62		1962-63	
		P	W	P	W	P	W	P	W	P	W
Abilene	(Dickenson)	11.7	60.8	11.6	60.1	11.1	60.5	10.7	61.7	11.7	62.0
Arkansas City	(Cowley)	11.1	60.9	11.1	61.9	11.6	63.0	10.1	61.6	11.3	60.9
Atchison	(Atchison)	11.7	60.7	11.0	60.0	11.1	59.1	9.9	58.9	12.0	60.1
Beloit	(Mitchell)	11.3	62.0	12.7	57.9	11.2	61.5	10.6	60.6	12.2	60.8
Clay Center	(Clay)	11.5	60.6	11.7	60.6	11.4	57.9	10.2	61.5	11.3	61.4
Columbus	(Cherokee)	10.2	61.5	9.8	62.1	10.5	62.5	9.8	60.6	10.2	60.3
Concordia	(Cloud)	11.6	60.8	11.5	61.0	11.3	59.1	10.1	61.5	11.9	61.2
Dodge City	(Ford)	13.2	59.4	13.8	56.3	11.7	61.8	11.3	61.7	12.5	61.4
Emporia	(Lyon)	11.6	60.8	11.0	60.6	11.5	62.7	11.1	61.4	11.9	61.5
Garden City	(Finney)	11.8	60.9	13.6	58.2	11.7	63.0	11.3	62.4	12.1	61.3
Goodland	(Sherman)	13.8	59.7	14.5	59.2	12.9	61.2	11.1	58.5	13.2	60.9
Great Bend	(Barton)	11.0	61.1	12.8	57.9	11.0	61.8	10.4	61.5	11.6	61.9
Hays	(Ellis)	12.2	61.9	12.2	59.9	11.1	61.6	10.7	59.0	11.6	60.5
Hutchinson	(Reno)	11.2	61.3	11.9	61.1	11.7	62.0	10.3	62.4	11.9	61.3
Junction City	(Geary)	11.4	60.0	12.0	60.5	11.3	61.5	10.7	61.6	11.4	62.8
Larned	(Pawnee)	11.7	60.6	13.1	56.5	11.5	62.0	10.6	61.5	12.5	60.9
Lawrence	(Douglas)	11.5	60.2	10.3	61.2	11.0	60.8	10.9	60.7	12.0	62.6
Liberal	(Seward)	12.3	60.4	13.8	59.3	12.8	61.9	11.6	61.3	12.2	61.0
Lyons	(Rice)	11.4	60.9	11.8	60.1	11.4	61.1	10.7	62.7	11.6	62.0
McPherson	(McPherson)	11.5	60.6	12.0	61.8	11.9	60.2	11.2	62.9	11.8	61.5
Newton	(Harvey)	11.6	61.3	11.4	61.6	12.1	61.0	11.0	63.1	12.8	60.5
Norton	(Norton)	10.7	61.4	12.5	58.3	10.4	61.3	10.4	61.1	10.5	60.4
Ottawa	(Franklin)	11.1	60.6	10.3	61.2	10.9	62.6	10.8	61.8	12.4	61.7
Pittsburg	(Crawford)	10.6	61.3	10.6	62.5	10.7	62.8	10.8	60.1	11.0	60.7
Pratt	(Pratt)	11.1	60.7	13.5	36.6	11.2	62.1	10.3	63.1	12.2	61.0
Salina	(Saline)	11.5	60.9	13.9	62.0	11.5	60.5	10.7	61.6	12.3	61.6
Topeka	(Shawnee)	11.5	60.2	11.4	61.1	12.0	60.0	10.9	61.7	11.8	61.0
Tribune	(Greeley)	12.9	58.2	14.1	59.9	12.8	62.3	11.9	58.9	12.7	61.9
Wellington	(Sumner)	11.7	63.2	11.3	62.3	11.7	62.7	9.6	62.8	11.3	60.4
Wichita	(Sedgwick)	11.6	62.5	11.4	62.6	11.8	62.6	10.6	63.0	11.0	60.6
Winfield	(Cowley)	11.1	60.9	11.1	61.9	11.6	63.0	10.1	61.6	11.3	60.9

*Source: Wheat Quality Survey 1958-1969, Kansas Crop and Livestock Reporting Service, Kansas Department of Agriculture, Statistical Division and USDA, Statistical Reporting Service, Topeka, Kansas.

P = percent protein content

W = test weight (pounds per bushel)

APPENDIX C (continued)

1963-64		1964-65		1965-66		1966-67		1967-68		1968-69		1969-70	
P	W	P	W	P	W	P	W	P	W	P	W	P	W
11.4	62.9	11.5	60.9	10.8	61.4	11.5	63.1	13.3	59.6	11.2	62.6	10.9	61.0
12.3	62.6	12.4	61.4	10.7	61.5	11.6	62.5	12.0	59.5	10.7	60.5	10.5	60.4
10.9	61.4	11.8	57.8	11.6	60.9	11.8	62.3	12.4	60.4	11.0	61.8	11.3	61.0
11.3	62.0	12.1	62.1	12.0	60.9	12.6	62.2	13.9	60.7	12.2	61.9	11.2	62.3
11.7	61.3	11.9	60.8	11.8	60.2	12.6	62.4	14.1	59.7	11.6	62.7	10.8	61.3
11.9	62.6	11.6	61.0	10.5	61.3	10.2	63.2	10.9	61.6	10.3	61.3	9.7	60.7
11.7	61.5	11.6	61.0	11.9	59.7	11.4	62.4	12.9	59.4	12.0	62.1	11.2	61.1
11.9	62.4	12.6	61.3	12.0	62.1	12.3	61.8	13.3	61.0	13.6	61.0	10.2	62.6
13.5	60.4	11.7	60.9	11.4	60.3	11.7	62.9	13.6	57.9	11.2	61.0	11.0	58.2
13.6	60.1	12.9	62.4	11.9	61.5	13.5	61.0	13.6	59.2	13.5	61.6	11.1	62.1
13.0	62.2	12.7	61.4	12.7	60.0	11.6	62.8	11.8	60.2	12.6	61.4	11.8	61.0
12.0	62.1	12.6	60.5	11.7	60.2	12.2	61.6	12.9	60.9	11.3	61.9	10.5	61.6
12.5	61.6	12.4	61.7	12.0	60.3	13.4	60.9	14.8	58.7	12.7	62.3	10.8	61.3
12.0	62.3	12.3	61.2	10.4	62.4	12.1	62.2	13.1	60.1	10.8	62.7	10.7	61.3
11.1	62.1	11.4	61.2	11.0	61.8	11.9	63.1	13.7	58.6	11.4	62.7	11.5	58.8
11.9	62.0	13.6	60.1	12.4	60.9	13.4	60.9	14.0	60.2	13.0	60.8	11.0	61.0
12.3	60.7	11.5	60.4	12.0	60.2	11.5	62.4	12.0	58.3	10.8	62.3	10.8	59.2
12.6	61.0	13.5	60.3	11.9	61.7	12.6	60.8	12.5	61.0	14.0	61.0	10.5	61.9
12.2	62.8	12.8	60.1	11.3	61.6	12.0	62.6	13.7	60.6	11.2	62.7	11.2	60.8
12.0	63.3	12.0	60.3	10.8	62.0	12.0	62.6	13.7	59.9	11.0	61.8	11.4	59.6
12.1	63.4	11.1	61.1	10.6	62.5	11.7	62.9	13.6	58.4	10.6	61.8	11.0	60.8
11.0	61.8	11.8	62.5	10.1	58.0	12.1	61.8	12.5	60.3	11.8	62.3	11.3	60.8
12.7	61.6	12.6	59.4	11.8	60.2	11.0	63.0	11.8	59.0	11.0	61.6	10.5	59.5
12.0	62.6	11.2	59.7	10.7	61.3	10.6	62.9	10.5	61.4	10.5	61.6	10.0	60.1
12.1	61.9	13.3	60.7	10.5	62.8	12.4	61.9	12.2	61.1	11.6	62.7	10.5	61.5
11.7	62.7	12.2	60.3	11.1	61.5	12.2	62.3	13.8	59.8	11.6	62.4	10.9	59.7
12.0	61.8	12.3	59.9	11.6	61.5	12.4	62.1	13.1	59.3	11.2	62.0	11.2	60.3
13.2	61.4	13.4	61.5	12.7	61.0	13.2	61.0	13.8	60.1	14.0	60.0	12.6	61.1
12.6	62.4	11.1	62.4	10.7	62.0	11.1	62.7	13.5	60.1	11.0	62.0	10.7	61.7
12.0	62.4	11.2	60.5	10.5	62.0	11.0	62.7	14.0	60.2	10.7	62.6	10.8	61.4
12.3	62.6	12.4	61.4	10.7	61.5	11.6	62.5	12.0	59.5	10.7	60.5	10.5	60.4

APPENDIX D

Rail Rates in Cents Per cwt to Kansas City with Effective Dates

Towns	July 1958	October 24 1960	October 15 1964	July 1 1968	April 1 1969	November 18 1969	June 9 1970
Abilene	33½	34	24	26	25	27	28½
Arkansas City	33½	34	24	26	25	27	28½
Atchison	20½	21	12	12	12	13	13½
Beloit	33½	34	24	26	25	27	28½
Clay Center	32	32½	22½	24	23½	25	26½
Columbus	27	27½	17½	19	18½	20	21
Concordia	32	32½	22½	24	23½	25	26½
Dodge City	38½	39	29	31	30	32	33½
Emporia	27	27½	17½	19	18½	20	21
Garden City	44	44½	34½	37	36½	39	41
Goodland	45½	46	36	39	38	40	42
Great Bend	37½	38	28	30	29	31	32½
Hays	37½	38	28	30	29	31	32½
Hutchinson	35	35½	25½	27	26½	28	29½
Junction City	30	30½	20½	22	21½	23	24
Larned	38	38	28	30	29	31	32½
Lawrence	20½	21	12	13	13	14	14½
Liberal	47½	48	38	41	40	42	44
Lyons	35	35½	25½	27	26½	28	29½
McPherson	35	35½	25½	27	26½	28	29½
Newton	33½	34	24	26	25	27	28½
Norton	37½	38	28	30	29	31	32½
Ottawa	20½	21	12	13	13	14	14½
Pittsburg	26	26½	16½	18	17½	19	20
Pratt	37½	38	28	30	29	31	32½
Salina	33½	34	24	26	25	27	28½
Topeka	24	24½	14½	16	15½	16	17
Tribune	45½	46	36	39	38	40	42
Wellington	33½	34	24	26	25	27	28½
Wichita	33½	34	24	26	25	27	28½
Winfield	33½	34	24	26	25	27	28½

APPENDIX E

Rail Rates to Salina in Cents Per cwt with Effective Dates

Towns	July 1958	October 24 1960	October 15 1964	July 1 1968	April 1 1969	November 18 1969	June 9 1970
Abilene	20½	21	12	13	13	14	14½
Beloit	30	30½	20½	22	21½	23	24
Clay Center	30	30½	20½	22	21½	23	24
Concordia	30	30½	20½	22	21½	23	24
Dodge City	37½	38	28	30	29	31	32½
Garden City	44	44½	34½	38	36½	39	41
Goodland	44	44½	34½	38	36½	39	41
Great Bend	32	32½	22½	24	23½	25	26½
Hays	33½	34	24	26	25	27	28½
Hutchinson	27	27½	17½	19	18½	20	21
Larned	33½	34	24	26	25	27	28½
Liberal	45½	46	36	39	38	40	42
Lyons	16½	17	16½	18	17½	19	20
McPherson	20½	21	12	13	13	14	14½
Newton	27	27½	17½	19	18½	20	21
Tribune	45	46	36	39	38	40	42
Wellington	33½	34	24	26	25	27	28½

APPENDIX F

Rail Rates to Hutchinson in Cents Per cwt with Effective Dates

Towns	July 1958	October 24 1960	October 15 1964	July 1 1968	April 1 1969	November 18 1969	June 9 1970
Dodge City	33½	34	24	26	25	27	28½
Garden City	37½	38	28	30	29	31	32½
Great Bend	26	26½	16½	18	17½	19	20
Larned	30	30½	20½	22	21½	23	24
Liberal	38½	39	29	31	30	32	33½
Lyons	20	20½	12	12	12	13	13½
McPherson	20	20½	12	12	12	13	13½
Newton	21	21½	12	12	12	13	13½
Pratt	26	26½	16½	18	17½	19	20
Tribune	44	44½	34½	37	36½	39	41
Wichita	24	24½	14½	16	15½	16	17

APPENDIX G

Rail Rates to Wichita in Cents Per cwt with Effective Dates

Towns	July 1958	October 24 1960	October 15 1964	July 1 1968	April 1 1969	November 18 1969	June 9 1970
Abilene	32	32½	22½	24	23½	25	26½
Arkansas City	21	21½	12	12	12	13	13½
Beloit	37	38	28	30	29	31	32½
Concordia	35	35½	25½	27	26½	28	29½
Dodge City	35	35½	25½	27	26½	28	29½
Garden City	44	44½	34½	37	36½	39	41
Goodland	51	51½	41½	45	43	46	48½
Great Bend	32	32½	22½	24	23½	25	26½
Hutchinson	24	24½	14½	16	15½	16	17
Larned	33½	34	24	26	25	27	28½
Liberal	44	44½	34½	37	36½	39	41
Lyons	30	30½	20½	22	21½	23	24
McPherson	26	26½	16½	18	17½	19	20
Newton	20	20½	12	12	12	13	13½
Norton	50	50½	40½	44	42½	45	47½
Pratt	30	30½	20½	22	21½	23	24
Salina	32	32½	22½	24	23½	25	26½
Tribune	47½	48	38	41	40	42	44
Wellington	20	20½	12	12	12	13	13½
Winfield	21	21½	12	12	12	13	13½

APPENDIX H

Rail Rates to Enid, Oklahoma in Cents Per cwt with Effective Dates

Towns	July 1958	October 24 1960	October 15 1964	June 24 1968	April 1969	November 18 1969	June 9 1970
Arkansas City	33½	34	24	26	25	27	28½
Columbus	47½	48	38	41	40	42	44
Dodge City	47½	48	38	41	40	42	44
Garden City	51	51½	41½	45	43	46	48½
Liberal	50	50½	40½	44	42½	45	47½
Pittsburg	50	50½	40½	44	42½	45	47½
Pratt	37½	38	28	30	29	31	32½
Wellington	30	30½	20½	22	21½	23	24
Wichita	33½	34	24	26	25	27	28½
Winfield	33½	34	24	26	25	27	28½

APPENDIX I

Residual Values for Kansas City Price Differential
Analysis for Mid-November 1958

<u>Observations</u>	<u>Actual</u>	<u>Estimate</u>	<u>Residual</u>
1	24.00	23.38	0.62
2	22.00	24.46	-2.46
3	23.00	24.95	-1.95
4	26.00	23.74	2.26
5	22.00	23.70	-1.70
6	27.00	24.14	2.86
7	18.00	17.65	0.35
8	23.00	24.53	-1.53
9	25.00	22.86	2.14
10	25.00	23.69	1.31
11	26.00	24.48	1.52
12	19.00	23.87	-4.87
13	20.00	23.48	-3.48
14	30.00	25.29	4.71
15	24.00	25.50	-1.50
16	24.00	23.82	0.18
17	26.00	24.17	1.83
18	18.00	18.28	-0.28

DIFFERENTIAL WHEAT PRICES
IN THE STATE OF KANSAS AND RAIL RATES
TO TERMINAL AND SUBTERMINAL MARKETS

by

NATHANIEL OMATAI OKOLIKO EJIGA
B. Sc., Ahmadu Bello University, 1969

AN ABSTRACT OF A MASTER'S THESIS

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The thesis deals with the relationship between wheat prices paid by grain elevator managers in the state of Kansas and rail rates to terminal and subterminal markets during the period July 1958 to June 1970. Since most of the wheat grain is shipped by railroads, it was hypothesized rail rates therefore are the chief reason the price of wheat for a given quality varies among elevators. Also put forward is the idea that elevator managers base their price on the central market price and the rail rates to such markets.

There were two reasons for interest in the study. The first was to see which factors are the main causes for price differences for wheat between elevators and central markets and how much of the difference is attributable to the rail rate factor. The second reason was interest in the application of such principles in deciding what pricing policies a legal monopsonist might use to further equity and to encourage production according to comparative advantage.

The study was carried out by identifying thirty one Kansas towns with daily newspapers that reported local wheat prices over the period of the study. Mid-month reported prices were gathered for these points and the difference from the wheat prices in the relevant terminal locations were determined; the relevant terminal market being the market that receives the wheat grain from these locations. A second data source by the Kansas Crop and Livestock Reporting Services using the mid-month prices of the 105 counties was also used in the analyses. Five central markets were considered in the study--Kansas City, Salina, Hutchinson and Wichita all in Kansas and Enid, Oklahoma. The price differences and the rail rates to the corresponding central markets were used in the analyses in conjunction with locational wheat quality data. The analyses for each central market was made by using a canned computer program for multiple stepwise regression taking the price

differentials as the dependent variable while rail rates and wheat quality factors were taken as independent variables.

The analyses focussed on testing three main hypotheses namely: that there is a correlation between price differences and rail rates; that the rail rate factor is the most significant independent variable; and that the relative effects of rail rates vary over time and space. All the hypotheses were at least partly confirmed. The strongest confirmation was found for the Kansas City market differentials and varying degrees of support of the other central market differential analyses was found. On the average, the rail rate factor was found to be the most significant variable, followed by protein content, and test weight. Moisture content and dockage factors were found less significant. In general, rail rate factor was not as significant for Salina and Hutchinson markets as it was for the other central markets. Among the two sets of data used, the county data in general showed more significant results than the town data and this was probably because there were more county observations.

Because rail rates had smaller relative coefficients, it was concluded that any advantages to be realized from the other factors may be passed on to the farmer more than any advantages from rail rates. However because rail rate coefficients were found to be more stable over time than the coefficients of the other factors, rail rate advantages may make a big contribution over time. In applying the principle to the pricing policy of a legal monopsony, it was found that the monopsony should consider both quality and shipping costs, probably giving the most weight to quality factors.

Two main problems of the data were identified: the clustering of observations and the presence of heteroskedasticity which might have affected the results.