

MONTHLY

REVIEW

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FEDERAL RESERVE BANK OF MINNEAPOLIS

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Toward an index of Ninth district industrial production

At a time when a number of the more important domestic problems — poverty, taxation, labor utilization, mass transit, and urban renewal — are of a regional nature, the need for more and higher quality subnational economic data is both obvious and acute. Because of the geographic diversification of the Federal Reserve System, district data are important because they play an integral role in the determination of monetary policy; but the same information is also of considerable value to other groups — especially state and local governments and the business community — as a guide to decision-making on economic matters.

From a more theoretical viewpoint, comprehensive regional data and analysis probably would provide further insight into a number of observable economic phenomena. For example, meaningful measures of subnational or district production over time may increase understanding of both economic growth and of business cycles on the national level, or aid in explanation of diverse regional reactions to changes in national economic policy.

With the various Federal Reserve banks playing a leading role, the state of regional analysis, in general, has improved significantly in recent years; but gaps still exist. Among the more pressing current needs is for the development of a district measure of physical output — one which would be available on a monthly basis and with a minimal time lag¹

and which would also be useful both as an approximation of economic growth and as a sensitive indicator of the current stage of the business cycle. What is needed is a series on a district level comparable to the Federal Reserve Board's "Index of Industrial Production." Also, a regional index should be capable of being extended to subareas of production such as durable and nondurable manufacturing and to specific industry categories in a way similar to that of the national FRB index.

It is the objective of this article to attempt to develop just such an index by empirically estimating a functional relationship between output and two primary factors of production — labor and capital.² One of the important aspects of the model is the substitution of industrial use of electricity for capital. Unfortunately, the analysis is not as

¹"Value Added by Manufacturers" from the *Census of Manufacturers* is probably the best single measure of subnational output and changes, but since it is only computed annually and available after a considerable time lag, it is of little value for appraising current business conditions. Its usefulness is further limited because it is measured in current dollars and therefore cannot be strictly interpreted as a measure of physical output. Value added by manufacturers does have some value for the present analysis as a validation of indirect estimates of production made in the past (see Table 4).

²This article is a progress report on the type of research which has been done on the topic of district production indexes; it is quite unlikely that the index developed here will be computed on a routine basis, but the methodology developed is likely to be pursued with more refined data.

accurate nor as complete as might be desired because the quality and scope of the data, particularly electric power information, is not optimal.³ For this reason, the analysis is restricted to the board aggregate Federal Reserve Board's "Index of Electricity — General Industrial" (as published in the *Federal Reserve Bulletin*) on the national level and a similar index for the Ninth district. Thus, the preliminary model can only be used to estimate total district production and is not extended to subgroups such as specific industries.

Of fundamental importance in the model analysis is the use of electric power consumption as a substitute for capital. This is done primarily because of a scarcity of available data on the level of capital stock, especially on a subannual basis, for both the nation and the district. The substitution assumes a high positive correlation between the level of capital stock and electricity consumption, and this seems reasonable because a large portion of electricity is used in the operation of production equipment.⁴ To a certain extent, this assumption is supported by the scatter diagrams of kilowatt-hour consumption and gross book value of assets for all manufacturing and for three selected industries (Chart 1). All four diagrams indicate a positive relationship. Another argument for using an electric power series for current production analysis is that the Federal Reserve System is in the process of developing an extensive data collection system whereby data eventually will be readily available and easily broken down into industry categories.

Use has been made of the electric power series taken alone as an estimator of regional output, but

³For example the electric consumption index includes sales to all large users of electricity and is not strictly an industrial measure. More comprehensive electric power data are only now in the process of being developed and are not yet available over a long enough period of time to be useful.

⁴The use of electricity consumed rather than the level of capital stocks may actually be more realistic for purposes of estimating output because the former would be more sensitive to the actual intensity of use of capital, whereas the latter would simply measure capital stock in existence but not necessarily in use.

because of an upward bias in the series, this type of analysis is not realistic. It is obvious from both Chart 2 and Table 1 that the use of electric power data alone to estimate industrial production on the national level would have resulted in a gross overestimate. From 1957 to 1965 the electric power series increased 62 per cent, while industrial production rose only 42 per cent. For the period 1961-65 the respective figures were 37 per cent and 31 per cent.

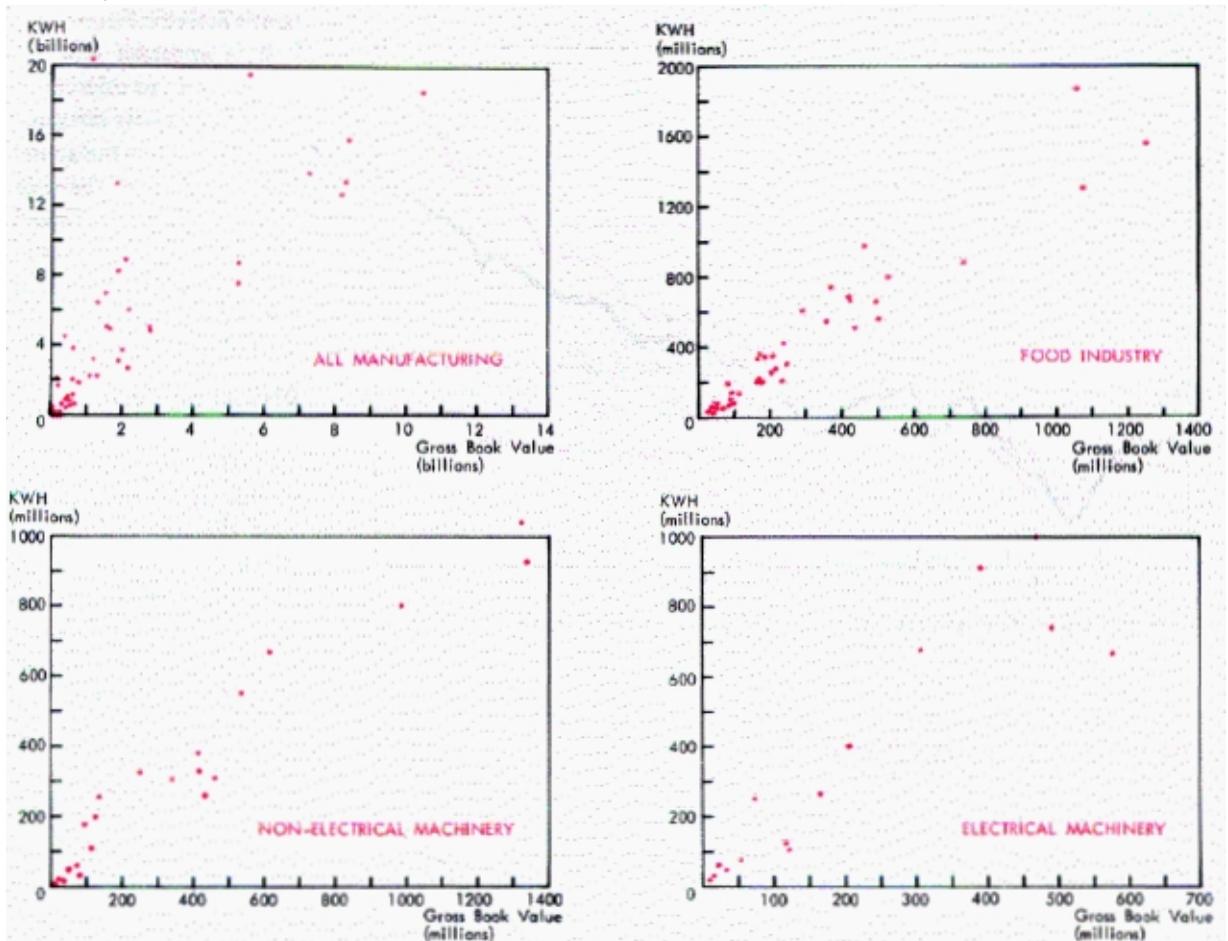
The use of the electric power series, of course, certainly would have been more accurate than simply that of production worker manhours. Again this is apparent from observation of Table 1. Output per unit of labor input is much more variable than output per electricity input. As some have pointed out, it would seem reasonable to say that production worker manhours forms a lower bound and the electricity series an upper bound for estimates of output; but because of the great disparity between the two series, this conclusion, however valid, is of little analytical value. In the following, an attempt is made to show how both manhours and electricity consumed might rationally be combined into a meaningful production index.

The model

The model to be developed is based on the traditional Cobb-Douglas⁵ production function, $Y = AL^{\alpha}K^{\beta}$, where Y, L, and K represent output, labor, and capital respectively. The parameter A is a broad measure of efficiency which is often made a function of time in more sophisticated analysis, but it is assumed to be constant for present purposes. The exponents α and β are the respective elasticities of labor and capital, and it is the estimation of these values together with A that will define the specific functional relationship being sought. By using the Federal Reserve Board's "Index of Industrial Production" as a measure of output and "Production Worker Man-

⁵See Charles W. Cobb and Paul H. Douglas, "A Theory of Production," *American Economic Review*, Vol. XVIII, No. 1 (March, 1928), pp. 139-165.

Chart 1 — Scatter diagrams of electrical power consumption and capital stock, United States, 1957



hours” and “Electricity — General Industrial” for labor and capital in a multiple correlation analysis⁶ (monthly data from January 1957 to December 1965) the following estimating equation is derived: $\hat{Y} = -.608L^{.984} K^{.745}$. That the estimated index is associated quite closely⁷ with the actual index is obvious from observation with Chart 3. The estimated year-to-year changes (Table

⁶For computational purposes, an equivalent form of the Cobb-Douglas function

$\ln Y = \ln A + \alpha \ln L + \beta \ln K$ was used. All data were seasonally adjusted.

2) conform much more closely to the actual changes than was true using either the manhours or electric power series alone (Table 1). The estimated total change from 1957 to 1965 and from 1961 to 1965 of 44.2 per cent, and 32.4 per cent is very close to the changes in the actual index of 42.3 per cent and 30.6 per cent. It should also be noted

⁷In statistical terms, the multiple coefficient of determination (R^2) was .991, while the partial correlation between output and labor ($r_{Y,L}$) was 0.57, and between output and capital ($r_{Y,K}$) was 0.986. Both α and β were significantly different from zero at the 0.99 confidence level.

Chart 2 — Estimates of industrial production, United States, 1957-65

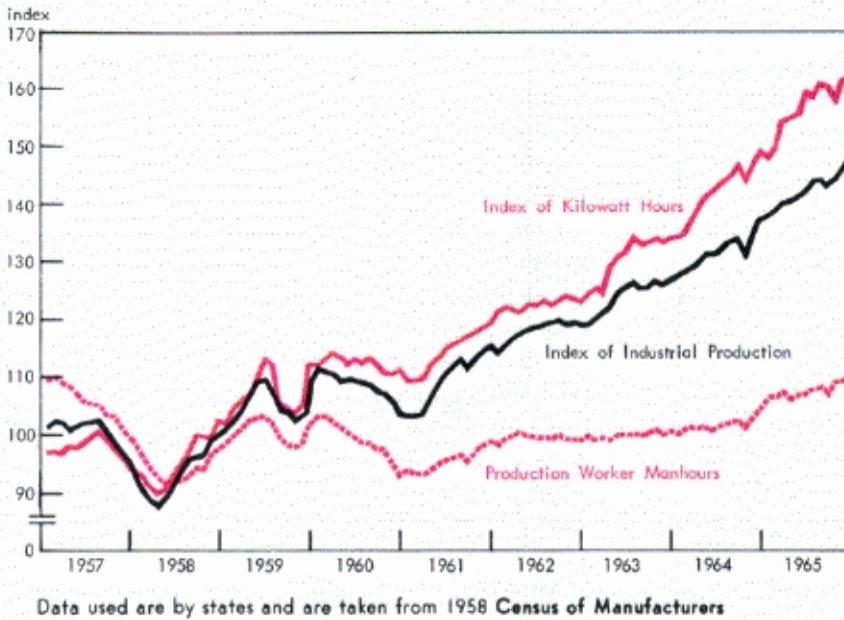
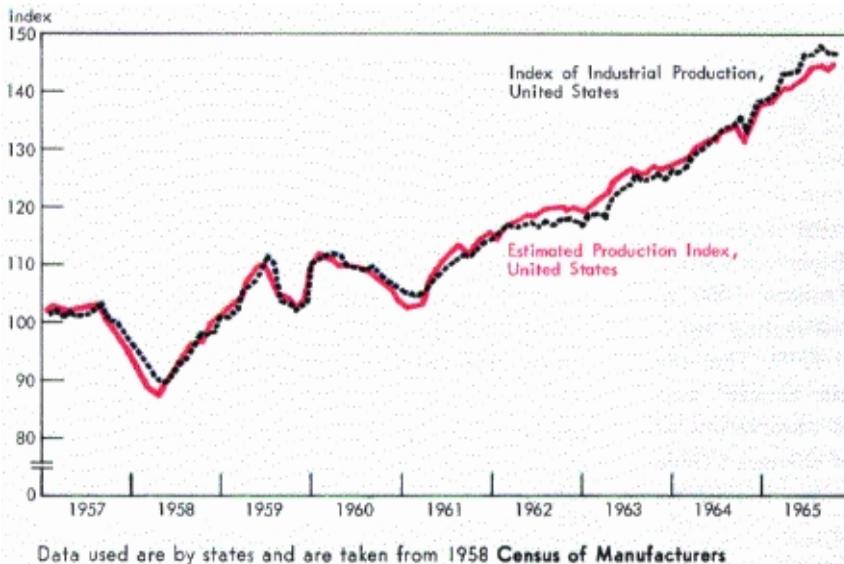


Chart 3 — Comparison of estimated production index and actual index, United States, 1957-65



that this index is very sensitive to changes in economic activity. From Chart 3 it is apparent that the estimated production index had exactly the same turning point as the actual index, and that the two were very closely linked during the 1958 recession, the 1959 steel strike, and the automobile strike in the fall of 1964.

District analysis

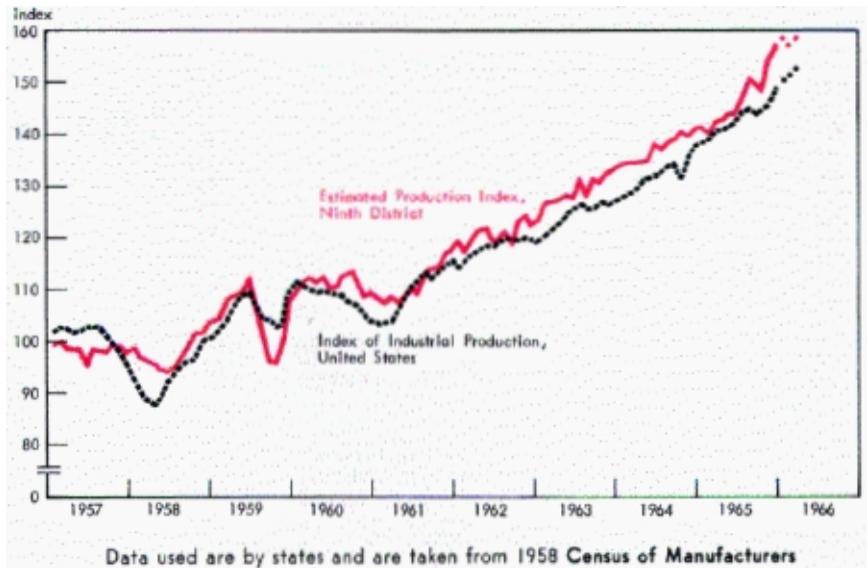
Having developed this estimating function for the nation, it remains to extend the analysis to the Ninth district. The key to this extension is the assumption that the same functional relationship that was developed for the nation also holds for the district. Obviously the accuracy of the district production estimates rests heavily on the validity of this assumption, and there are reasons why the relationship may be significantly different—the most important being the difference in industrial composition of the two areas as outlined in Table 3 which lists the ten largest industries in the Ninth district. For the present, however, it will be assumed that the relationship is an accurate representation of district activity.⁸

Continuing the model development, it is a simple matter to substitute district data for man-hours and electricity consumed to arrive at an estimate of district production. These estimates are shown monthly and compared to the national index in Chart 4, and the annual averages and per cent changes are detailed in Table 4. From these data, certain trends become apparent. Estimated production for the district closely paralleled production for the nation as shown by the relative change in the two indexes over various periods (Table 5). Further, during the 1957-58 recession, production declined by only 5.1 per cent for the district while the national index fell 14.3 per cent from peak to trough. This, of course, is partially explained by the relatively noncyclical nature of most industry in the district. The district index fell much more sharply during the 1959 steel strike; however, over the entire period studied, the relative changes in the two indexes are remarkably close and offer evidence that economic growth in recent years has been at least as rapid as that of the nation.

Data for the first three months of 1966 are shown in Chart 4 as disconnected points. This method of illustration is used to emphasize the fact that the data for this period were projected beyond the period which was used to estimate the

*Through further research, attempts will be made to develop an adjustment factor to apply to the estimating equation that will compensate for the differences in industry composition.

Chart 4 — Comparison of estimated production index, Ninth District, with actual index, United States, 1957-first 3 months of 1966



production function coefficients, and consequently, the way in which this index would be used in current analysis. Although district production did not grow as fast as the nation during the first quarter of 1966, it did advance to new record-high levels.

At this time it is not possible to accurately extend the model to the industry level. National data on electricity consumption by industry are only now being developed, and are not yet available for a period of time long enough to be able to provide reasonably good estimates of the various parameters in the production function. When these data do become useful, it will be a simple matter to develop production functions for specific industries on the national level, assuming that the same relationship holds for the district, and then estimate production indexes for the important industries in the district.

TABLE 1 — VARIOUS PRODUCTION INDEXES, UNITED STATES, 1957-65

	(1957-59=100)					
	Index of Industrial Production		Production Worker Manhours		General Industrial Electricity	
	Actual index	Annual %change	Actual index	Annual %change	Actual index	Annual %change
1957	100.7		105.4		97.6	
1958	93.7	-6.3	94.1	-10.7	95.3	-2.4
1959	105.6	12.7	100.5	6.8	107.1	12.4
1960	108.7	2.9	99.2	-1.3	112.5	5.0
1961	109.7	0.9	95.6	-3.6	114.8	2.0
1962	118.3	7.8	99.5	4.1	122.8	7.0
1963	124.3	5.1	100.1	0.6	131.2	6.8
1964	132.3	6.4	102.2	2.1	142.8	8.8
1965	143.3	8.3	108.4	6.1	157.7	10.4
1957-65		42.3		2.3		61.6
1961-65		30.6		14.4		37.4

TABLE 2 — COMPARISON OF ESTIMATED AND ACTUAL INDEXES OF PRODUCTION, UNITED STATES, 1957-65

	(1957-59 = 100)			
	Actual Index of Industrial Production		Estimated Index of Industrial Production	
	Annual average	Per cent change	Annual average	Per cent change
1957	100.7		100.4	
1958	93.7	-6.3	94.7	-5.6
1959	105.6	12.7	105.8	11.1
1960	108.7	2.9	109.2	3.2
1961	109.7	0.9	109.4	0.2
1962	118.3	7.8	116.8	6.8
1963	124.3	5.1	122.8	5.1
1964	132.3	6.4	131.8	7.3
1965	143.3	8.3	144.8	9.8
1957-65		42.3		44.2
1961-65		30.6		32.4

TABLE 3 — COMPARATIVE INDUSTRY COMPOSITION BY VALUE ADDED, UNITED STATES AND NINTH DISTRICT

SIC Code	Industry	Ninth District*	United States
20	Food and kindred products	20.7	11.2
35	Nonelectrical machinery	17.2	8.9
36	Electrical machinery	7.9	8.6
27	Printing and publishing	7.4	5.5
26	Paper and allied products	6.3	3.8
28	Chemicals and allied products	6.2	9.2
32	Stone, clay and glass products	5.7	3.8
34	Fabricated metal products	5.2	6.2
37	Transportation equipment	4.7	11.9
39	Miscellaneous manufacturing	4.2	3.1
	Durable manufacturing	53.8	56.7
	Nondurable manufacturing	46.2	43.3

*Only data for Minnesota was included because complete data from other states for 1963. Since Minnesota accounts for 86.5 per cent of district production (as measured by value added) this should be a reasonable representation of the district.

Source: 1963 Census of Manufacturers

TABLE 4 — ESTIMATED PRODUCTION INDEX AND ACTUAL VALUE ADDED BY MANUFACTURE, NINTH DISTRICT*, 1957-65

	Estimated Production Index		Value Added by Manufacture	
	Annual average	Per cent change	Annual total (000)	Per cent change
1957	98.5		\$2,392,273	
1958	98.0	-0.6	2,424,219	1.3
1959	104.7	6.8	2,748,421	13.4
1960	110.0	5.0	2,762,027	0.5
1961	112.6	2.4	2,873,884	4.1
1962	120.8	7.3	3,065,687	6.7
1963	129.1	6.9	3,277,157	6.9
1964	137.2	6.3	n.a.	
1965	146.9	7.1	n.a.	

*Four states

Source: Various surveys and Census of Manufacturers

TABLE 5 — RELATIVE GROWTH IN NATIONAL AND DISTRICT PRODUCTION

	Per cent change National Production	Per cent change District Production
1957-65	42.3%	49.1%
1959-65	35.7	40.3
1961-65	30.6	30.5
1963-65	15.3	13.8

Summary

This article has attempted to illustrate one possible approach that might be followed in developing a district production index. Further research is clearly needed to refine the index produced here, particularly with respect to the assumption of identical production, functions in both the district and the nation.

Initial estimates of district manufacturing output indicates that the district compares quite favorably to the nation. During the expansion phase of the current business cycle, which is now more than five years old, the district has experienced growth rates in production which are at least as great as the national average.

Statistical review available

Copies of the 1965 Annual Statistical Review, presenting data for principal statistical series relating to the Ninth Federal Reserve district, are now available from the Research department of this bank.



Current conditions . . .

District agricultural conditions and prospects, based on late May and early June reports, are seen as good to excellent. Soil moisture conditions are generally adequate except for some spotty areas in western areas; temperatures have been normal; and prices of farm products have continued favorable. Much can happen to both farm production and income as the season develops, but at least the 1966 agricultural economy is off to a good start.

The district's nonagricultural economy also has continued to push ahead since the first of the year and in comparison with the similar period a year earlier. Total district employment expanded by 2.6 per cent during the first quarter of 1966 and preliminary April data indicates this rate of growth has continued. Unemployment has decreased and is substantially below year earlier levels. Industrial production as measured by the use of electric power expanded at better than a 12 per cent annual rate during the first four months of this year. A further increase (about 5 per cent in the first quarter) in production worker man-hours in district manufacturing also denotes continued economic growth.

Bank debits (the dollar value of checks written) during April showed a 13 per cent increase over April 1965 with an even larger gain indicated during the first four months of this year compared with the same months last year. Both the numbers and valuations of the district's building per-

mit series were up significantly from year earlier comparisons, although the total valuation of construction contracts let have, thus far, been somewhat disappointing. Finally, *Business Week* estimates of personal income in Ninth district full states show about an 8 per cent growth rate in personal incomes during the first quarter—slightly above the national growth rate.

In summary, near the mid-year point, almost all the important district economic series are revealing an optimistic picture except for the danger of inflation as the demand for labor, goods, and services presses on available supplies.

The banking picture in the Ninth district continues to be one of modest deposit growth, particularly for demand deposits, and of heavy loan demand. As a result, the loan to deposit ratios at the larger weekly reporting banks rose sharply throughout 1965 and the first quarter of 1966. At the end of May the ratio was at 66.2. Loan-to-deposit ratios at other district banks have also risen, but at a somewhat lower pace (a 57 per cent ratio by late May). Other measures of some restrictions in bank liquidity includes greater use of federal funds in recent months and increased borrowing at the Federal Reserve Bank of Minneapolis. During the first four months of 1966, the use of federal funds was up 57 per cent and "Fed" borrowing was up 47 per cent compared with the same period in 1965.

The following selected topics describe particular aspects of the district's current economic scene:

Cash farm receipts show increase

Relatively higher commodity prices, together with slightly larger marketings of farm products, moved district cash farm receipts to record levels during the first quarter of 1966. Total receipts amounted to \$826 million in the district, up 13 per cent from the same period of 1965.

A marked rise in cash receipts from the sale of livestock and livestock products accounted for the entire gain in total cash receipts. Livestock receipts were 25 per cent ahead of those of a year earlier, while cash receipts from the sale of crops were 7 per cent lower.

The pattern of cash farm receipts varied considerably among the district states. The largest increase over a year ago occurred in Montana and South Dakota where the totals were up by more than 22 per cent. In Minnesota cash farm receipts advanced by 13 per cent. The only state to experience a decline was North Dakota where a drop in crop receipts pulled the total down by 2 per cent from that of 1965.

Most of the rise in farm income was attributable to higher farm commodity prices. While some price declines occurred, especially in hogs, the general level, as reflected in indexes of farm prices received, have been mostly unchanged and well above the year-earlier level. For example, the all-commodity index in Minnesota averaged about 93 during the first four months as compared with an average of about 80 during the same period of 1965. The all-commodity indexes in the other states advanced to a modest extent during the first quarter and during the first four months were generally well above those of a year earlier.

The major price change during the first quarter occurred in hogs. The average farm level price

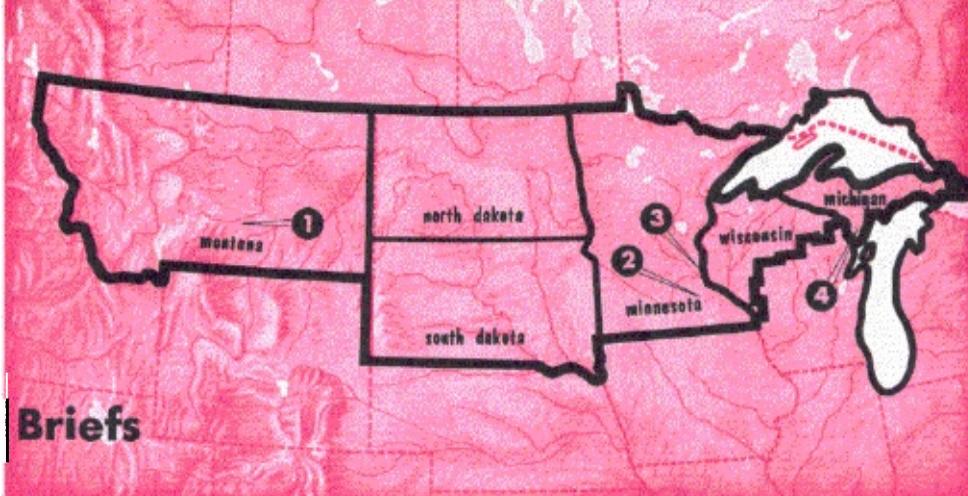
in the district dropped from about \$27.20 per cwt. in January and February to about \$21.89 in April. Hog prices averaged just over \$26.00 per cwt. as compared with \$16.00 a year earlier. The average farm level price for all beef cattle in the district moved from \$19.50 per cwt. in January to \$22.63 in April, resulting in a gain of about \$4.00 per cwt. over March 1965. Feed grain prices moved higher during the quarter and by the end of April were at or above those of a year earlier. Soybean prices continued to lag those of the previous year while average farm level wheat prices were slightly above the year-earlier period.

Livestock feeding up

Current livestock-on-feed reports indicate that Ninth district producers are following the national shift toward greater output. The number of hogs and pigs on farms in Minnesota and South Dakota, the only two states reported, was up 2 per cent from a year earlier on March 1, with the most significant increase being a gain of 11 per cent in the number of hogs held for breeding purposes. The number of pigs on feed was up 1 per cent. Thus, much of the expansion in district hog marketings is likely to come in early fall. Marketings in the next few months should show little change from the comparable period of 1965.

Cattle marketings decline

First quarter beef cattle marketings from Ninth district states were off 3 per cent from a year earlier compared with a 6 per cent increase in the national totals. The number of cattle and calves on feed in the district as of April 1, however, was up 11 per cent from a year earlier and cattle marketings between April 1 and July 1 are expected to exceed those of the same period of 1965 by 8 per cent. A slightly greater relative gain in fed cattle marketings from district states is expected during the second half of 1966.



Economic Briefs

1. Refinery to expand

Continental Oil Company will spend more than \$4 million to expand its Billings, Montana refinery from its current 37,000 barrels-per-day capacity to 44,000 barrels per day. Construction will start late this summer.

2. New plants for Faribault

Two new manufacturing buildings have been announced for Faribault, Minnesota. Construction of one is underway, a 14,000 sq.-ft. Control Data Corp. computer component assembly plant. Also, McQuay, Inc., makers of heating and ventilating equipment, will open a second \$2 million plant facility, doubling the size of their present operation. Between 200 and 250 persons will be employed at the computer plant when it is fully operative; employment at the McQuay plant will be increased from 260 to 500.

3. Airport hotel-motel slated

Construction will begin this fall on a \$1.5 to \$2 million hotel-motel at the Minneapolis-St. Paul International Airport. The 6-story facility will feature an indoor-outdoor swimming pool and sauna baths open to people waiting at the airport as well as to hotel occupants.

4. Plant to be enlarged

Eaton, Yale & Towne, Inc. which last summer bought the former Marble Electric plant at Gladstone, Michigan has announced plans to enlarge its operations and employ more than 300 persons in the manufacture of electric motors. The former Marble Arms plant will be razed to make way for the new \$2 million Eaton expansion; Marble Arms will move into its own new building to be erected in Gladstone's Industrial park.