

## Geographical Price Surfaces

Price analysts are interested in three different aspects of prices—differentials in prices over geographical areas, and differentials with respect to different grades of a product, as well as the changes over periods of time. That is, they are interested in prices with respect to space and form as well as time.

Changes in prices over periods of time are important, and have received most of the attention of price analysts, in line with their importance. But changes in prices over areas of space are important, too, particularly in the modern decentralized markets of today which cover large areas of geographical space.

Spatial hog price problems have been well analyzed in several publications.<sup>1</sup> Some more technical difficulties have arisen with respect to several other commodities, especially those that are directly affected by government price-support programs.

When the corn-loan program was being formulated in 1933, there were data available only as far back as 1924, and these were inconclusive. Consequently the structure of the program was revised considerably in the years that followed.

For example, the loan rates for corn during the first few years of the corn-loan program were uniform over the commercial corn area. The corn-loan surface was geographically flat. It was obvious from the first that this did not fit the corn-price surface over the area. Elementary economic theory alone would indicate that, since corn moves in large quantities from the surplus-producing areas of the western and central Corn Belt through to the East,

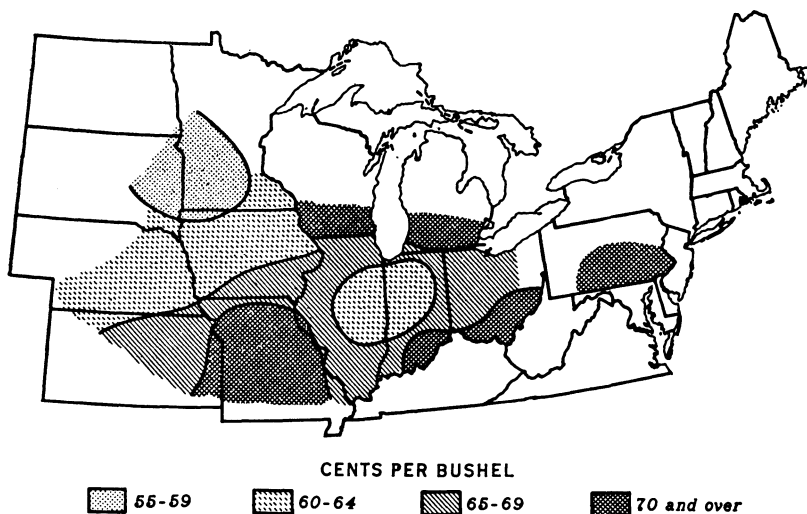
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<sup>1</sup> These are summarized in G. S. Shepherd, *Marketing Farm Products*, Iowa State Univ. Press, 5th ed., 1969, Chap. 14.

price differentials between the surplus and deficit areas must be at least large enough to cover the costs of transportation.

As additional price data accumulated from the crop-reporting districts (about 10 counties per district), it became apparent that the price surface was even more undulating than had been anticipated earlier. Figure 14.1 shows in some detail the average farm prices of corn during the interwar years, 1924-39, over the commercial corn area. "Iso-price" lines, connecting approximately equal prices, like contour lines on a topographical map, help to bring out the character of the "price surface" over the area.

Figure 14.1 shows that the corn-price surface is not flat like the ocean, nor is it uniformly sloped in any single direction. The rough general tendency is for the price surface to slope downward from the east to the west, and from the south to the north; but the slope is not uniform. Valleys and ridges, plateaus, and even basins, occur in the price surface. In central and eastern Illinois and western and central Indiana during that period there was a basin of 63-cent prices surrounded by a ring of higher prices on all sides. Going west from that area, prices at first do not decline; they rise. It was necessary to surmount a ridge of 64- and 65-cent prices



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Fig. 14.1 — The price surface for corn has a general slope upward from west to east, except for a depression in eastern Illinois and western Indiana, where large quantities of corn in excess of local needs are produced. The lowest prices are found in the northwest corner of the Corn Belt. (Average farm price, by crop-reporting districts in the commercial corn area.)

in western Illinois and southeastern Iowa before reaching the low-price valley that ran northwest from central Iowa, deepening as it went.

Actual differences in prices shown in Figure 14.1 were in most cases less than the transportation costs between the different points. It is evident from these price relations, as well as from data regarding corn shipments and destinations, that the corn produced in the surplus-producing areas did not move from the western and central part of the Corn Belt clear over to the eastern states, unless it be in a few exceptional years, and in comparatively small quantities. Corn from western and central Iowa ordinarily goes to eastern Iowa and as far east as Chicago but very little of it seems to go east of Illinois. Less is known about shipments from eastern central Illinois, but it appears from the price charts that corn does not move regularly, year after year, from Illinois to Indiana and Ohio, for prices in Indiana average about the same as in Illinois, and in Ohio they average only 4 or 5 cents higher.

Apparently, what happens is this: The price surface changes greatly from year to year, and in any one year the differentials from certain areas to certain others may be great enough to cover transportation costs between these areas. In another year these price differentials change, perhaps even reverse, and corn flows differently. The average figures show very small average-price differentials, but in any one year the price differentials may be large. Investigation of the years separately is required.

It is difficult to carry several price maps for individual years in the mind's eye at the same time, for comparison; the variability of the price surface from one year to another can be shown more clearly by sacrificing some detail and showing only cross sections rather than entire price surfaces. A cross-section comparison can be made by use of data from a row of crop-reporting districts running from east to west along the middle of the Corn Belt, with the district centers approximately equal distances (about 100 miles) apart. The prices in these districts may be represented by vertical bars, the chart then looking something like a picture of a picket fence with the stakes driven unevenly into the ground.

The Corn Belt widens out toward the west, so that it is advisable not only to show a section along the Corn Belt from east to west, but also a cross section cutting across the western end of the belt from north to south. The districts selected for this north-south section should lie successively adjacent to one another, their centers being closer together than those in the east-west line, because the gradation of prices is steeper and the distances in-

volved are shorter. Each such chart, therefore, consists of two parts, one showing the east-west section and the other showing the north-south section.

Charts of the kind described, one of which has been prepared for each year, are too complicated and numerous to be reproduced here, but they show a story that can be told in a few sentences. They show that the character of the price surface changes greatly from year to year. In most years, it differs widely from the 16-year average surface shown in Figure 14.1. In 1927, 1928, 1929, and 1932, the surface sloped steeply upward from west to east; in 1936, it sloped almost as steeply downward from west to east; in 1925, 1926, 1931, 1934, 1935, and 1937, the general contour was horizontal, but the surface was uneven, in different places in the different years. In the other 5 years, the surface had a general sloping character similar to that of the 16-year average, but it had a different sort of unevenness each year. The price surface of the cross section from north to south was more nearly stable from year to year than that of the cross section from west to east, but in 1931 the normal steep upward slope from north to south was reversed, and in 1932 it was almost flat; and no two years were alike.

#### **VARIATIONS IN CORN PRICE DIFFERENTIALS BETWEEN IOWA, INDIANA, AND OHIO**

The price surface varies greatly from month to month, as well as from year to year. The data to show this for all the crop-reporting districts, or even for the cross-section districts, are too numerous to provide any clear mental impression. But the data for a few representative states and districts tell the story more clearly than the mass of data for all of the districts together.

The top line in Figure 14.2 shows the difference between the price of corn in Ohio and the price of corn in Iowa, by years, from 1909 to 1955. The Iowa price is used as the base; it is represented by the horizontal zero line across the chart. The Ohio price is plotted as so much above or below the Iowa price as represented by this horizontal zero line. The chart shows that the Ohio price ranged from 17 cents above to 10 cents below the Iowa price—a total range of 27 cents.

The lower line shows the same sort of comparison of Nebraska and Iowa prices, by years. The price differentials in this case cover a range of 20 cents.

Figure 14.3 shows the same sort of information by months, instead of by years. It shows that the monthly corn price differentials fluctuate rapidly over a wide range, within the season as

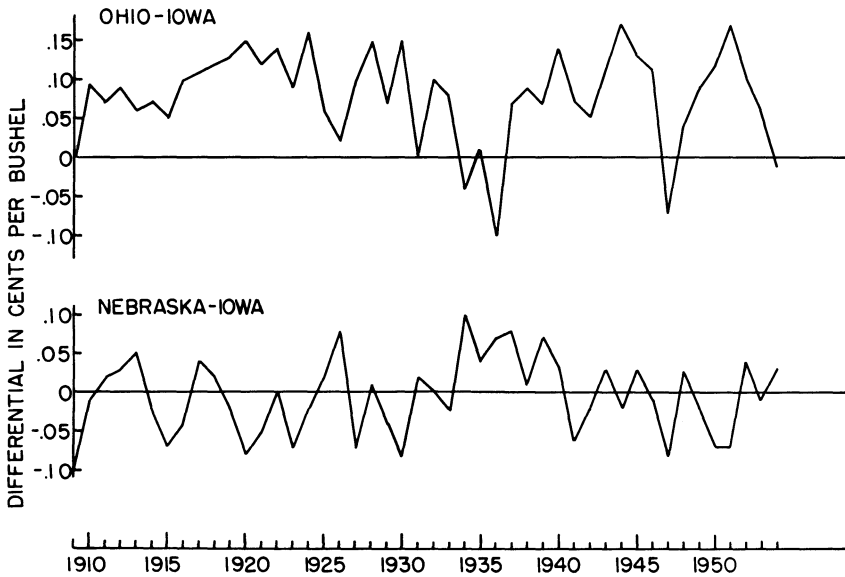


Fig. 14.2 — Annual (December-May average) corn price differentials between Iowa and Ohio, and Iowa and Nebraska, 1909–55.

well as between seasons. The range of the monthly differentials is nearly twice as great as the range of the yearly differentials.

Chief reason for the variations in corn price differentials from year to year among the different states apparently is variations in corn production. Figure 14.4 shows the inverse correlation that exists between relative prices and relative production, for Iowa and three other states during the interwar period 1924–39.

As a result of the study of these and other data, the administrators of the corn-loan program in 1941 replaced the original geographically flat or uniform loan rates by a structure of geographically different rates. The differentials among the loan rates were based upon the average price differentials over the preceding twenty years. It was expected that this structure of loan rates would fit the area with a minimum of disturbance to feeding, shipping, manufacturing, etc., that had been built up under the influence of competitive economic force and had presumably resulted in the most efficient location of these activities.

There was a question whether the differentials in the loan rates should be changed from year to year to conform with the different relative sizes of crops in the different states from year to year. The decision was made not to do this, but to retain a fixed structure of differentials from year to year, conforming with

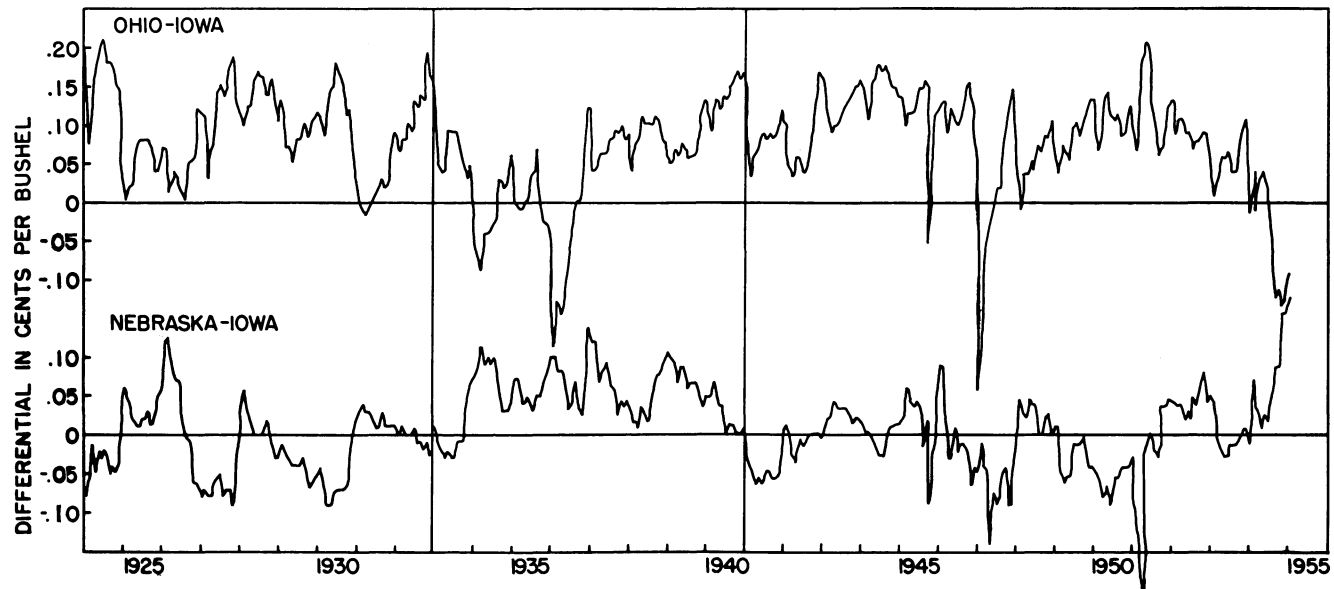


Fig. 14.3 — Monthly corn price differentials between Iowa and Ohio, and Iowa and Nebraska, 1921–55. Crop year is October to September (1924 means Oct. 1924 to Sept. 1925).

*average* crops and price differentials in the past. This would reduce the amount of shipping out from one state one year and shipping in another year as relative crop sizes changed; it was believed that the costs of moving corn into and out of local storage would be less than the costs of shipping corn into and out of geographical areas.

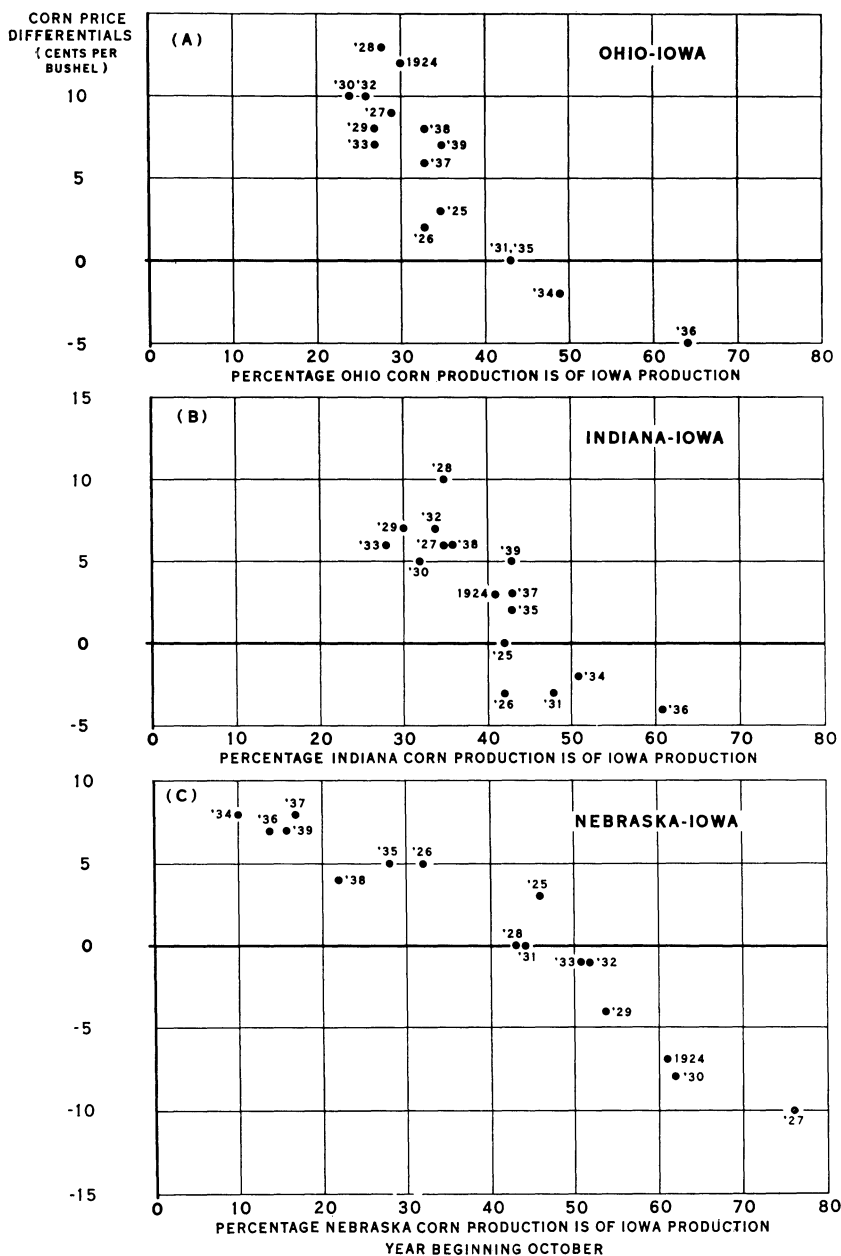
It was expected that this fixed structure of corn loan rates would reduce the variations in corn price differentials among the states from month to month and from year to year. It is interesting to observe, from Figures 14.2 and 14.3, that this has not happened. The differentials have continued to vary much the same as they did before the corn-loan program started back in 1933.

### **GEOGRAPHICAL DIFFERENTIALS IN WHOLESALE MEAT PRICES**

The discussion cited in Footnote 1 of the present chapter shows that a considerable amount of variability exists among hog prices at different markets. The same thing is true of wholesale meat prices. Figure 14.5 shows how the prices of fresh pork loins at New York, for example, vary in relation to the corresponding prices at Chicago, from 1946 to near the end of 1949.

Effects of the fixed differential price ceilings imposed by the OPA until the middle of 1946 are clearly shown in the chart. So are the unsettling effects of the removal of price ceilings. After things settled down to normal, however, the price relations varied greatly from week to week. "Normal" appears to be represented by considerable variation. The freight rate on fresh pork loins from Chicago to New York was about \$1.00 per 100 pounds through most of 1947, rising to \$1.43 by September 1, 1949. Price variations before World War II were less in dollars and cents, but greater in percentage terms, than since the war.

If these were daily price data, relative price variations could be explained as the result of relative gluts and scarcities at New York that lasted until smaller and larger shipments could be made from Chicago to wipe them out. It takes a day or two to get pork from Chicago to New York. But these are weekly average price data. It is not easy to explain why packers at Chicago would continue to ship fresh pork loins to New York for a week or two at a time to sell for \$2.00 to \$3.00 per 100 pounds less than they would bring in Chicago, or why they would let substantial differentials in excess of the freight rate persist for several weeks at a time. The same sort of situation exists for other wholesale cuts of pork, and of beef as well. There must be good reasons for it. A study of the causes and



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Fig. 14.4 — Relation between corn price differentials and relative corn production for various states; A. Corn price differentials between Ohio and Iowa (plotted up the side) and the percentage that Ohio production is of Iowa production (plotted along the bottom); B. Same sort of relationship for Indiana and Iowa; C. For Nebraska and Iowa.



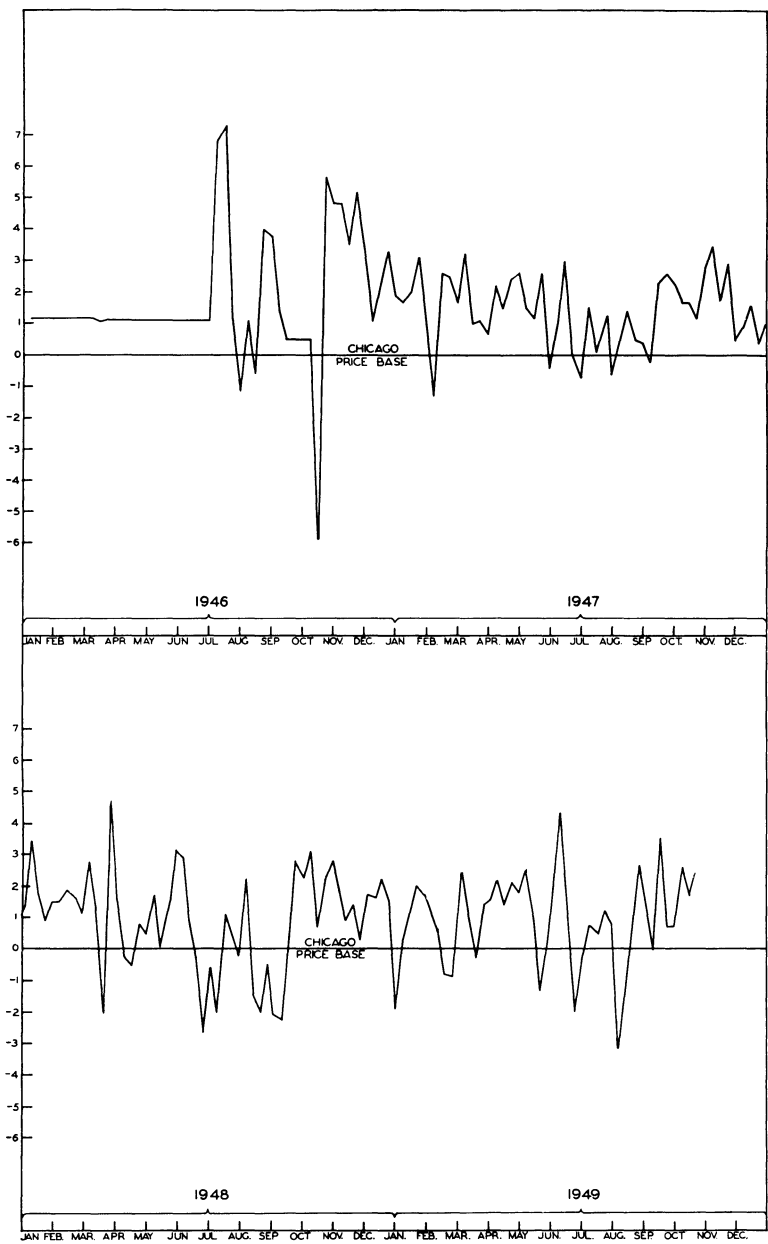
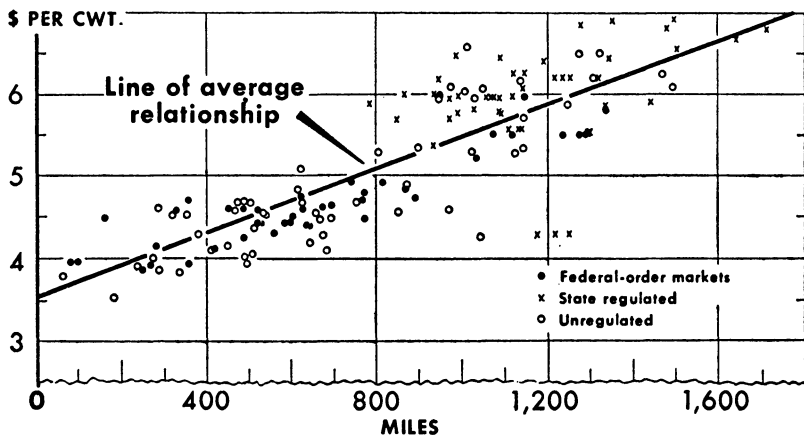


Fig. 14.5 — Weekly differentials in prices, in cents per pound, for fresh pork loins at New York and Chicago.



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Fig. 14.6 — Fluid milk prices, July 1953–June 1956, plotted against distance from Wisconsin.

effects of this situation would constitute a good marketing research project.

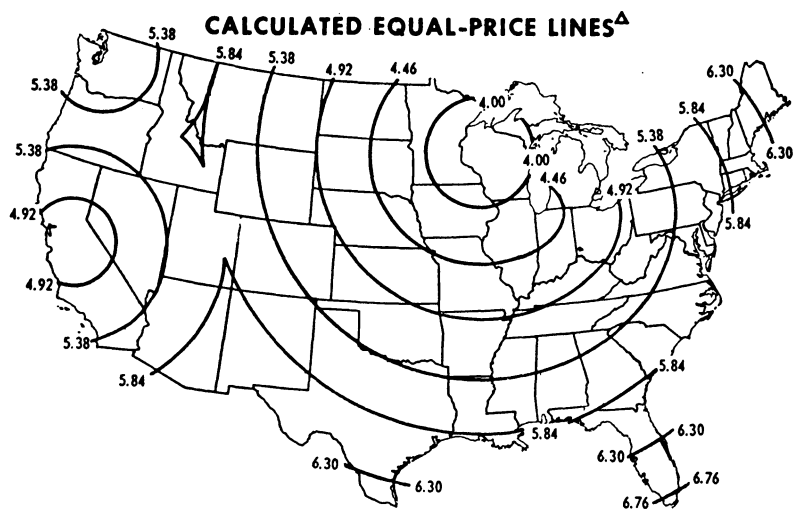
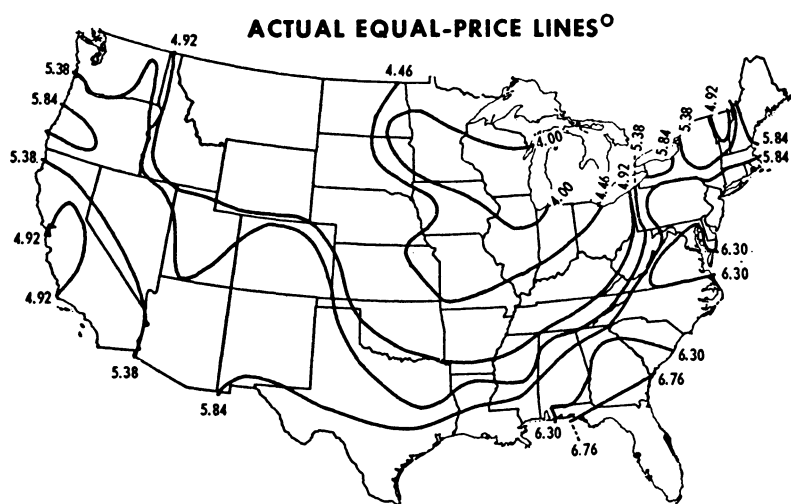
### MILK PRICE DIFFERENTIALS <sup>2</sup>

The differentials between the prices of milk in different areas are more stable from month to month and year to year than the differentials for corn. The milk price regulations governing the different milk markets differ from market to market, and it is instructive to study the price differences between the areas at any one time, to see what the effects of the different regulations on prices might be.

Figure 14.6 shows the dealers' buying price for fluid milk at 143 markets located east of the Rocky Mountains, plotted against the distance from Eau Claire, Wisconsin (the heart of the milk surplus area). The chart shows that the price of milk increased an average of 19 cents per 100 pounds per 100 miles increase in distance from Eau Claire. This corresponds roughly with the costs of transportation and other transfer costs.

There is some scatter about the regression line in the chart. Only 75 per cent of the differences in prices was directly associated with distance; the other 25 per cent was the result of other factors. The location of the individual points above or below the line helps to identify the markets which were affected by these other factors.

<sup>2</sup>This section draws on "Regulations Affecting the Movement and Merchandising of Milk," Marketing Res. Rept. No. 98, AMS, USDA, 1955, pp. 88-96.



<sup>Δ</sup> BASED ON DISTANCE FROM ALTERNATIVE SUPPLY AREAS.

<sup>o</sup> BASED ON PRICES IN 160 MARKETS

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Fig. 14.7 — Actual equal-price lines (price contours) for milk, July 1953–June 1954, and calculated equal-price lines based on distance from alternative supply areas.

(The names of the individual markets and the number of cents which their prices were above or below the line were given in a table in the original report; it is too long to reproduce here.) This paves the way for investigating in each case what the other factors were.

The relations among the prices of milk at 160 markets all over the United States are shown in a different way, by "iso-price" lines, in the upper part of Figure 14.7. This map includes alternative supply areas from Seattle, Washington, and Fresno, California, as well as from Eau Claire. The lower part of the chart shows prices based on distances from these alternative supply areas. The comparison of two charts shows that actual prices are lower than transportation costs alone would explain, in the intermountain areas of the West, and in the Northeast; they are higher in the East and Southeast.