Taking the Measure of Manufacturing

BY TIMOTHY SCHILLER & MICHAEL TREBING

Despite manufacturing's decline as a share of the U.S. economy, it is still a significant sector, and an increasing number of surveys monitor its movements. Why this continuing strong interest in manufacturing? Because it is more cyclically sensitive than the total economy, the manufacturing sector can serve as an indicator of cyclical fluctuations as they develop. In this article, Tim Schiller and Mike Trebing outline several of the most important surveys and indexes that track manufacturing, describe their similarities and differences, and discuss their usefulness in providing timely and accurate data on the sector.

The decline in the manufacturing sector as a share of the U.S. economy in the last half of the 20th century has been one of the most notable changes in the nation's economic structure. In nominal terms (that is, in current dollars), manufacturing's share of the total output of the U.S. economy is only about half of what it was in 1950. Manufacturing employment has also declined as a share of total employment. These trends have been even stronger in the Third Federal Reserve District — Pennsylvania, New Jersey, and Delaware — than in the nation. Despite these trends, manufacturing is still a significant part of the U.S. economy, and it remains a key indicator of changes in national and regional economic conditions. Thus, even while manufacturing's share of total output has declined, it continues to be closely monitored and analyzed. Data collection devoted to monitoring manufacturing has not declined; in fact, it has increased, and the manufacturing sector receives as much attention now, both nationally and regionally, as it ever has.

Why the continued strong interest in manufacturing? Manufacturing remains an important industry, and because it is more cyclically sensitive than the total economy, the manufacturing sector can serve as an indicator of cyclical fluctuations as they develop.[1]

Several measures have been developed to monitor conditions in the manufacturing sector. One of the broadest and oldest series is the Federal Reserve System's national Industrial Production Index, which has sub-indexes for manufacturing, mining, and utilities. Because of the cyclical sensitivity of these sectors, this monthly index is included as a component of the index of coincident indicators of the overall economy.

Other monthly measures of

[1] The cyclical sensitivity of manufacturing is evident in an analysis of the average decline during recessions. The average decline in gross domestic product (GDP) during the nine recessions in the past 50 years was 1.7 percent; the average decline in manufacturing as measured by the Industrial Production Index was 7 percent. GDP itself can be separated into the production of goods excluding structures and all other production. The average decline in the goods component, of which approximately 75 percent is manufacturing, was 4.7 percent during recessions; the average decline in the production of services and structures was 0.1 percent.

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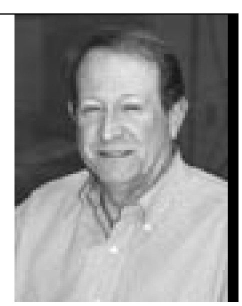

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manufacturing come from the Census Bureau, which compiles statistics on manufacturers' orders, shipments, and inventories. Among private organizations, the Institute for Supply Management publishes a monthly survey of changes in manufacturing activity that receives wide attention. There are also regional surveys and indexes of manufacturing, such as the Philadelphia Fed's Business Outlook Survey.

LONG-RUN TRENDS IN MANUFACTURING

Before we look at some of the short-run measures of manufacturing, a brief review of the long-run trends in the sector will provide some context. From 1950 to 2000 (the last full year before the 2001 recession), manufacturing's share of current-dollar GDP fell from 29 percent to 15 percent. Nevertheless, by this measure, manufacturing is still the third largest of the industry classifications into which the economy is usually divided for analytical purposes (Table 1).[2] From 1950 to 2000, the number of manufacturing jobs in the nation increased by around 3 million, a 21 percent gain. Meanwhile, total nonagricultural employment increased by approximately 87 million jobs, nearly a 200 percent gain. As a result, manufacturing's share of nonagricultural employment declined by more than half, from 34 percent to 14 percent.[3] Still, manufacturing is the fourth largest industry division by employment (Table 2).[4] (There have also been shifts in the regional distribution of manufacturing within the U.S. For a discussion of how they have affected the Third District's region, see *Manufacturing in the Region*.)

The decline in manufacturing's share of national nonagricultural employment and nominal GDP can be attributed to several developments. In part, this decline in share represents stronger-than-average growth in productivity in this sector of the economy. This growth in productivity made it possible for real output in manufacturing (the value of output adjusted for inflation) to expand while the number of workers required to produce the expanded output decreased.[5] Another factor in manufacturing's declining share of employment and output is the fact that a greater portion of the U.S. economy is now devoted to the consumption of services.[6] And even if goods had retained their share of U.S. consumption, the share of domestically produced goods would have declined because imports now make up a greater portion of goods consumed in the U.S. than they did in the past.[7]

Also contributing to the

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[2] These are the industry divisions of the Standard Industrial Classification (SIC) system. Beginning in 2004, GDP by industry will be organized using the North American Industry Classification System (NAICS).

[3] Agricultural employment is not measured in the same way as employment in other sectors, so it is not included in the employment comparisons used here.

[4] Employment data for 2000 (the most recent year in the table) are available in NAICS, but we use SIC for historical comparisons and to be consistent with the GDP data, which will use SIC until 2004.

[5] From 1950 to 2000 manufacturing output per hour increased 3.8 times while output per hour in the total nonfarm business sector increased 2.7 times.

[6] In 1950 manufactured goods made up 63 percent of personal consumption expenditures. By 2000, manufactured goods accounted for just 41 percent of personal consumption expenditures.

[7] In 1950, U.S. exports of manufactured goods exceeded imports. By 2000, the balance of trade in manufactured goods was reversed, and U.S. imports of manufactured goods exceeded exports.

TABLE 1

GDP Shares, Current$, Percent

	1950	2000
Services	8.2	21.5
Finance, insurance, and real estate	10.5	20.1
Manufacturing	28.6	15.5
Government	10.8	12.4
Retail trade	10.8	9.0
Transportation and public utilities	9.1	8.2
Wholesale trade	6.7	7.1
Construction	4.5	4.7
Agriculture, forestry, and fishing	7.0	1.4
Mining	3.2	1.4

TABLE 2

National Nonagricultural Employment Shares (Percent)

	1950	2000
Services	11.9	30.7
Retail trade	14.9	17.7
Government	13.3	15.7
Manufacturing	33.7	14.0
Finance, insurance, and real estate	4.2	5.8
Transportation and public utilities	8.9	5.3
Wholesale trade	5.9	5.3
Construction	5.2	5.1
Mining	2.0	0.4

Manufacturing in the Region

The broad trends that affected the national manufacturing sector during the last half of the 20th century also had an impact on manufacturing in the tri-state region (Pennsylvania, New Jersey, and Delaware). Manufacturing has declined as a share of both output and employment in the region. Besides the national trends, the region has also been affected by the shift of manufacturing away from northern and eastern areas of the nation and toward the southern and western areas (see the article by Ted Crone).

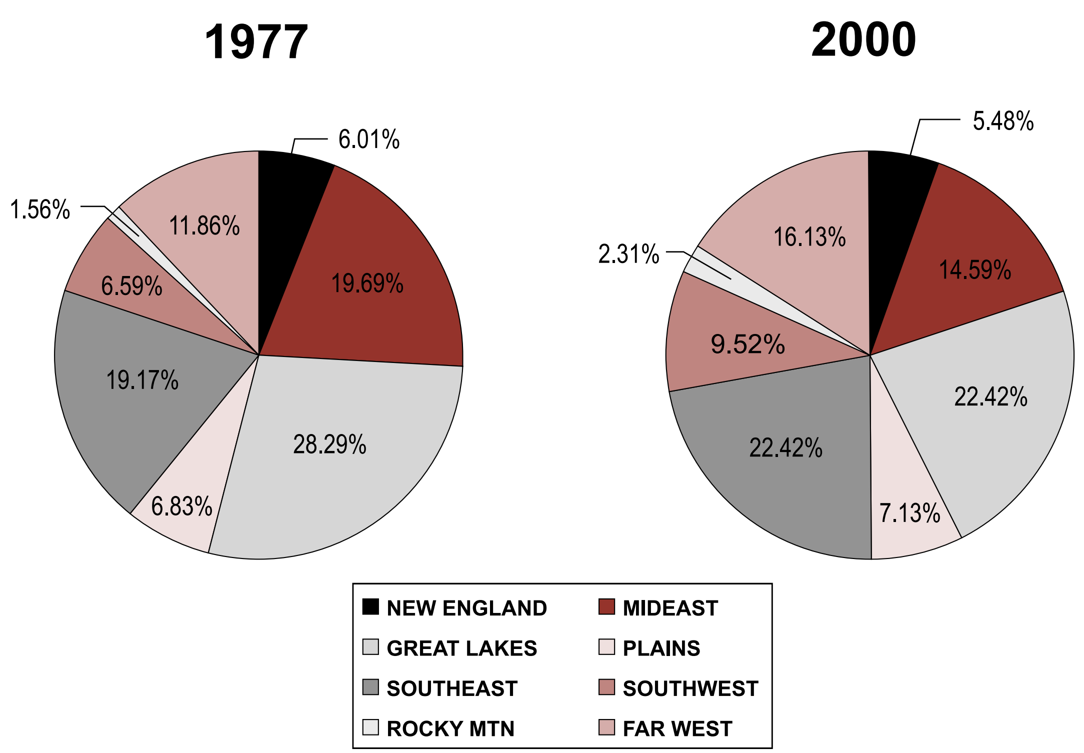
The shift in manufacturing within the nation has resulted in increases in the share of manufacturing output in the five southern and western economic regions as defined by the Bureau of Economic Analysis and declines in the three northern and eastern regions — New England, Mideast, Great Lakes (see Figure).[a] The three states in the Third Federal Reserve District, which are in the Mideast region, shared in this decline.[b] In fact, the Mideast had the greatest relative decline in its share of manufacturing output among all the regions. Within the Mideast region, the relative decline in manufacturing was greater in New York than in any of the other states.

[a] The eight BEA regions are New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountain, and Far West.

[b] The Mideast region also includes New York and Maryland.

FIGURE

Shares of Manufacturing Output*



*Output is measured by total GSP for the 50 states and the District of Columbia. Regions are those defined by the Bureau of Economic Analysis.

Consequently, the share of the Mideast region's manufacturing output accounted for by Pennsylvania, New Jersey, and Delaware (as well as Maryland) rose slightly from 1977 (the first year for which gross state product data are available) to 2000. Even though each of the three states fared better than the Mideast region as a whole, they each lost shares of national manufacturing output (see Table).

As the region's manufacturing sector has declined with respect to national manufacturing, it has also diminished as a part of the region's overall economy. In Pennsylvania, New Jersey, and Delaware, manufacturing output as a share of total state output declined from 1977 to 2000, and the relative decline in the three states was greater than in the nation. Manufacturing's share of the total GSP of all 50 states fell from 23 percent in 1977 to 16 percent in 2000.[c] Manufacturing's share of GSP in Delaware decreased from 35 to 15 percent; in New Jersey it decreased from 27 to 14 percent; and in Pennsylvania it decreased from 29 to 19 percent. Pennsylvania's economy was more manufacturing oriented than the national economy in 1977, and it remained somewhat more manufacturing oriented in 2000. Over the same period, New Jersey moved from a greater concentration in manufacturing than the nation to a lesser concentration. Delaware, which started with a significantly greater concentration in manufacturing, moved to a virtually equal concentration.

Employment from 1977 to 2000 shows a pattern similar to that in the data for output. Nationally, manufacturing employment declined 6 percent. The decline was much greater in all three Third District states. Manufacturing employment fell 31 percent in Pennsylvania, 40 percent in New Jersey, and 14 percent in Delaware. As a share of employment, manufacturing declined from 24 percent to 14 percent nationally. The decline in manufacturing's share of employment in each of the three states was greater: from 30 percent to 16 percent in Pennsylvania, from 27 percent to 12 percent in New Jersey, and from 28 percent to 14 percent in Delaware. In 2000, manufacturing retained a greater share of employment in Pennsylvania than it did in the nation, but the difference narrowed. Manufacturing employment fell from a greater to a lesser share in New Jersey than in the nation. In Delaware, manufacturing's share decreased from above the national share to an equal share.

[c] There is a slight difference in the methods by which national output (GDP) and state output (GSP) are calculated, and this accounts for the difference between manufacturing's share of national output and its share of the total of states' GSP.

The trend of dispersion in manufacturing around the country away from the traditionally heavy manufacturing centers was also reflected to some extent within the region. From 1977 to 2000, manufacturing employment declined in all the metropolitan statistical areas in the three states except Lancaster. Moreover, the manufacturing jobs that remain in the region have become more dispersed. Manufacturing jobs in some of the more populous counties in the larger metro areas are now a smaller percentage of total manufacturing employment in the three states. This is true for Allegheny and Philadelphia counties in Pennsylvania; Essex and Union counties in New Jersey; and New Castle County in Delaware. Conversely, some of the counties in the less populous metro areas had higher percentages of the manufacturing jobs in the tri-state area, for example, Lancaster, York, and Centre counties in Pennsylvania; Cumberland, Middlesex, Somerset, and Hunterdon counties in New Jersey; and Kent County in Delaware. This dispersion of manufacturing jobs from large metro areas to smaller ones was part of a general shift in the shares of all types of jobs from more densely populated to less densely populated areas (see the article by Gerald Carlino).

Dispersion also took place within the large metro areas, as suburban counties gained shares of manufacturing employment and central city counties lost shares. Examples include gains in share for Bucks, Burlington, and Camden counties in the Philadelphia metro area and Morris County in the Newark, NJ, metro area.

TABLE

State Shares of National Manufacturing Output*

	% 1977	% 2000
Delaware	0.46	0.35
New Jersey	3.83	3.20
Pennsylvania	6.31	4.82

*Measured as a percent of the manufacturing portion of total GSP for the nation decline of measured employment in the manufacturing sector has been the increased outsourcing of manufacturing firms' ancillary nonproduction functions. Workers in areas such as accounting, marketing, and shipping would have been counted in manufacturing employment if they were employees of manufacturing firms. If they are employed by accounting firms, advertising agencies, and transportation companies — as many now are — they are counted in service-producing employment. Similarly, a large increase in the use of temporary workers in the manufacturing sector increased the number of workers counted in the services industry (where temporary employment is counted) and decreased the number counted in manufacturing.[8] Manufacturing firms now make greater use of service firms that provide ancillary functions, and they more frequently turn to agencies that supply temporary workers rather than using their own employees for these activities. In addition, some of the decline in measured manufacturing employment has come about because workers had been classified by the industry of the firm for which they worked; now they are classified by the type of work done at their place of employment.[9]

MEASURING MONTHLY CHANGES IN MANUFACTURING OUTPUT

Changes in Levels. As noted earlier, the manufacturing sector continues to be more cyclical than the overall economy (especially the service sectors). The cyclical variability of manufacturing has prompted efforts to develop measures of manufacturing that would give frequent and timely indicators of change in activity in the sector.

The Federal Reserve's Industrial Production Index (IP) has evolved from statistical efforts that began in 1919 with the goal of providing monthly measures of the physical volume of production and trade (it does not give dollar value) in major industries and in total.[10] Because it is an index number, this measure can be used to compare the level of activity in one period with the level in another and to show changes over time.

The Census Bureau publishes other indicators of the level of manufacturing activity. These measure the dollar value of manufacturers' shipments, orders, and inventories. The data series are monthly from 1958 and include measures for many subsectors of manufacturing as well as total manufacturing. Like the Industrial Production Index, these series can be used to compare the level of activity in one period with that in another period and to show changes over time. For the Census measures and the Industrial Production Index, interest in the monthly reports focuses on the change from the previous month as an indication of the direction of change in manufacturing activity.

There are few monthly data below the national scale on the level of output in the manufacturing sector. The Federal Reserve Bank of Dallas computes a monthly Texas Industrial Production Index, similar to the national index, but most sub-national data are annual.[11] The most detailed data are at the state level, and they are available with a lag from the Census Bureau's *Annual Survey of Manufactures*, which includes a measure of value added in manufacturing. Some data on manufacturing establishments and employment are included in *County Business Patterns*, another annual series available with a lag from the Census Bureau.[12]

The cyclical variability of manufacturing has prompted efforts to develop measures of manufacturing that would give frequent and timely indicators of change in activity in the sector.

Breadth of Changes. In addition to measuring the level of production, there's another way to track changes in activity: national and regional surveys that directly measure the breadth of change in the manufacturing sector. These surveys often attract interest because of their timeliness.

One of the most widely followed measures of manufacturing activity is the index based on the monthly survey of manufacturing firms by the Institute for Supply Management (ISM), which was formerly the National Association of Purchasing Managers. The ISM's index is still of-

[8] The increase was especially sharp in the 1980s and 1990s; see the article by Bill Goodman and Reid Steadman.

[9] The new NAICS classifies workers by the type of work performed at their location. For example, a manufacturing firm's research facility is now classified under services instead of manufacturing.

[10] For a description of the Industrial Production Index methodology, see the publication from the Board of Governors.

[11] For a description of the Texas Industrial Production Index, see the article by Franklin Berger and William Long.

[12] The lag between the reference year and publication year for these Census Bureau statistical series is up to two years.

ficially called the Purchasing Managers Index, or PMI. In its current form, the PMI is a weighted average of five indexes that track monthly changes in new orders, production, employment, supplier delivery times, and inventories at ISM's member firms. Firms surveyed report whether each of these measures of activity has increased, decreased, or been unchanged since the previous month.

Surveys of the direction of change have several advantages compared with other economic statistics. They are usually less intrusive and easier for firms to respond to, since they do not require specific numbers but only an indication of an increase, decrease, or no change. This contributes to a better response rate among firms surveyed and quicker compilation of results compared with more detailed survey questions. Diffusion indexes are derived from the difference between the percentage of survey respondents indicating an increase in some measure of activity and the percentage of survey respondents indicating a decrease in that measure. Over time, diffusion indexes reflect how changes in economic conditions actually develop, as the spread between the percentage of firms reporting increases and decreases widens.

According to Geoffrey Moore, former director of the Center for International Business Cycle Research, "One of the fundamental features of our economic system is that economic movements spread from one firm to another, from one industry to another, from one region to another, and from one economic process to another. Moreover, these spreading movements cumulate over time. This being so, it is desirable to have measures showing how this spreading and cumulation goes on. A diffusion index is just such a measure."

By measuring the diffusion, or spreading, of survey responses (toward one extreme or another of the index's range), diffusion indexes reflect the way changes in the pace of economic activity are propagated across firms. For example, in an economic expansion, the first effects are usually felt by just a few firms. When they experience a pickup in business, they step up production to meet the stronger demand. They buy more raw materials and machinery, hire more labor, and so forth. This process repeats itself at the firms that supply materials to the first few firms, and the higher employment leads to higher incomes and spending, which gives a boost to other firms and industries. As the process continues, the expansion spreads through the economy. As the expansion spreads, statistical measures of the level of output begin to increase, confirming in detail the process first reflected by the increase in diffusion indexes that signaled the beginning and spreading of the expansion.

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In addition to national measures of changes in manufacturing activity, there are regional surveys. Local associations of the ISM produce their own reports that include diffusion indexes. Currently, 13 local associations produce reports, although not all of them are monthly. The local associations that conduct surveys are Arizona, Austin, Buffalo, California, Chicago, Cleveland, Dallas, Georgia, Houston, New York, Northwest Ohio, Pittsburgh, and Western Washington. Within the Federal Reserve System, the Federal Reserve Banks of Philadelphia, Kansas City, New York, and Richmond conduct manufacturing surveys.[13] Diffusion indexes are compiled from these surveys, as they are from the ISM's survey. (See *Constructing Diffusion Indexes* for a description of the different ways in which the diffusion indexes discussed here are calculated.)

EVALUATING THE INDICATORS OF MONTHLY CHANGE FROM NATIONAL AND REGIONAL SURVEYS

While the Federal Reserve Board's index of industrial production tells us a great deal about trends in the manufacturing sector and about the magnitude of the monthly changes in production, market participants rely on surveys to get an even earlier indication of changes in the sector. Both the PMI and the index constructed by Chicago's local association of the ISM, which is called the Business Barometer Index, have a long history, and they are available near the beginning of each month.[14]

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[13] Monthly releases are available on the Federal Reserve Banks' web sites: Richmond, www.rich.frb.org/research/surveys/; Kansas City, www.kc.frb.org/mfgsurv/mfgmain.htm; New York, www.newyorkfed.org/rmaghome/regional/mfg_survey/index.html; Philadelphia, www.phil.frb.org/econ/bos/. More details on the surveys conducted by Philadelphia, Richmond, and Kansas City are available in the article by Michael Trebing, the article by Christine Chmura, and the one by Tim Smith.

[14] Historical data are available for the PMI from 1931 and for the Chicago Purchasing Managers index from 1948.

Both are used extensively to forecast changes in the IP index, which is published later in the month. Several Federal Reserve Bank manufacturing surveys are also available before the IP index, and the Philadelphia Fed's Business Outlook Survey (BOS) is the oldest of these.

Table 3 presents the correlations between four measures of monthly change in manufacturing activity: monthly changes in the manufacturing component of the industrial production index (IP-M), the Philadelphia Fed's general activity index, the PMI, and the Chicago Purchasing Managers Business Barometer Index. The correlations cover the 36-year period corresponding to the history of the Philadelphia Fed's Business Outlook Survey. Similar diffusion measures constructed at the Kansas City, New York, and Richmond Federal Reserve Banks have a much shorter history and thus are not included in the table.[15] The two purchasing manager surveys (the PMI and Chicago Business Barometer Index) are highly correlated with each other, and both are correlated with monthly changes in the IP-M. In addition, the correlation of the Philadelphia Fed's Business Outlook Survey index with the IP-M is comparable to the correlation between the IP-M and the PMI.

Constructing Diffusion Indexes

The principle of the diffusion index is the same for all of the diffusion indexes discussed in this article, but their arithmetic computation varies. Consequently, the base or "no change" level and the minimum and maximum values that the indexes can take are different. The Philadelphia Fed's Business Outlook Survey consists of a number of questions about business processes such as new orders, shipments, employment, and workweek among manufacturing firms in the Third Federal Reserve District. Diffusion indexes are calculated for each question in the survey. To gauge how widespread changes in an indicator are among firms, we calculate the percentages of firms reporting increases, decreases, and no change, and we subtract the percentage decrease from the percentage increase. The resulting diffusion index can vary from +100, when all firms report an increase, to –100, when all firms report a decrease. The midpoint is 0, when the percentage of firms reporting increases equals the percentage reporting decreases. Firms in the survey have never been unanimous, so the diffusion index has taken on a value between –100 and +100. The indexes computed by other Federal Reserve Banks are similar. The closer the index is to either of these two extremes, the more diffuse, or widespread, is the change (either decrease or increase) in the indicator reported.

The Institute of Supply Management's Purchasing Managers Index (PMI) is computed differently. Instead of subtracting the percentage decrease from the percentage increase, the PMI adds one-half of the percentage of firms reporting no change to the percentage reporting an increase to form the index. As a result, the PMI can vary from 0 to 100, with 50 being the midpoint. Another difference among the surveys is that the overall index in the Philadelphia Fed's Business Outlook Survey is derived from a separate question that measures manufacturers' assessments of overall business conditions; in the other surveys, the overall index is a composite of the indexes calculated for specific questions.

FORECASTING INDUSTRIAL PRODUCTION WITH MANUFACTURING SURVEYS

The diffusion indexes from the major surveys are positively correlated with changes in IP-M, but how much *new* information do they provide about manufacturing? The availability of diffusion indexes ahead of the release of the industrial production indexes provides a test of their usefulness in forecasting the current month's change in the manufacturing component of the IP. The ISM releases its data on the first business day of each month covering the previous month. In addition to the composite index for manufacturing (PMI), the ISM produces 10 sub-indexes, including one for production. Since the IP indexes are not released until mid-month, the information contained in the ISM indexes provides forecasters with a way to predict the IP-M.

The statistical relationship between the PMI and the IP-M is well established, which explains the attention it receives from financial analysts.[16] Table 4 presents statistical

[15] The regional measures for the Richmond Fed shipments index and the Kansas City production index have the lowest correlation with the monthly change in the IP-M (0.42 for Richmond and 0.43 for Kansas City). The broadest measure in the Richmond Fed's survey is manufacturing shipments, and seasonally adjusted data are available from November 1993. Kansas City's index is not available seasonally adjusted because of its short history (available only since July 2001), which may explain its lower correlation to the national manufacturing measures. The New York Fed's new Empire State Index is highly correlated with the IP-M (0.66), but its limited history (since July 2001) may limit its usefulness as a forecasting tool.

[16] See the articles by Mark Rogers; Ethan Harris; and Evan Koenig.

TABLE 3

Correlation Coefficients for Key Measures of Monthly Change in Manufacturing

	Monthly Change in Manufacturing Component of Industrial Production Index (IP-M)*	Philadelphia Fed Business Outlook Survey, General Activity Index	ISM Composite Index (PMI)	Chicago Purchasing Managers Business Barometer Index
Monthly Change in Manufacturing Component of Industrial Production Index (IP-M)*	1.0	0.57	0.54	0.48
Philadelphia Fed Business Outlook Survey, General Activity Index		1.0	0.74	0.67
ISM Composite Index (PMI)			1.0	0.92
Chicago Purchasing Managers Business Barometer Index				1.0

NOTES: Sample period is from May 1968 to June 2003, the period for which data are available for the Business Outlook Survey.

* Monthly change is calculated as the log difference in the index multiplied by 100, which is approximately equal to percent change.

TABLE 4

Forecasting Monthly Change in the U.S. Manufacturing Production Index (IP-M)

	Explanatory Variables:	R^2	Coefficient on Diffusion Index*
1.	Current Month's Purchasing Managers Composite Index (PMI)	0.29	0.064 (13.2)
2.	Current Month's Purchasing Managers Production Index	0.36	0.065 (15.2)
3.	12 lagged values of percent change in IP-M	0.21	
4.	12 lagged values of percent change in IP-M plus current month's PMI (composite index)	0.32	0.065 (8.2)
5.	12 lagged values of percent change in IP-M plus current month's ISM production index	0.36	0.068 (9.8)
6.	Percent change in manufacturing hours (current and lagged 3 months)	0.60	—
7.	Percent change in manufacturing hours, lagged IP-M, plus current month's PMI (composite index)	0.61	0.023 (3.7)
8.	Percent change in manufacturing hours, lagged IP-M, plus current month's ISM Production Index	0.63	0.035 (6.0)

NOTES: Regressions are based on the estimation period of 1969 to 2003. Monthly change is calculated as the log difference multiplied by 100, which is approximately equal to percent change.

* Absolute values of t-statistics are shown in parenthesis. The t-statistic tests the hypothesis that the diffusion index coefficient is significantly different from zero. In all of the regressions the diffusion index is significant at less than the 0.01 level, meaning there is less than a 1 percent probability that the diffusion index coefficient is equal to zero.

results of various regression models to estimate how well the indexes from the ISM survey predict the monthly change in the production index for manufacturing. Since the ISM produces both a composite diffusion index and a production index, results using each are shown in the table.[17] The regressions are estimated using data from 1969 through June 2003. That time period was chosen to correspond to availability of data for the Business Outlook Survey so that a comparison of forecast performance could be made. In each of the models shown, the dependent variable (the variable to be forecast) is the monthly percent change in the Industrial Production Index for manufacturing (IP-M). The explanatory variables include indexes from the ISM survey and other information available to the market at various times prior to the release of the Industrial Production Index.

The results demonstrate that, by themselves, the diffusion indexes from the ISM survey "explain" 29 to 36 percent of the month-to-month variation in the monthly changes in the IP-M (see rows 1 and 2 of Table 4).[18] The results also indicate that the PMI and the production index from the survey add information, even when the history of the IP-M itself is in the regressions. (Rows 3, 4, and 5 include 12 lagged values of the change in the IP-M as explanatory variables.)

Near the beginning of the month (following the release of the PMI and the production index from the ISM survey, but ahead of the release of the IP-M), data on manufacturing employment and work hours also become available to the market. Table 4 also shows that available employment and average workweek statistics also forecast monthly IP-M. By creating a total manufacturing work-hour statistic (average hours multiplied by manufacturing employment), we can "explain" about 60 percent of the month-to-month variation in the IP-M (row 6). But even when we use this additional information on hours worked, the PMI and the production index from the same survey remain significant in explaining the variation in IP-M (rows 7 and 8). Table 4 shows that the diffusion indexes by themselves are useful for predicting changes in manufacturing production. It also shows that when the diffusion indexes are combined with other available information, they can increase the accuracy of a forecast of changes in the IP-M.

Although the PMI and accompanying indexes add information to a forecast for the IP-M, the availability of the Philadelphia Fed's Business Outlook Survey indexes makes it possible to create a forecast even sooner.

Although the PMI and accompanying indexes add information to a forecast for the IP-M, the availability of the Philadelphia Fed's Business Outlook Survey indexes makes it possible to create a forecast even sooner. Since the BOS is released on the third Thursday of the reference month for the IP-M, it is available almost a month earlier than the release of the IP-M and two to three weeks earlier than the PMI. Table 5 summarizes the statistical relationship between the Philadelphia Fed's general activity diffusion index and the monthly percent change in the IP-M for the months estimated over 1969 to 2003.

Table 5 (row 1) shows that the simple model using the general activity index from the Business Outlook Survey explains approximately the same percentage of variation in the change in the IP-M as the national Purchasing Managers Index.[19] Table 5, row 2 also includes a model using a constructed BOS "weighted index" based on the same weights the PMI uses for its five sub-indexes. (We substituted the BOS shipments index for the production index, since the BOS does not include a production index.) The R^2 for that model (0.26) was lower than that for the general activity index (0.33), so weighting the individual questions from the BOS

[17] The PMI is a composite index based on the seasonally adjusted diffusion indexes of five separate indicators with the following weights: new orders, 30 percent; production, 25 percent; employment, 20 percent; supplier deliveries, 15 percent; and inventories, 10 percent.

[18] The t-statistics indicate that the PMI diffusion index is statistically significant in the forecast of the IP-M, which is released about two weeks after the PMI. In all of the regressions, the coefficient on the diffusion index is significantly different from zero at less than the 0.01 level, meaning there is a less than 1 percent probability that the diffusion index coefficient is equal to zero.

[19] The relative size of the coefficients (0.024 for the BOS and 0.064 for the PMI) is to be expected because of differences in methods used for constructing indexes. The BOS diffusion ranges from -100 to +100 while the PMI ranges from 0 to +100; so the equivalent indexes are linear transformations of each other.

TABLE 5

Forecasting Monthly Change in the U.S. Manufacturing Production Index (IP-M) Using the Business Outlook Survey (BOS)

	Explanatory Variables:	R^2	Coefficient on Diffusion Index*
1.	Current month's Business Outlook Survey general activity index	0.33	0.024 (14.2)
2.	Current month's Business Outlook Survey weighted index**	0.26	0.038 (12.2)
3.	12 lagged values of percent change in IP-M	0.21	—
4.	12 lagged values of percent change in IP-M plus current month's BOS general activity index	0.34	0.021 (8.9)
5.	12 lagged values of change in IP-M plus current month's BOS weighted index	0.30	0.032 (7.2)
6.	Percent change in manufacturing hours (current and lagged 3 months)	0.60	—
7.	Percent change in manufacturing hours, lagged IP-M, plus current month's BOS general activity index	0.63	0.012 (6.3)
8.	Percent change in manufacturing hours, lagged IP-M, plus current month's BOS weighted index	0.62	0.016 (4.9)

NOTES: Regressions are based on the estimation period of 1969 to 2003.
The t-statistic tests the hypothesis that the diffusion index coefficient is significantly different from zero. In all of the regressions, the diffusion index is significant at less than the 0.01 level, meaning there is less than a 1 percent probability that the diffusion index coefficient is equal to zero.
Monthly change is calculated as the log difference multiplied by 100, which is approximately equal to percent change.

* Absolute values of t-statistics are in parenthesis.
** Since the PMI is a weighted index of five sub-indexes, the BOS weighted index was constructed using the same weights as the PMI, but we substituted the BOS shipments index for the production index, since the BOS does not include a production index.

does not improve its ability to predict. When the recent history of the IP-M and information on employment and hours are used in the regression model, the general activity diffusion index retains its significance and matches the PMI in its ability to forecast changes in the manufacturing component of the Industrial Production Index (rows 4, 5, 7, and 8).

The Appendix evaluates the usefulness of the remaining Business Outlook Survey diffusion indexes in forecasting other measures of manufacturing activity, such as the change in new orders, shipments, and employment.

Although the models' ability to track changes in the IP-M within the sample period in which the models are estimated is important, the real test of the models' performance is their ability to forecast change in production outside that sample period. An evaluation of the out-of-sample performance of the PMI and the diffusion index from the Philadelphia Fed over the past several years can best be seen in the figure. The model forecasts are based on the historical relationships between IP-M and the diffusion indexes through December 2000 (Figure). That is, the monthly prediction after that time is based on the models estimated from the available diffusion indexes up to that time. The chart displays the actual monthly change in the IP-M and its predicted value based on the simple models using the PMI and the diffusion index from the Philadelphia survey as the sole explanatory variables. While neither of the models precisely captures the highly volatile month-to-month changes in the IP-M, the forecasts from the models track the broader accelerations and decelerations in the IP-M over several months. A closer examination of the forecast errors shows that, on average, the BOS model outperforms the PMI model for the period January 2001 to June 2003 (Table 6). This period covers the recent downturn in the manufacturing sector as well as the early stages of recovery. The standard measures of forecast performance — the root mean squared error and mean absolute error — are slightly smaller for the model using the BOS than for the model using the PMI.

SUMMARY

Although manufacturing has experienced rapid technological and managerial advances and continues to do so, it remains an important sector of the economy that is subject to significant cyclical movements. Therefore, business analysts and economic policymakers follow the sector closely. They rely on frequently published measures of activity, such as monthly reports and surveys, to track changes in this sector.

Qualitative surveys, such as the one conducted by the Institute for Supply Management, are intended to give an early read on changing conditions. The Institute's Purchasing Managers Index provides timely information on the manufacturing sector nationally. Regional surveys of manufacturing can provide even earlier indications about changes in the national manufacturing sector, in addition to the information they provide about conditions in their own regions' manufacturing sectors. The Philadelphia Fed's Business Outlook Survey is the oldest of the regional surveys produced by the Federal Reserve Banks. Moreover, the Philadelphia index comes out much earlier than the PMI, and it is as accurate as national surveys in predicting the monthly change in the U.S. Industrial Production Index for manufacturing.

TABLE 6

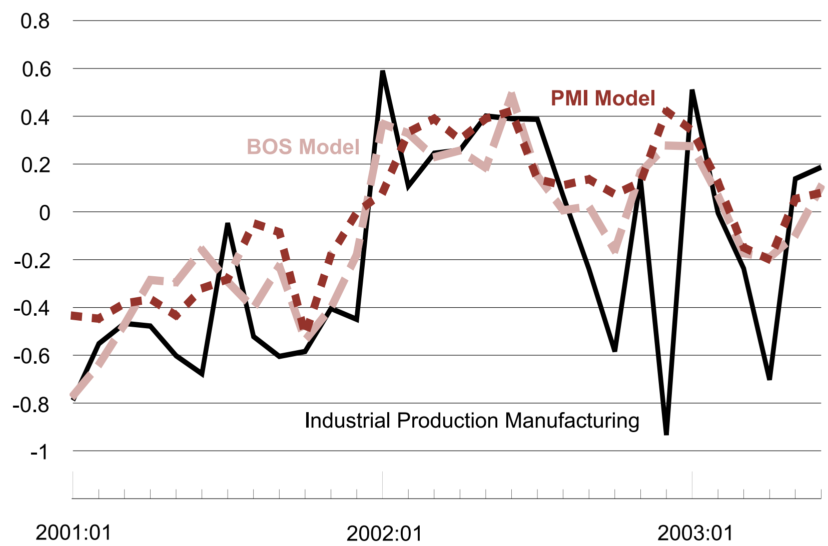
Forecast Prediction Performance for the Monthly Changes in the IP-M (BOS vs. PMI Model)

Model	RMSE	MAE
Business Outlook Survey Diffusion Index	0.318	0.215
PMI	0.378	0.268

NOTES: Estimation period was January 1969 to December 2000. Out-of-sample forecast errors are based on January 2001 to June 2003.
RMSE is root mean squared error and MAE is mean absolute error.
Regressions are for monthly percent change in Industrial Production Index for manufacturing and the explanatory variables are the subject diffusion indexes. Monthly change is calculated as the log difference multiplied by 100, which is approximately equal to percent change.

FIGURE

Model Forecasts and Actual Change in IP-M (Out-of-Sample Forecast for 2001:01 to 2003:06)



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APPENDIX

Comparing the BOS Results with National and Regional Manufacturing Data

Although the main goal of the Philadelphia Fed's Business Outlook Survey is to obtain meaningful and timely information about the pace of growth of the Third Federal Reserve District's manufacturing sector, the evidence suggests that it can be useful in gauging national manufacturing activity as well. To determine the usefulness of the diffusion indexes from the survey's questions on specific measures of manufacturing activity, we again use the common technique of regression analysis.

The table shows the results of 12 regression models in which the current month's diffusion indexes alone are used to predict the change in the corresponding regional or national data. The BOS indexes are most successful at forecasting total industrial production, manufacturing production, regional and national manufacturing employment, manufacturing inventories, delivery times, and producer prices. The individual BOS indexes have very weak explanatory power (a low R^2 statistic) for national shipments, new orders, manufacturing workweek, and unfilled orders. The only series for which the BOS has no statistically significant relationship to the underlying national data (a low t-statistic on coefficient) are the manufacturing workweek and unfilled orders.

TABLE

Simple Regression Results—Explaining U.S. and Regional Economic Measures Using Counterpart Business Outlook Survey Diffusion Indexes

Dependent Variable: *National Data*	**Constant**	**Diffusion Index Coefficients (t-statistic)**	**R^2**	**Time Period**
Industrial Production	0.015 (0.44)	0.020 (13.32)	0.30	1969:01 2003:06
Manufacturing Production	0.005 (0.13)	0.028 (14.18)	0.33	1969:01 2003:06
Manufacturing Shipments	-0.067 (-0.46)	0.292 (3.24)	0.07	1992:02 2003:06
Manufacturing New Orders	-0.082 (-0.43)	0.034 (2.77)	0.05	1992:02 2003:06
Delivery Times/Vendor Deliveries	56.16 (109.00)	0.722 (14.52)	0.34	1969:01 2003:06

TABLE (continued)

Simple Regression Results—Explaining U.S. and Regional Economic Measures Using Counterpart Business Outlook Survey Diffusion Indexes

Dependent Variable: *National Data*	**Constant**	**Diffusion Index Coefficients (t-statistic)**	**R^2**	**Time Period**
Manufacturing Employment	-0.03 (-1.59)	0.023 (14.75)	0.35	1969:01 2003:06
Manufacturing Workweek	0.003 (0.92)	0.003 (0.92)	0.00	1969:01 2003:06
Manufacturing Unfilled Orders	-0.00 (-0.02)	-0.001 (-0.22)	0.00	1992:02 2003:06
Manufacturing Inventories	0.288 (6.14)	0.025 (5.63)	0.19	1992:02 2003.06
Producer Prices (Finished Goods)	0.148 (5.18)	0.016 (11.01)	0.23	1969:01 2003:06
Producer Prices (Intermediate Goods)	-0.244 (-5.70)	0.020 (16.89)	0.41	1969:01 2003:06
Regional Data				
District Manufacturing Employment (Tri-State)	-0.152 (-7.03)	0.018 (8.44)	0.31	1990:01 2003:04
District Manufacturing Employment (District Totals)	-0.151 (-5.19)	0.018 (6.74)	0.22	1990:01 2003:04

Source: Federal Reserve Board, Census Bureau, Bureau of Labor Statistics, Institute of Supply Management. District manufacturing data for state employment include Delaware, New Jersey, and Pennsylvania. District employment is the total of manufacturing employment for the metropolitan statistical areas (MSAs) within the Third Federal Reserve District. All of the dependent variables (except vendor deliveries) are calculated as the log difference multiplied by 100, which is approximately equal to percent change. The delivery times variable is the ISM's diffusion index for current month supplier deliveries.