Views from the Ohio Manufacturing Index

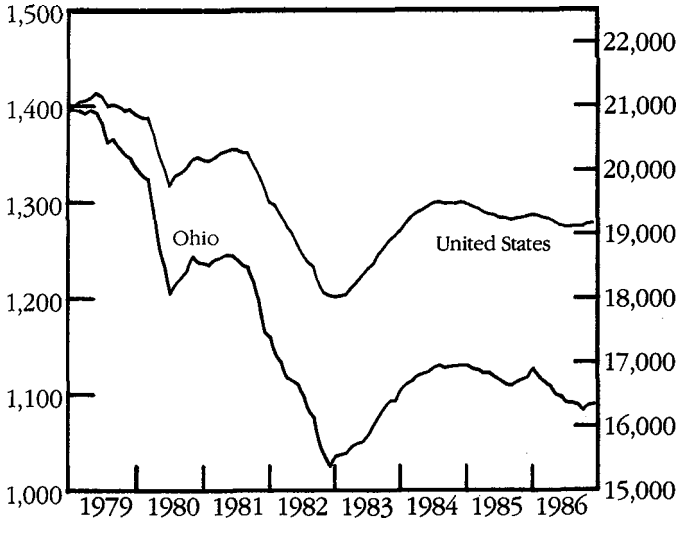
by Michael F. Bryan
and Ralph L. Day

Michael F. Bryan is an economist and Ralph L. Day is an economic analyst at the Federal Reserve Bank of Cleveland. The authors gratefully acknowledge the assistance of Diane Smith, Nannette Thompson, and Frances Davis of the Federal Reserve Bank of Cleveland's Data Services Department, who compiled the electric power consumption data used in this study.

A Preview

Economists and other observers are closely examining the manufacturing sector these days, fearing that America's industrial base is disappearing. Certainly, the steady decline in the proportion of total jobs in manufacturing, as shown in figure 1, supports this view. However, a more careful look reveals that manufacturing's overall share of real national output has remained essentially unchanged since 1950.[1]

Ohio and U.S. Manufacturing Employment
Thousands, seasonally adjusted



SOURCE: Bureau of Labor Statistics and Ohio Bureau of Employment Services.

FIGURE 1

A more reasonable worry, it would seem, is the uneven regional distribution of manufacturing growth that is obscured by nationally aggregated data. Unfortunately, the information used by analysts to evaluate regional manufacturing output has been limited to quinquennial census data and, when available, annual survey data.

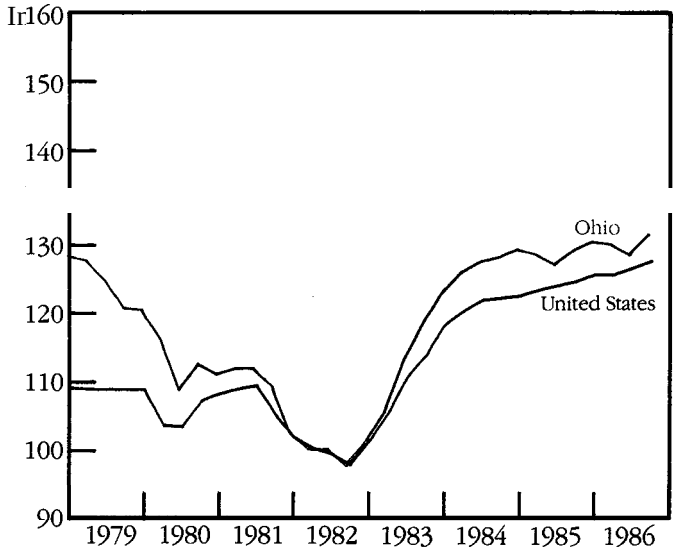
Iack of timely regional data prompted the establishment of regionally based production indexes by the Federal Reserve Banks of Atlanta, Boston, Dallas, and San Francisco.[2] The Federal Reserve Bank of Cleveland has recently developed a monthly manufacturing production index for the state of Ohio—the Ohio Manufacturing Index (OMI).

The OMI is an experimental index of real output by Ohio manufacturers that is derived from state-level manufacturing employment and electric power consumption data. The OMI tracks manufacturing output at the two-digit standard industrial classification (SIC) level of aggregation, beginning in January 1979 and ending in December 1986. The methodology and procedures used to develop the index are outlined in the technical appendix that follows this article.

1 For an overview of developments in the U.S. manufacturing sector, see Michael F. Bryan. "Is Manufacturing Disappearing?" Economic Commentary, Federal Reserve Bank of Cleveland, July 15, 1985; and Patricia E. Beeson and Michael F. Bryan, "The Emerging Service Economy," Economic *Commentary*, Federal Reserve Bank of Cleveland, June 15, 1986.

2 Regional production indexes produced by the Federal Reserve Banks of Boston and Atlanta have been discontinued, primarily due to budget reductions.

In *1984*, Ohio firms represented *6.3* percent of the nation's manufacturing output, making Ohio the third-largest manufacturing state, trailing only California *(11.0* percent) and New York *(7.4* percent) in manufacturing prominence.3



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

FIGURE 2

Despite this size, the cyclical patterns of Ohio's manufacturing output remain largely unseen and are often thought to mirror national manufacturing trends. Yet, evidence from the OMI suggests that important differences exist between U.S. and Ohio manufacturers, particularly within individual industries. In this article, we introduce the OMI and discuss the new perspective it provides of manufacturing trends in Ohio.

Distribution of Manufacturing Output by State, 1984
(ten largest manufacturing states, **nominal** dollars)

State	Value Added (millions $)	Share of Nation	Distribution of Output: Durable (%)*	Distribution of Output: Nondurable (%)
United States	*983,560*	—	*57.6*	*42.4*
1. California	*108,373*	*11.0*	*68.1*	*31.9*
2. New York	*72,361*	*7.4*	*53.7*	*46.3*
3. OHIO	*62,346*	*6.3*	*68.3*	*31.7*
4. Texas	*55,556*	*5.6*	*49.9*	*50.1*
5. Illinois	*55,246*	*5.6*	*56.1*	*43.9*
6. Michigan	*53,069*	*5.4*	*75.8*	*24.2*
7. Pennsylvania	*51,725*	*5.3*	*56.2*	*43.8*
8. N. Carolina	*36,682*	*3.7*	*38.7*	*61.3*
9. New Jersey	*36,543*	*3.7*	*43.3*	*56.7*
10. Indiana	*33,762*	*3.4*	*70.3*	*29.7*

'Durable-goods manufacturing is defined to include SICs *24, 25,* and *32-39.*
SOURCE: 1984 Annual Survey of Manufactures, Bureau of the Census.

TABLE 1

I. A View of the Forest

Manufacturing employment in Ohio reached a peak of *1.4* million workers in March *1979. At* that time, manufacturing industries employed more than *30* percent of the state's workers. Since *1979,* however, manufacturing employment in Ohio has fallen by more than *20* percent. In recent months, it was roughly *1.1* million workers, or about *20* percent of Ohio's civilian work force (figure *1). As* in the nation, Ohio's manufacturing sector has failed to register significant employment growth in nearly three years.

However, because the relationship between employment and output is not constant over time, due to changes in productivity and to the substitution of capital for labor, inferences about the manufacturing sector drawn exclusively from a labor perspective can be misleading.

Unlike employment, real manufacturing output in Ohio, as measured by the OMI, has been rising throughout most of the current economic expansion (figure *2).* Between the recessionary trough occurring in the fourth quarter of *1982* and the fourth quarter of *1986,* real manufacturing output in the state rose *34.7* percent. Manufacturing output at the national level grew at a slower pace over the period, *30.4* percent.[4]

Differences between U.S. and Ohio manufacturing output trends arise principally from two related sources. First, the level of real output per worker (labor productivity) and the growth rate of labor productivity are greater in Ohio than in the rest of the country. Furthermore, the Ohio manufacturing business cycle tends to be more sharp than the national cycle, a consequence of the state's concentration of durable-goods manufacturing.

For example, *1984* census data show that Ohio workers produced roughly *8* percent more real manufacturing output per worker than is produced nationally. Between *1982* and *1984,* the rate of growth in labor productivity for Ohio manufacturers was roughly *20* percent, compared with only a *16* percent gain for the nation.[5] More-

3 Output estimates are based on value added.

4 The U.S. and Ohio manufacturing indexes may not be perfectly comparable because of differences in methodology. However, many of the data sources and the fundamental structure of the indexes are the same.

5 These productivity estimates are based on real value added per worker. Value added and employment data come from the Survey of Manufactures. Nominal value-added estimates were deflated using national price deflators supplied by the U.S. Department of Commerce.

over, evidence from the OMI indicates that Ohio's leading growth industries generally have above-average labor productivity. As a result, slightly slower rates of growth in total manufacturing employment since 1982 generated somewhat greater real manufacturing output gains for Ohio manufacturers than for U.S. manufacturers.

Distribution of the Ohio Manufacturing Sector by Industry, 1984
(durable-goods industries in CAPITALS)

Industry (SIC)	Industry Importance To Ohio (%)	Industry Importance To U.S. (%)	Ohio Share of U.S. (%)	Rank in the U.S.
1. TRANSPORTATION EQUIPMENT (37)	17.8	11.6	9.7	3
2. FABRICATED METALS (34)	12.6	6.9	11.6	1
3. NONELECTRICAL MACHINERY (35)	11.5	11.4	6.4	3
4. PRIMARY METALS (33)	9.7	4.3	14.3	1
5. Chemicals and Allied Products (28)	8.9	9.6	5.9	5
6. ELECTRICAL MACHINERY (36)	8.8	11.2	4.9	5
7. Food and Kindred Products (20)	7.7	10.0	4.9	6
8. Rubber and Plastics (30)	5.5	3.5	10.0	1
9. Printing and Publishing (27)	4.9	6.8	4.6	6
10. STONE, CLAY, AND GLASS (32)	3.6	2.8	8.1	2
11. Paper and Allied Products (26)	2.6	4.2	4.0	8
12. INSTRUMENTS	1.7	4.1	2.6	17
Remaining Manufacturers	4.7	13.6	2.2	—

SOURCE: 1984 Annual Survey of Manufactures, Bureau of the Census

TABLE 2

Ohio's manufacturing recovery was also preceded by a contraction that occurred earlier and was more severe than that experienced nationally. To illustrate, Ohio's last manufacturing recession may be more accurately viewed as a combination of two recessions. Between the first quarter of 1979 and the third quarter of 1980, manufacturing output in Ohio declined by slightly over 15 percent—about three times the percentage drop felt at the national level (5.2 percent). Ohio's second manufacturing contraction began in the third quarter of 1981, and by the fourth quarter of 1982, manufacturing production had fallen 12.6 percent, compared with a 10.7 percent decline over the same period for all U.S. manufacturers.

The relatively sharp business cycle experienced by Ohio manufacturers reflects the state's industrial composition (table 1). In the latest survey year, 1984, durable-goods manufacturing represented 68.3 percent of the state's total manufacturing output. Ohio is not the most durable-goods-intensive state of the 10 largest manufacturing states—Michigan's durable-goods share was 75.8 percent in 1984 and Indiana's share was 70.3 percent. However, the relative size of durable-goods manufacturing is considerably greater in Ohio than is the case nationally, where durable-goods manufacturing accounted for only 57.6 percent of the 1984 total.

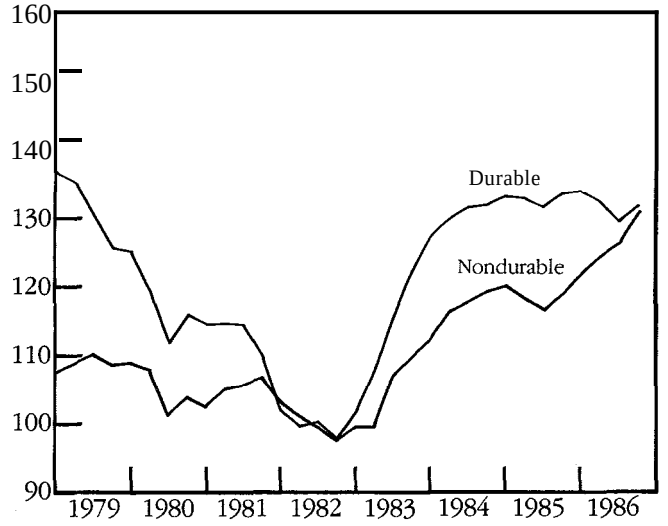
Michigan's dependence on durable-goods production is primarily a consequence of the automobile industry's dominance in that state (representing about 36 percent of its manufacturing output in 1984), while Ohio's durable-goods sector is more broad-based. For example, in 1984, Ohio's manufacturing output was distributed among five important durable-goods and one nondurable-goods industry (table 2). The state's largest manufacturing industry was transportation equipment, representing 17.8 percent of its overall manufacturing production, compared with a contribution of only 11.6 percent at the national level. Following transportation equipment were the fabricated metals (12.6 percent), nonelectrical machinery (11.5 percent), primary metals (9.7 percent), chemicals (8.9 percent), and electrical machinery (8.8 percent) industries.

In 1984, Ohio led all states in output for two durable-goods industries, fabricated metals and primary metals, and for one nondurable-goods industry, rubber and plastics. In addition, Ohio manufacturers were the second-leading producers of stone, clay, and glass products and the third-leading producers of transportation equipment and nonelectrical machinery, all durable-goods industries.

Historically, durable-goods producers have suffered more pronounced business-cycle swings than nondurable-goods producers; a phenomenon, it would seem, that is not yet clearly understood (figure 3). One view is that changes in the economic climate, which are accompanied by fluctuations in income and interest rates, result in intertemporal substitutions by consumers. Because durable goods, by definition, involve a longer consumption horizon than nondurable goods, these intertemporal substitutions are more keenly felt in the consumer durables market.

A possibly complementary view, from the perspective of the firm, is that changes in the desired capital stock, such as those arising from changes in consumer demand, generate exaggerated swings in net investment. This "acceleration principle" implies that the more "durable" the capital stock, the more pronounced

Ohio Durable and Nondurable Goods
Index, 1982 = 100



SOURCE: Federal Reserve Bank of Cleveland.

FIGURE 3

the production cycle for capital goods.

Beyond its business-cycle implications, Ohio's industrial mix probably makes the state's manufacturing sector more vulnerable to pressure from foreign rivals, and implies that Ohio's manufacturing economy is more sensitive to international trade fluctuations than is the national manufacturing economy. **A** recent analysis of the impact of exchange-rate movements on manufacturing revealed that a 10 percent increase in the value of the dollar generates about a 0.8 percent decrease in U.S. manufacturing output, whereas in Ohio, a similar exchange-rate increase generates roughly a 1.0 percent decrease in manufacturing output.[6]

Indeed, the 6 percent plunge in the value of the dollar between June and September 1986 was probably welcomed by Ohio's manufacturers, as the OMI showed five consecutive monthly advances between July and December 1986, and increased 2.3 percent in the final quarter, compared with only a 0.8 percent increase nationally.

From the broad perspective, then, Ohio's manufacturing economy seems to be characterized by a rather pronounced cycle, resulting from the combined influence of a large concentration of durable-goods manufacturers and a relatively high and growing level of productivity.

II. A View of the Trees

At the industry level, differences between the Ohio and national manufacturing economies are more striking. In some industries, the performance of Ohio's manufacturers between 1979 and 1986 exceeded national growth rates, and in a few cases, such as chemicals and fabricated metals, Ohio's growth has been impressive. Other industries, including paper, printing, electrical machinery, and stone, clay, and glass manufacturing, have lost ground relative to the rest of the country since 1979.

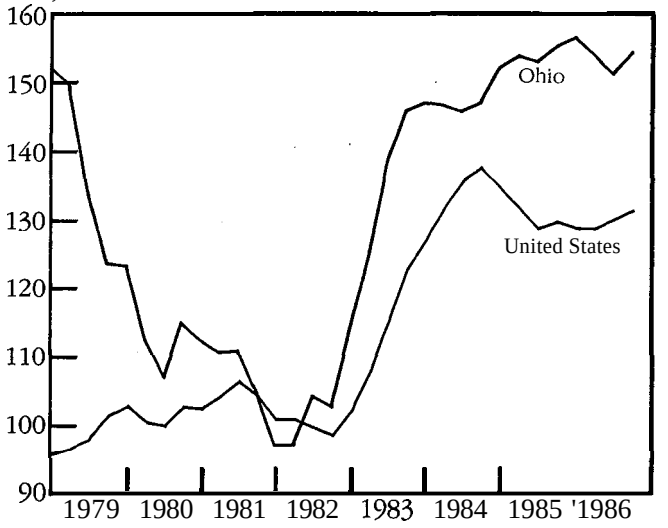
It is not the intention of this analysis to discuss each industry in detail, and only the state's largest industries have been singled out for comment. Industries that are not expressly considered in this section are presented in figures 4h through 40 at the end of the article.

• Transportation Equipment

Transportation equipment manufacturing, traditionally a pivotal industry in the national business cycle, was hit particularly hard by the recessions of the 1980s. The ensuing expansions, however, allowed transportation manufacturers in the U.S. and Ohio to surpass the output peaks established in 1979 (figure 4a).

Over the expansionary period spanning the fourth quarter of 1982 and the fourth quarter of 1986, transportation equipment output in the U.S. grew 48.2 percent. Over the same period, this industry's growth rate in Ohio was 50.4 percent, making transportation equipment production one of Ohio's fastest-growing manufacturing industries in recent years. Indeed, evidence from the OMI suggests that transportation

Transportation Equipment
Index, 1982 = 100

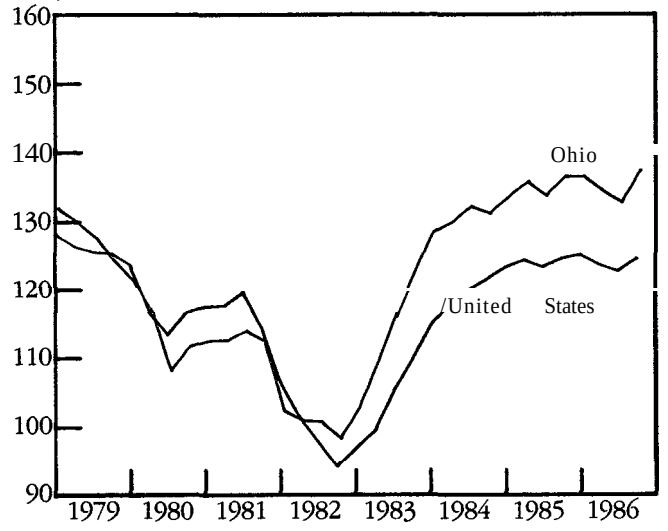


SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 4A

6 See CBO Staff Working Paper, "The Dollar in Foreign Exchange and U.S. Industrial Production," December 1985; and Amy Durrell, Philip Israilevich, and K.J. Kowalewski, "Will the Dollar's Decline Help Ohio Manufacturers?" *Economic Commentary*, Federal Reserve Bank of Cleveland, August 15, 1986.

Fabricated Metals
Index, 1982 = 100



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

FIGURE 4B

equipment production has generated about 25 percent of the state's manufacturing output growth since 1982 and may currently represent more than 20 percent of its manufacturing economy.

There are a number of reasons that Ohio's transportation equipment producers have expanded rapidly since 1982. For one, motor vehicle production, the fastest-growing component in the transportation field in this decade, represents a larger share of transportation equipment output in Ohio (about 70 percent) *than* it does nationally (about 48 percent). It would seem that motor vehicle production also contributed to Ohio's relatively severe decline in real transportation equipment output between 1979 and 1982.

Despite some strength since 1983, production of aircraft, railroads, and ships changed little between 1980 and 1985. These industries are significantly less important to the state's manufacturing economy than they are to the national economy.

In addition, real output per worker in transportation equipment production is roughly 15 percent greater in Ohio than in the U.S., and the rate of growth in labor productivity for transportation equipment workers between 1982 and 1984 was about 28 percent, compared with 19 percent nationally.

Another contributing factor to Ohio's recovering transportation equipment industry has been the establishment of a Japanese auto plant, and its supporting suppliers, in the state. Honda, which began producing in Ohio in 1982, currently assembles more *than* 145,000 cars there annually, generating roughly $650 million in annual manufacturing output?[7]

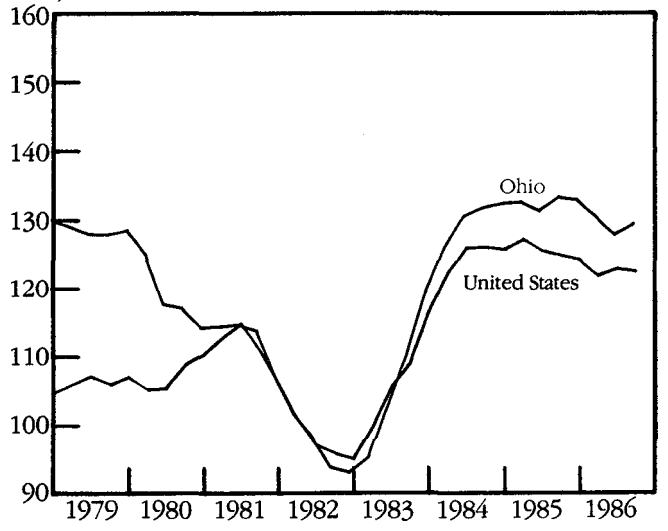
· Fabricated **Metals**

Fabricated metals has been a growth industry in Ohio's manufacturing economy (figure 4b). Although the state's fabricated metals manufacturers experienced approximately the same contraction as national manufacturers did over the 16 quarters between 1979 first quarter and 1982 fourth quarter (-25.6 percent versus -26.5 percent nationally), the recovery of fabricated metals production in Ohio has been stronger than the pace set nationally (40.0 percent over the 16 quarters ending in 1986 fourth quarter, compared with 32.3 percent for the nation).

Again, some of Ohio's improvement in fabricated metals production can be traced to a decided productivity advantage for the state. In 1984, real output per worker in fabricated metals was about 21 percent greater in Ohio than in the U.S., and the state's growth rate of productivity in this industry exceeded the U.S. rate (roughly 22 percent versus 14 percent).

Industrial mix also appears to be a contributing factor to Ohio's success in the fabricated metals area. About one-third of the state's fabricated metals production occurs in the forging and stampings field, whereas nationally this industry represents only about 18 percent of the fabri-

Nonelectrical Machinery
Index, 1982 = 100

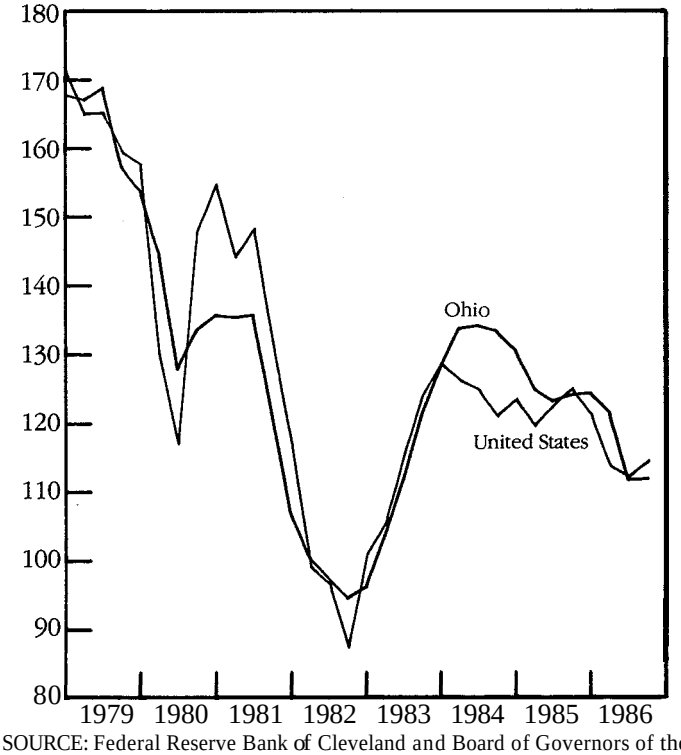


SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System.

FIGURE 4C

[7] These estimates assume domestic content of 50.0 percent, on an average 1985 new-car cost of $8,845. Not all of the U.S. content is captured in Ohio, as some domestic suppliers are located outside the state. See Michael F. Bryan and Michael W. Dvorak. "American Automobile Manufacturing: It's Turning Japanese," Economic Commentary, Federal Reserve Bank of Cleveland, March 1, 1986.

Primary Metals
Index, 1982 = 100



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

FIGURE 40

cated metals output. The forging and stampings industry generates much of its demand from production of consumer durables, particularly motor vehicles which, as stated earlier, have been important contributors to the current economic expansion.

At the national level, the fabricated metals industry has been dominated by the production of structural metals, which are used primarily in construction—an industry that has not fared as well as consumer durables during the recovery to date.

• **Nonelectrical Machinery**

Although the recovery in Ohio's nonelectrical machinery industry has been slightly greater than that experienced nationally (figure 4c), production of nonelectrical machinery in the state suffered a sharper decline during the recessions of 1980 to 1982. Between 1979 first quarter and 1982 fourth quarter, Ohio nonelectrical machinery production was off 27.8 percent versus a decline of only 8.6 percent nationally.

In this industry, at least, differences in productivity and productivity growth rates are not a major factor in industrial growth rate differences between the U.S. and Ohio. Here, the differences in national and Ohio industry performance are probably related to the mix of industries within the nonelectrical machinery category.

Ohio manufacturers rely heavily on the production of metalworking machinery, an industry dependent on durable-goods demand and one that has been under pressure in recent years from foreign competition. Approximately 20 percent of Ohio's nonelectrical machinery involves the production of metalworking machinery, more than twice the national incidence.

Surprisingly enough, the national nonelectrical machinery industry is heavily dominated by computer manufacturing, which generates roughly 25 percent of the nation's nonelectrical machinery output, but which accounts for only about 7 percent of the nonelectrical machinery output in Ohio. Computer production, which set a blistering pace early in this decade, has slowed appreciably since 1984.

• **Primary Metals**

Ohio is the largest producer of primary metals in the nation, as a result of its heavy concentration of steel and iron makers. And, as is true nationally, the performance in Ohio's primary metals industry has failed to regain the ground lost since 1979 (figure 4d). Data from the OMI indicate that at year-end 1986, Ohio primary metals makers were producing at only about 68 percent of their average 1979 output.

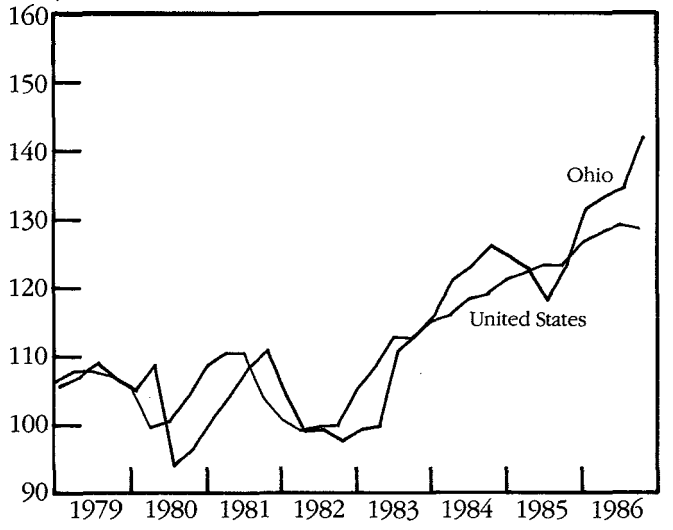
Ohio's experience in the primary metals area has been virtually identical to the nation's, even though real output per worker in this industry is apparently greater in Ohio than in the U.S. (about 23 percent more in 1984).

• **Chemicals and Allied Products**

In the U.S., the chemicals and allied products industry means drugs (more than 22 percent compared with 5 percent in Ohio), but in Ohio it means soaps (34 percent versus 18 percent nationally). The patterns outlined by the OMI suggest that, despite similar performances between 1979 and 1985, Ohio chemicals producers substantially outpaced the nation last year (figure 4e). During the current expansion (ending in the fourth quarter of 1986), the growth rate of the chemicals industry nationally was 28.5 percent, which is well below the 45.2 percent advance registered for Ohio.

Differences in productivity between Ohio and U.S. manufacturers are also influential in this industry; real output per worker in Ohio was 19 percent greater than for workers nationally, and the growth rate of productivity in Ohio between 1982 and 1984 exceeded the nation's (33 percent versus 25 percent).

Chemicals and Allied Products
Index, 1982 = 100



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

FIGURE 4E

. Electrical Machinery

At the national level, electrical machinery production enjoyed a boom between 1982 fourth quarter and 1984 third quarter because of an enormous increase in the output of communications equipment and electronic components (figure 4f). These industries manufacture products essential to the skyrocketing telecommunications field. But Ohio's experience in electronic equipment manufacturing has been unimpressive, rising only to its pre-recession levels.

At the national level, one-third of the electrical machinery industry involves the manufacture of communications equipment. This compares with only about a 12 percent share in Ohio. Moreover, electrical components used in the production of computers, namely semiconductors, are much more important to national electrical machinery manufacturing than to manufacturing in Ohio (about 26 percent versus 9 percent).

Ohio's electrical machinery manufacturing industry relies primarily on the manufacture of appliances. Although the household appliance industry has been relatively healthy in recent years, its growth pales in comparison to the gains felt in the communications and computer fields.

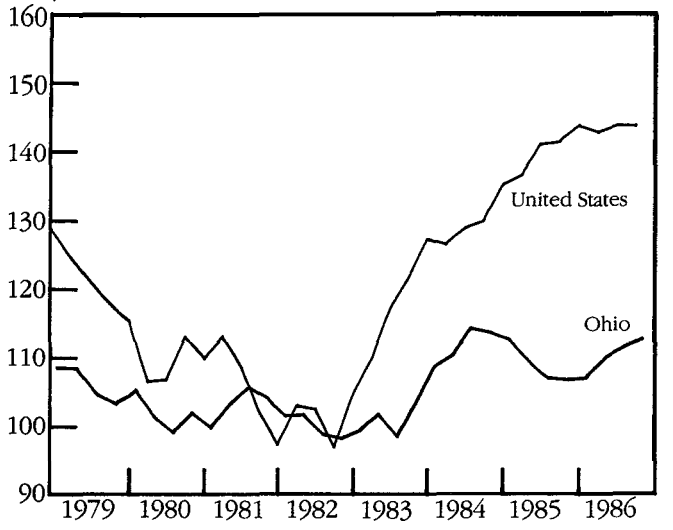
· Rubber and Plastics

Plastics has supplanted rubber as the dominant component of the rubber and plastics industry in Ohio, and the OMI appears to reflect this transition (figure 4g).

The rubber and plastics industry has enjoyed growth in both Ohio and the nation over the present expansion, but Ohio's experience has been more volatile. The sharp cycle here is probably a result of Ohio's rubber-makers, whose production follows the often-turbulent fortunes of the transportation equipment industry.

Ohio seems to be shedding its dependence on rubber production. In 1977, Ohio's rubber and plastics industry was dominated by rubber-makers (54 percent versus 46 percent in plastics). Yet, within six years the roles were reversed, as rubber-makers accounted for only 39 percent of the state's output in the rubber and plastics industry.

Electrical Machinery
Index, 1982 = 100



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

FIGURE 4F

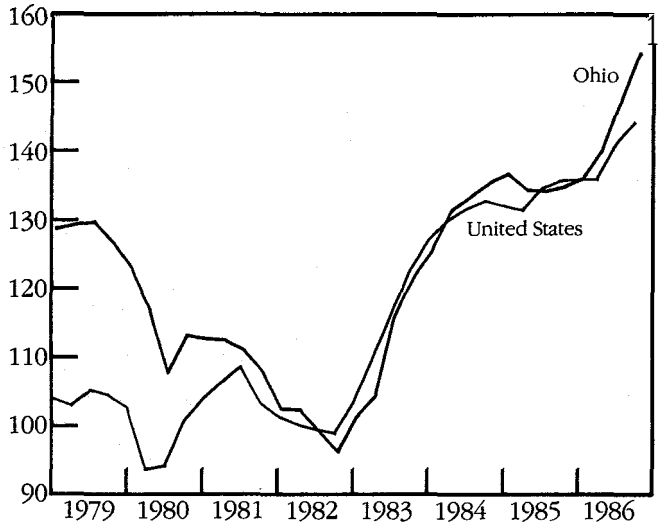
III. An Overview

The OMI and its subindexes are a product of ongoing research at the Federal Reserve Bank of Cleveland. It is therefore important to emphasize that these indexes are experimental and may not be wholly reliable from month to month, or within some industries. The structure of the indexes and the data used in their construction are subject to revisions. Future revisions may be especially large between 1984 and 1986, over which period the productivity assumptions were intentionally conservative.

With these caveats noted, the patterns traced by the index make sense in light of Ohio's manufacturing mix and differences in productivity levels and growth rates. The state's manufacturing cycle tends to be sharper than that experienced at the national level.

Industry-level data show that Ohio manufacturers are recovering the transportation equipment output lost in the last recession, as a result of the state's active motor vehicles industry.

Rubber and Plastics
Index, 1982 = 100



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

FIGURE 4G

Indeed, the demand for consumer durables in this decade probably accounts for much of the growth experienced by Ohio manufacturers since 1982, such as that experienced by Ohio's fabricated metals producers.

In addition, many of these recovering industries are characterized by relatively high and rising productivity levels, which in part explains why the growth of Ohio manufacturing production since 1982 exceeds the national experience, despite slightly more modest gains in manufacturing employment.

Unfortunately, not all manufacturing industries in the state have improved their position relative to the rest of the country. Ohio manufacturing growth in recent years appears to be most prominent in industries whose futures are regarded by many as uncertain. However, Ohio has lost ground in manufacturing fields that are considered growth industries nationally, such as printing and publishing, and electrical machinery manufacturing.

Technical Appendix — Methodology for the Ohio Manufacturing Index (OMI)

A number of production index methodologies have been proposed. The procedure chosen for the construction of the Ohio Manufacturing Index (OMI) involves a minimum of time to produce and has been shown to be relatively accurate for the Texas economy (see Fomby [1986]). The OMI is structurally similar to the regional production indexes produced at other Federal Reserve Banks and is virtually identical to that produced by the Federal Reserve Bank of Atlanta (see Stroebel [1978]).[1]

We begin by assuming that Ohio manufacturers are profit maximizers who operate in a competitive market. If we further assume that Ohio manufacturers are subject to a two-factor (labor and capital) linear homogeneous production function (constant returns to scale), we can use Euler's theorem to show that:

(1) $VA = (P_L L) + (P_K K)$,

where VA is manufacturing output measured by value added, P_L and P_K are the unit price of labor and capital inputs, respectively, and L and K are the industry's employment of labor and capital.

Equation 1 can be algebraically manipulated to yield the more complex, but easily estimable, time series:

(2) $$VA_t = (P_L L/VA)\ (VA/L)_t\ L_t + (P_K K/VA)\ (VA/K)_t\ K_t = \Sigma (S_i O_{i,t} i_t) \text{ for } i = L, K,$$

where S_i are the factor shares for labor (L) and capital (K) inputs, $O_{i,t}$ are the output ratios for inputs in period t, and i_t represents the level of inputs in period t.

The Ohio Manufacturing Index uses fixed shares of labor and capital, but allows for monthly productivity increases by a factor C_i. Specifically, the output ratios are adjusted monthly such that:

(3) $O_{i,t} = O_{i,t-n}(1 + C_i\ n)$,

where n represents the number of months that have elapsed since the last survey of Ohio manufacturers. The productivity factor is defined by:

(4) $$C_i = \left[\frac{VA_m/i_m}{VA_o/i_o}\right]^{1/\phi} - 1$$

where m and o are two survey years and ϕ is the monthly interval separating the two surveys. Input productivity factors since 1984, for which data do not yet exist, were assumed to be equal to the average productivity factor between 1978 and 1984.[2]

1 The Sixth District Manufacturing Production Index uses man-hours to measure labor inputs, while the OMI uses employment levels. In addition, the Sixth District Index seasonally adjusts the computed indexes, while the OMI seasonally adjusts the factor inputs prior to index construction.

Percentage Share of Labor and Capital For Ohio Manufacturers

Industry (SIC)	Labor (%)	Capital (%)
Manufacturing	*40.3*	*59.7*
Durable-Goods Manufacturing	*44.0*	*56.0*
Nondurable-Goods Manufacturing	*31.9*	*68.1*
Food and Kindred Products *(20)*	24.9	75.1
Apparel and Other Textile Products *(23)*	43.2	56.8
Lumber and Wood Products *(24)*	44.0	56.0
Furniture and Fixtures *(25)*	46.2	53.8
Paper and Allied Products *(26)*	46.1	53.9
Printing and Publishing *(27)*	41.5	58.5
Chemicals and Allied Products *(28)*	19.7	80.3
Rubber and Miscellaneous Plastic Products *(30)*	45.2	54.9
Stone, Clay, and Glass Products *(32)*	43.2	56.8
Primary Metals Industries *(33)*	43.8	56.2
Fabricated Metal Products *(34)*	45.5	54.5
Machinery, Except Electrical *(35)*	50.1	49.9
Electric and Electronic Equipment *(36)*	38.0	62.0
Transportation Equipment *(37)*	40.9	59.1
Instruments and Related Products *(38)*	44.6	55.4

SOURCE: *1984* Annual *Survey* of Manufactures, Bureau of the Census.

APPENDIX TABLE 1

The fixed factor shares (S_i) were estimated using Ohio manufacturing data from the *1984* Survey of Manufactures. The share of labor (S_L) was calculated as the ratio of the total manufacturing payroll to the value added in manufacturing in nominal dollars. The share of capital (S_K) was derived by:

(5) $S_K = 1 - S_L$.

The factor shares are reported in table *1* of this technical appendix.

The output ratios were calculated for the survey years *1978, 1983,* and *1984* and for the census year *1982*. The labor output ratio (O_L) is real value added to total employment. The capital output ratio (O_K) is similarly constructed, using electric power consumption as a proxy for the employment of capital.[3]

The OMI was produced for *15* two-digit SIC industries and for the durable-goods, nondurable-goods, and total manufacturing aggregates (appendix table *1)*. Five manufacturing industries are not reported because of constraints on the data: tobacco products (21), textile mill products (22), petroleum and coal products (29), leather and leather products (31), and other miscellaneous manufacturing *(39)*. Fortunately, these five industries are relatively small contributors to the Ohio economy, representing only about *2* percent of this state's value added in *1984*.

The OMI and components are available monthly ($n = 96$) and quarterly ($n = 32$), both seasonally adjusted and nonseasonally adjusted. Index values are reported on a *1982 = 100* basis.

Description of the Data and Procedures

- The Ohio Manufacturing Index and the durable- and nondurable-goods aggregates represent a summation of the industry-level indexes, weighted according to share of real value added in *1984*.
- Ohio manufacturing value added and payroll data are available for the census year *1982* and for the survey years *1978, 1983,* and *1984*.
- Value added was deflated using national price deflators for these two-digit industries, supplied by the U.S. Department of Commerce.
- Monthly employment data in Ohio by two-digit industrial classifications were supplied by the U.S. Bureau of Iabor Statistics and the Ohio Bureau of Employment Services.
- Ohio electric power, measured in kilowatt-hours, is used as a proxy for capital use. Electric power data were collected by two-digit SIC codes by the Data Services Department of the Federal Reserve Bank of Cleveland.[4] The data include self-generated electric power. The monthly timing of electric power consumption data is not exact and tends to overlap between months. For this reason, electric power data are entered into the OMI as a three-month moving average.
- The input series are independently seasonally adjusted using the X-11 ARIMA adjustment procedure.

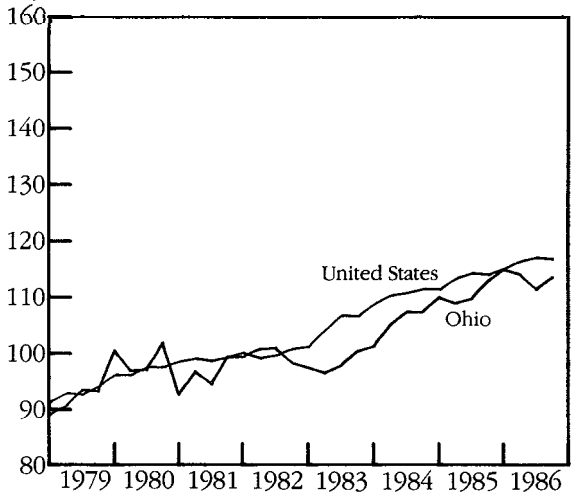
2 In many industries, this period is associated with little or no growth in factor productivity. Consequently, this assumption may be unrealistically low. Withoul firm data lo the contrary, however, a conservative approach seemed appropriate.

3 Virtually all regional and national industrial production indexes employ electric power data to approximate capital usage. See Moody (1974) for a justification of this procedure.

4 A short description of electrical consumption data sources used in lhis study is available from the authors upon request.

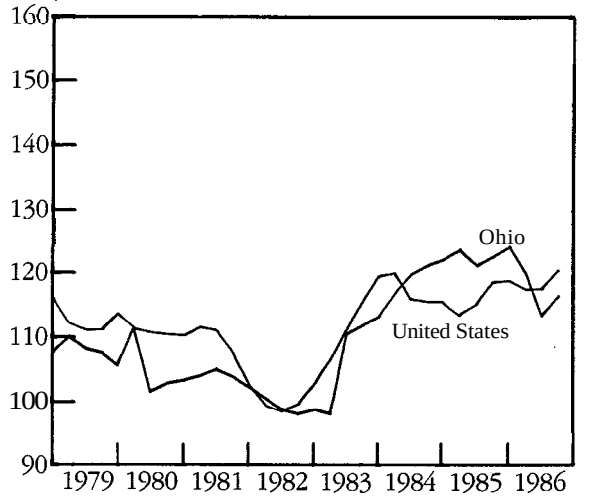
H. Food Production Index

Index, 1982 = 100



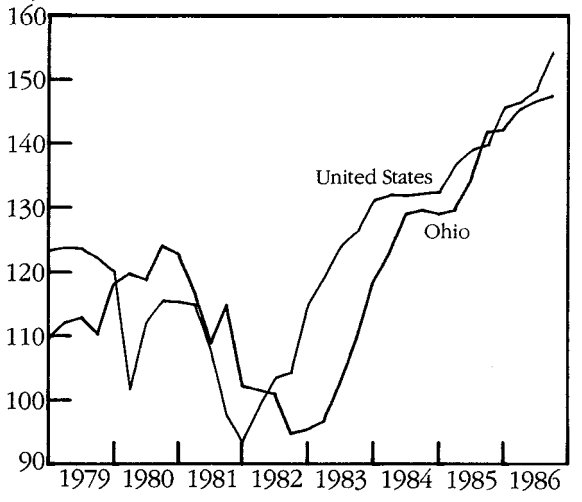
I. Apparel and Other Textiles

Index, 1982 = 100



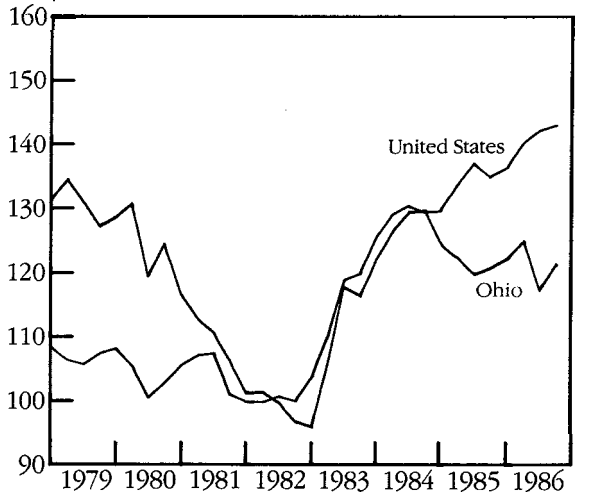
J. Lumber and Wood Products

Index, 1982 = 100



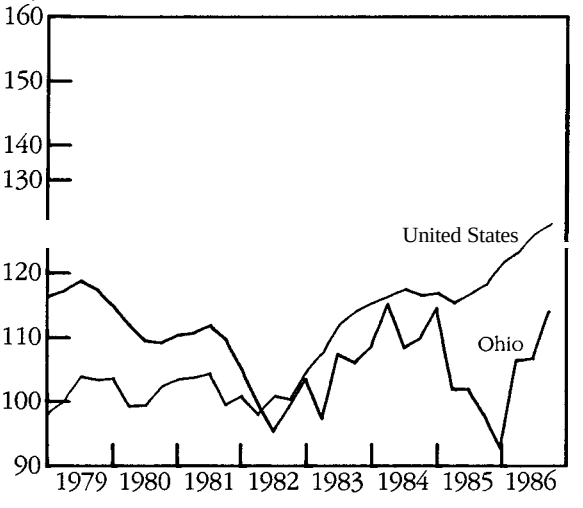
K. Furniture and Fixtures

Index, 1982 = 100



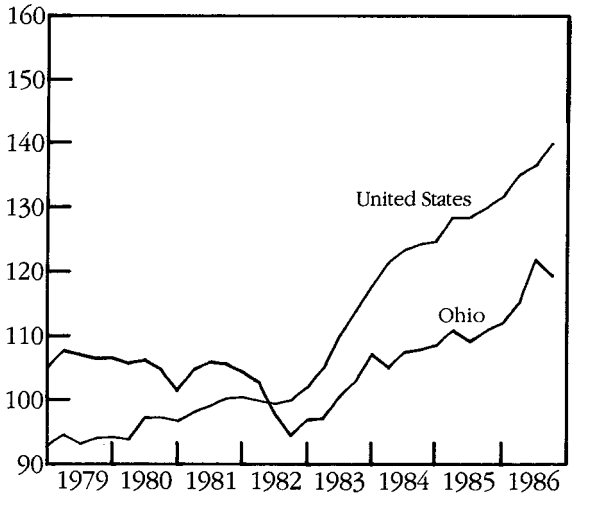
L. Paper and Allied Products

Index, 1982 = 100



M. Printing and Publishing

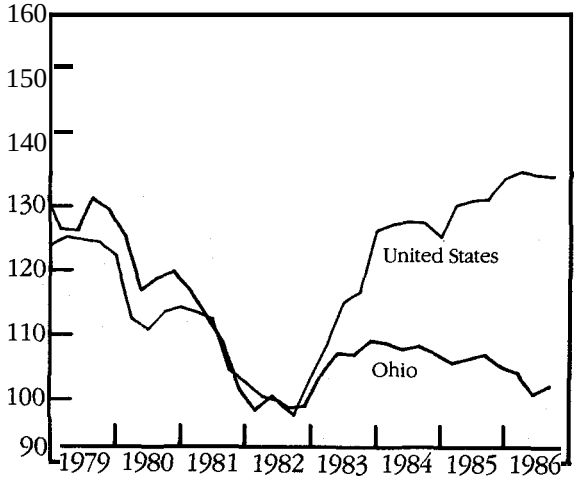
Index, 1982 = 100



SOURCE: Federal Reserve Bank of Cleveland and Board of Governors of the Federal Reserve System

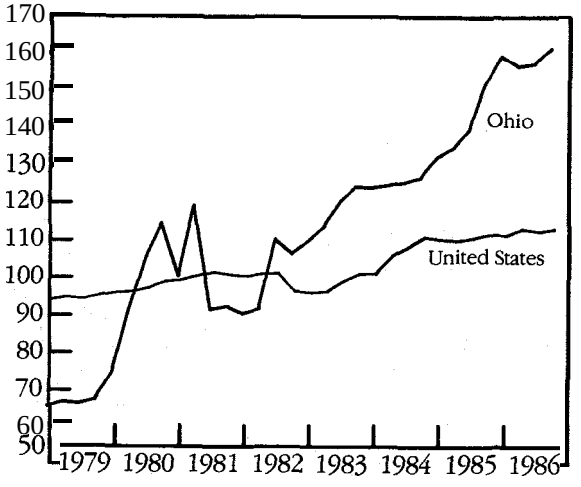
N. Stone, Clay, and Glass

Index, 1982 = 100



O. Instruments and Related Products

Index, 1982 = 100



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

FIGURES 4 N, O

Technical Appendix References

Fomby, Thomas B. "A Comparison of Forecasting Accuracies of Alternative Regional Production Index Methodologies," *Journal of Business and Economic Statistics*, vol. 4, no. 2 (April 1986), pp. 177-186.

Moody, Carlisle E. "The Measurement of Capital Services by Electrical Energy," *Oxford Bulletin of Economics and Statistics*, vol. 36, no. 1 (February 1974), pp. 45-52.

Stroebel, F.R. "Sixth District Manufacturing Index, Technical Note and Statistical Supplement," Federal Reserve Bank of Atlanta, 1978.

Sullivan, Brian P. "Manufacturing Capacity - New Texas Index Assesses Utilization," *Business Review*, Federal Reserve Bank of Dallas, September 1975.