

The Midwest Manufacturing Index: The Chicago Fed's new regional economic indicator

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The Federal Reserve Bank (FRB) of Chicago and the community that it serves—the Seventh Federal Reserve District—share a common interest in monitoring regional manufacturing activity on a timely basis. In the process of formulating monetary policy, the Bank is concerned about how economic activity in the Seventh District differs from the nation and how monetary policy affects that difference. Manufacturers need to know how regional economies are performing, in order to interpret their own shipments data and plan production schedules. Local governments must be aware of any changes in economic activity that translate into declining revenues or rising demand on expenditures.

Starting in the September issue of the new *Chicago Fed Letter*, the FRB of Chicago will publish a unique monthly index of manufacturing activity for its entire five-state District (see Figure 1)—the Midwest Manufacturing Index (MMI, Figure 2). While more or less following the same cyclical pattern as the Federal Reserve Board's Index of Industrial Production, two aspects of the MMI are noteworthy. First, the MMI shows a much stronger recovery in manufacturing activity since the last recession than is suggested by manufacturing employment expansion. Second, the MMI has a markedly different trend than the Board's Index. Manufacturing activity in the Seventh District has been on a gradual decline since at least 1973 (the starting point of the MMI), while for the nation as a whole, manufacturing activity has been generally expanding.

The decline in manufacturing activity—in a technical sense, deindustrialization—may be having serious repercussions throughout all sectors of the District's economy.¹ The ability to separate month-to-month movements in manufacturing activity into an underlying trend component and a business cycle component (which can often conceal the trend) is valuable for understanding not only what is currently happening but also what has been happening in the regional economy—such de-

velopments as the growth of “high-tech” industries and the services industry, for example. In addition, the index provides a quantitative background against which to evaluate the effects of national and state policies on the Seventh District's economy. (These topics are discussed in other articles in this issue of *Economic Perspectives*.)

A basic understanding of how the MMI was constructed is necessary to make the best use of the timely information it will convey. While similar in intent to the Board's Index, the MMI is based on methodology developed by the FRB of Atlanta.² This article provides a concise description of how the index was formulated and how the data were incorporated.

Conceptual background

Because of its availability and sensitivity to the business cycle, manufacturing employment has long been the primary tool for tracking a regional economy. Unfortunately, manufacturing employment data have a major limitation as a comprehensive measure of manufacturing activity. Employment is only one of many inputs in the production process that transforms labor, capital, energy, and materials into final output—the true measure of manufacturing activity in a region. As a participant in the process, employment can provide, at best, only a partial picture of the manufacturing activity in a region.

Perhaps the most serious omission in the analysis of manufacturing activity has been the measurement of capital usage. For example, during the early stages of a recovery, labor productivity may be expanding as labor and capital are used more intensively. Or, as the economy nears a business-cycle peak, manufacturers may expand their capital stock faster than at any other time over the business cycle. In both cases, changes in employment would

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Figure 1
The Seventh Federal Reserve District



understate the rate at which manufacturing activity is expanding.

The Board's Index of Industrial Production avoids the problem of inadequate coverage by using measures of national output that combine data on physical output, such as tons of steel, with data on shipments, hours worked, and electrical power usage.³ In the 1950s and 1960s, the FRB of Chicago also produced output indexes for the metropolitan areas of its District, based on electrical power data.⁴ From time to time, other FRBs have provided a similar service, using various methodologies. At present, however, only indexes for Texas and Ohio are being maintained.⁵

The broad intent of any production index is to provide a means of summing up a diversity of goods manufactured in a region and of monitoring their movement over time, in much the same way as the Gross National Product does for all economic sectors. In its simplest form, an index of manufacturing activity can be formulated as:

$$(1) \quad I_{t+m} = \left(\frac{\sum_j w_{j,t+m} Q_{j,t+m}}{\sum_j w_{j,T} Q_{j,T}} \right) * 100$$

where \sum_j = summation sign

T = the base period (1973)

$t + m$ = a given month, m , in year t

j = a specific product
 $w_{j,t+m}$ = weight applied to a specific product in $t + m$
 $Q_{j,t+m}$ = industry j 's output in $t + m$
 I_{t+m} = index of aggregate production in $t + m$.

In other words, the index is simply the sum of all the industrial items produced by the region in one year divided by the sum of the base year.

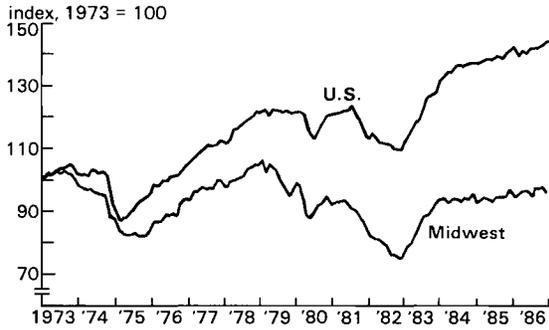
Obtaining measures of regional outputs, however, is not an easy task. Although some physical units of output are available on a regional basis (e.g., tons of steel), such data are extremely rare. Dollar values of physical outputs, deflated to remove the influence of inflation, would be an acceptable alternative to physical units, but even information on values of goods produced in a region are rare.

Shipments are an inappropriate measure of output at the regional level. Only that portion actually produced within the region should be included in the index, or the problem of double counting will distort the movement of the index. For example, data on either units or values of automobiles sold by producers in a region would not distinguish between the portion actually contributed by the regional producers and the portion purchased as an intermediate product (e.g., tires, engines, etc.).

A preferred measure for physical output produced in a region is a constant dollar measure of *value added*. Value added is measured by subtracting purchased materials from the value of shipments. Included in value added are primarily returns to labor and capital, and, to a lesser extent, capital recovery, economic profits, interest on debt, taxes, and the purchase of business services. Using value added, therefore, avoids the double counting problems inherent in shipments data. Unfortunately, value-added data by region are only available on an annual basis and even then with a considerable time lag.

For a monthly index, data from the major inputs that comprise value added—labor and capital services—can be derived on a regional basis from the data collected by the Board for its Index. Labor services can be measured by employment and average monthly hours worked. Capital services can be approximated by data on electrical power usage provided to the Board by utility companies.⁶ While these two inputs may still not be capturing all the

Figure 2
Midwest Manufacturing Index vs. U.S.
industrial production index



SOURCE: Board of Governors of the Federal Reserve System and the Federal Reserve Bank of Chicago.

factors that are influencing manufacturing activity from month to month, they are a vast improvement over mere employment data.

Construction of the index

Perhaps the most common method of combining labor and capital services into a production index is to use a sum-of-payments approach. Under the proper assumptions, labor and capital services can estimate output by adding the weighted value of both inputs together each month.⁷ Starting with an individual industry, the basic formula becomes:

$$(2) \quad RVA_{j,t+m} = \sum_j P_{lj,t+m} L_{j,t+m} + \sum_j P_{kj,t+m} K_{j,t+m}$$

where j = a specific product
 RVA = real value added
 P_l = price of labor, or average hourly earnings
 P_k = rental price of capital services
 L = labor services, or total hours worked
 K = capital services, or kilowatt hours.

While monthly data on labor and capital services are available, rental prices of capital services are not. To avoid using prices, three modifications are made to this equation. First,

prices are multiplied by the ratios of the inputs to the final output to compute each input's share of output. For example, labor's share of output would be $s_l = P_l * L / RVA$. Capital's share, $s_k = P_k * K / RVA$, under the constant returns to scale assumption is assumed to be one minus labor's share. These ratios should be fairly stable over time, so that annual data can be used to represent monthly values with reasonable confidence.

Second, each input's productivity (i.e., $q_l = RVA/L$ and $q_k = RVA/K$) must be added, so that monthly input data can be converted to a measure of output based on value added (i.e., $q_l * L = RVA$). The output associated with a given level of labor services can then be combined with the output associated with a given level of capital services by weighting each input by its share of output to produce the desired measure of total output represented in the equation above.

Finally, both the share weights and the productivity weights would be expected to change gradually from month to month, reflecting the underlying trend in each measure. To capture that trend on a monthly basis requires distributing the annual growth rates evenly over twelve months. For example, labor's share of output grows from one year to the next at a compounded growth rate, or:

$$C_{lj,t} = (s_{lj,t} / s_{lj,t-1})^{1/d} - 1$$

where d equals 12. The compounded growth rate is then distributed by taking the value of the first year and adding the monthly adjustment, such that

$$s^*_{lj,t+m} = s_{lj,t} (1 + C_{lj,t+m})$$

where m takes a value from 1 to 12. Monthly values for capital shares, $s^*_{kj,t+m}$, and both productivity weights, $q^*_{lj,t+m}$ and $q^*_{kj,t+m}$ are constructed to accompany the monthly labor and capital services data.

The final formula for estimated output for a specific industry becomes:

$$(3) \quad RVA^*_{j,t+m} = s^*_{lj,t+m} q^*_{lj,t+m} L_{j,t+m} + s^*_{kj,t+m} q^*_{kj,t+m} K_{j,t+m}$$

Since this equation is used to construct an index for each industry, each industry index must be combined, according to its share of total output, to generate a composite index of man-

ufacturing activity. The final formula that represents the MMI is:

$$(4) \quad I_{t+m} = \frac{\sum_j w_{j,t} RVA_{j,t+m}^*}{\sum_j w_{j,T} RVA_{j,T}^*}$$

where $w_{j,t} = (RVA_{j,t} / \sum_j RVA_{j,t})$.

The data-base manipulations

The raw data needed to assemble the index are derived from three sources: the Bureau of Labor Statistics, the Bureau of the Census, and the Federal Reserve Board. The labor data are based on total work hours for 17 two-digit industries collected at the state level for each of the five states composing the Seventh District (Indiana, Illinois, Iowa, Michigan, and Wisconsin). Total worker hours were computed by multiplying total workers times average hours worked. An assumption is made that the ratio of total workers to production workers is constant, so that the total hours measure is proportional to actual total production worker hours. Value added and payroll data, used in constructing weights, also correspond to the entire five states in the District. Capital services, however, are limited to electrical power usage within the District itself (southern Wisconsin and Michigan, northern Illinois and Indiana, and all of Iowa).

Transforming the raw data into the ultimate form in which they will enter the equations involves several manipulations. The first and most basic step is to seasonally adjust all raw monthly data and to deflate all nominal dollar values to constant 1982 dollars. Nominal dollar values are deflated using national producer price indexes for the appropriate industries (actually, using wholesale price indexes for commodities that correspond closest to an industry's output). Seasonal adjustments are made using the widely used X-11 seasonal adjustment procedure.

In some cases, a complete set of monthly data could not be obtained for a given industry or for a given state within an industry. Three industries (tobacco, textiles, and apparel) were dropped from the index, because employment data were nonexistent. These three industries in aggregate represent less than 1.5 percent of the total value added of manufacturing in the

District. Also, five industries (printing, petroleum, stone/clay/glass, and miscellaneous) lacked employment data for at least one state prior to 1980, again because the industry was insignificant in that state's economy. For these five industries, the labor input was measured by the reporting states. Because the productivity adjustment factor was also based on the limited state data, labor's share of the estimated index was unaffected. Although these industries were also a comparatively small portion of total value added (less than 3 percent), the information contained in the employment data is worth saving. As a result, these industries were not excluded from the index.

For a similar reason, average hours worked data were inserted for the period prior to 1976. Little data on hours were reported prior to 1976 and, rather than lose the information contained in the movement of employment levels and electrical power usage between 1972 and 1976, the observed values for January 1976 were applied to all previous months. Since the value for average hours worked ranged between 38 and 40 hours per week and tended to change in small increments, the labor component based solely on employment levels still contributes a substantial amount of information about fluctuations in manufacturing activity. Moreover, these early years are of primary interest for providing an historical trend in output rather than for the month-to-month movements.

Missing data were also a problem in constructing the weights for each input. The *Annual Survey of Manufactures* (ASM) has not published regional data for three years—1979, 1980, and 1981. In order to bridge this gap, data for 1978 and 1982 were treated as if they were a single year, except that the value for d became 48 instead of 12. In other words, the growth rate stretched over 48 months rather than 12 months.

Finally, the values for the monthly weights had to be extrapolated from the end of 1984 to the final month, because ASM data beyond 1984 is not yet available. The approach used in this index generally follows the FRB of Atlanta convention. The share weights, s_i^* and s_k^* , were held fixed at their last monthly value. The productivity weights, q_i^* and q_k^* , however, were allowed to continue to follow the trend set by their growth rates applied to 1984.

Concluding remarks

The MMI is constructed from a common methodology that is the easiest to maintain on a monthly basis and, more importantly, correlates well with the observed annual data of real value added.⁸ It is important to emphasize that employment figures and the MMI are the *only monthly data* currently available for the District's manufacturing sector. The MMI is a more comprehensive barometer of manufacturing activity than is employment. In addition, the MMI provides a direct link to economic activity at the national level through its kinship to the FRB Index.

As new ASM data become available, the MMI will be revised and the extrapolated values will be updated. Future research will be designed to improve the month-to-month accuracy of the MMI and to disaggregate the index into sub-industries and sub-regions that are important in monitoring the District's economy.

¹The issue of deindustrialization has been hotly debated in the literature in recent years. For empirical evidence of deindustrialization in the Seventh District, see Schnorbus and Giese, forthcoming 1987.

²Some minor modifications to the Atlanta version have been made. For a detailed discussion of the Atlanta version, see Pyun, 1970.

³For a detailed description of the Board's Index, see Industrial Production, 1986.

⁴See, for example, "Electrical Power Consumption—An Output Indicator in Milwaukee," 1962.

⁵For references to past production indexes, see Pyun, 1970. For a recent update, see Bryan and Day, 1987.

⁶See Moody, 1974, for the technical justification.

⁷See Sullivan, 1975, for a discussion of the assumptions underlying the product exhaustion theorem.

⁸See Fomby, 1984, for an empirical analysis of alternative methodologies.

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