

**Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.**

**Diverging Measures of Capacity Utilization:
An Explanation**

Norman Morin and John J. Stevens

2004-58

NOTE: Staff working papers in the Finance and Economics Discussion Series (FEDS) are preliminary materials circulated to stimulate discussion and critical comment. The analysis and conclusions set forth are those of the authors and do not indicate concurrence by other members of the research staff or the Board of Governors. References in publications to the Finance and Economics Discussion Series (other than acknowledgement) should be cleared with the author(s) to protect the tentative character of these papers.

Diverging Measures of Capacity Utilization: An Explanation^{*}

Norman Morin
Federal Reserve Board

John J. Stevens
Federal Reserve Board

August 2004

Abstract

In the wake of the recent recovery in manufacturing production, the capacity utilization rates published by the Federal Reserve Board (FRB) have rebounded much more slowly than those published by the Institute for Supply Management (ISM). As a result, some observers have speculated that the manufacturing sector may have considerably less slack than is indicated by the FRB measures. Our view is that the two characterizations of manufacturing slack are not as incongruent as they first appear. This paper discusses the practical and conceptual differences between these measures of capacity utilization, and concludes that the recent divergence simply reflects the character of the latest business cycle.

^{*} The opinions expressed here are those of the authors and not necessarily those of the Board of Governors of the Federal Reserve System or its staff. We thank Carol Corrado, Ralph Kauffman, Paul Novak, Norbert Ore, and Joyce Zickler for helpful comments on the issues discussed in this paper.

Introduction

How much spare capacity is there in the overall manufacturing sector? The answer to this question is often thought to be a leading indicator of aggregate inflationary pressure and a signal of future industry capital spending.² Earlier this year, this question was brought into the spotlight when the utilization rates published by the Institute for Supply Management (ISM) in its Semiannual Economic Forecast diverged from those published by Federal Reserve Board (FRB) in its monthly G.17 Statistical Release, *Industrial Production and Capacity Utilization*.³ The upper panel of chart 1 compares these two utilization rate measures; because the ISM rates generally run 4 to 5 percentage points above the FRB rates (for reasons discussed later), the lower panel shows the same series adjusted for the difference in their mean values over the November 1989 to April 2004 time period. As can be seen, a large gap appears to have opened recently. The FRB measure dropped almost 9 percentage points during the most recent recession and, as of April 2004, remained about 4 percentage points below its 1972–2003 average of 80.0 percent. In contrast, while the ISM measure dropped by a similar amount in the recent downturn, it rebounded more quickly between the end of 2001 and early 2002 and climbed sharply between November 2003 and April 2004.

Recent press articles have pointed to the sharp rise in the ISM rates as a signal of impending inflationary pressures within manufacturing that are being missed by the FRB operating rates.⁴ Many of these articles go on to argue that the Federal Reserve's measures remain too low because they fail both to reflect technology-induced obsolescence of older equipment and to remove idled plants that industries consider permanently closed. The prima facie case for the two measures painting different

² See Morin and Stevens (2004) for a discussion of the predictive ability of the FRB measures of capacity utilization for industry capital spending, industry capacity expansion, and industry price changes.

³ The FRB and ISM are currently the only two organizations that publish aggregate capacity utilization rates for the United State manufacturing sector on a regular basis. The long-run trend in the FRB rates largely reflects the results of the Census Bureau's annual Survey of Plant Capacity (SPC), which is a survey of 17,000 manufacturing establishments that is jointly funded by the FRB and the Department of Defense.

⁴ "The Outlook: Capacity Question Frames Industry Direction," Timothy Aepfel, Wall Street Journal Europe, May 24, 2004. "Ahead of the Tape," Wall Street Journal, June 16, 2004. "A Different Measure of Capacity Utilization and a Very Different Message," Dismal Scientist from Economy.com, May 6, 2004. "Fed Fiddles as Inflation Roars to Life," Larry Kudlow, Kansas City Star, May 20, 2004.

pictures of manufacturing slack appears on the surface to be persuasive and to have intuitive appeal. However, as discussed below, the Federal Reserve Board and the Census Bureau exert substantial effort to ensure that closed plants and technological change are reflected in the published measures of utilization. Therefore, the explanation must lie elsewhere. Our view, like that expressed by Federal Reserve Board member Donald Kohn (2004), is that the two pictures of manufacturing slack are not as incongruent as they first appear. We attribute the recent divergence between the FRB and ISM measures to the character of the latest business cycle—in particular, to the significant drop in manufacturing employment that extended well past the official business cycle trough.

We begin by discussing the key differences between the FRB and ISM utilization rates and review how plant closures and technological obsolescence are captured by the two measures. Next, we examine the cyclical properties of employment and capacity utilization during the last few business cycles. Because the ISM utilization rate has been published in its current form only since 1989, we make an effort to infer the likely behavior of the ISM rates prior to this time by using the ISM's measure of supplier delivery performance. Lastly, we examine the internal consistency of the responses to other questions in the ISM's most recent semiannual economic survey to see what we can learn about the sharp increase in ISM utilization rates.

Differences between the FRB and ISM measures

The FRB and ISM have similar definitions of capacity, but in practice the results may differ because of the way in which respondents treat margins of adjustment related to variable inputs like labor and materials. The capacity indexes produced by the Federal Reserve Board are designed to capture the concept of *sustainable maximum output*, the greatest level of output a plant can maintain within the framework of a realistic work schedule after factoring in normal downtime and assuming sufficient availability of labor and material inputs to operate the capital in place (see box). The concept roughly corresponds to the full-input point on a production function, with the qualification that capacity represents a sustainable maximum rather than some higher unsustainable short-

term maximum.⁵ Note that plant managers are specifically instructed to consider the equipment that is in place and ready to operate, without treating their current staffing or the availability of labor or materials input as a limiting factor. In other words, factors of production that are easily varied are not constraints on capacity.

Definition of Capacity in the Survey of Plant Capacity

Full Production Capability – The maximum level of production that this establishment could reasonably expect to attain under **normal** and **realistic** operating conditions fully utilizing the machinery and equipment in place. In estimating market value at full production capability, consider the following

- Assume **only** the machinery and equipment in place and ready to operate will be utilized. Do not include facilities or equipment that would require extensive reconditioning before they can be made operable.
- Assume **normal** downtime, maintenance, repair, and cleanup. If full production requires additional shifts or hours of operation, then appropriate downtime should be considered in the estimate.
- Assume labor, materials, utilities, etc. are fully available.
- Assume number of shifts, hours of plant operations, and overtime pay that can be sustained under **normal** conditions and a **realistic** work schedule.
- Assume a product mix that was **typical** or representative of your production during the fourth quarter. If your plant is subject to short-run variation assume the product mix of the current period.
- Do not assume increased use of productive facilities outside the plant for services (such as contracting out subassembly work) in excess of the proportion that would be normal during the fourth quarter.

In contrast, the ISM index asks respondents to measure their current output relative to “normal capacity.” The definition of normal capacity is left to the respondent, and at least a portion of the respondents appear, as we will argue in more detail later, to treat labor as a quasi-fixed factor. Our conversations with representatives at the ISM suggest that while the FRB and ISM share a similar view of what constitutes capacity, we agree that, in practice, respondents are likely to evaluate the SPC definition of capacity somewhat differently from the phrase “normal capacity.” The difference is likely to be most pronounced around business cycle turning points, particularly after a protracted downturn when the assessment of “normal” may have changed considerably.

The FRB and ISM differ in other ways as well. The levels of the two measures differ because of sample design and concerns about historical consistency. The FRB measures are, for the most part, benchmarked to utilization rates compiled from the

⁵ For example, a firm may postpone routine maintenance or temporarily boost overtime to produce above capacity. In the long run, these actions are not sustainable.

responses of 17,000 individual plant managers to the Survey of Plant Capacity. In contrast, the ISM survey is much smaller—typically about 400 respondents—and is largely a firm-level survey. Previous analysis of firm-level surveys (such as the now-defunct McGraw-Hill survey) showed that firm-level respondents tend to report higher utilization rates, because they recognize bottlenecks at the corporate level that an individual establishment within the company may not face. In addition, the ISM, unlike the SPC, is not a probability sample, and individual responses are unweighted; this could influence utilization rates if large firms, which have a greater presence in the ISM survey than in manufacturing in general, have systematically different rates of capacity utilization than small firms in the same industry.

An important question is how plant closures and obsolete equipment are handled by the FRB and ISM. In the ISM, the closure of a firm results in the loss of a respondent, and thus that firm/establishment is simply not in the survey. If ISM respondents view a portion of their capital as obsolete, they presumably eliminate it from their assessment of normal capacity. However, this begs the question, if the equipment is still operable, might firms begin to use it if the demand environment becomes more favorable? Perry (1973) noted that survey-based measures of capacity yield what is sometimes termed “lost-and-found” capacity: Capacity is lost in a downturn and found again during the recovery, as respondents may be more willing in a downturn to exclude from their calculation of capacity the marginal plant or equipment, and as the economy recovers include the plant or equipment that was considered “uneconomical” in the downturn.

The methodology used by the Federal Reserve directly handles both plant closures and shifts in investment toward increasingly technologically advanced equipment that becomes obsolete more rapidly. Because the SPC survey respondents are plant managers, we believe that they are aware of and account for the technological obsolescence of the equipment in their own factories. Furthermore, these survey data, and other capacity data used by the Federal Reserve, fully reflect permanent plant closings within, at most, a year or so of the initially published utilization rates.⁶

⁶ For example, the currently published capacity utilization estimates for the fourth quarter of 2003 are not yet benchmarked to the 2003 Survey of Plant Capacity. When the regular annual revision of industrial production and capacity utilization is completed this fall, the benchmarks will be incorporated. However, over the last eleven annual and comprehensive revisions to industrial production and capacity utilization,

When an industry has shuttered capacity, it will be captured in the FRB measures in multiple ways. First, when a plant that is in the SPC sample closes it can be indicated on the SPC survey form, and this plant will be excluded from the calculation of industry capacity; if the survey form is not returned, Census staff follow up to determine the status of the plant. A new probability sample for the SPC is drawn every 5 years from the Census of Manufactures, and it is augmented annually to reflect new plant births and to replace closed plants. Second, for some industries, physical data on capacity is used (for example, from an industry trade association); for these data sources, the capacity of the closed plants will be removed from the industry total. Lastly, we may make a judgmental edit to the estimate of capacity if it is for a year for which the SPC has not yet been published and if we have sufficient evidence to suggest that an edit is warranted.

In addition to the SPC and physical capacity data, the FRB incorporates into the capacity estimates alternative indicators of capacity such as measures of industry-level capital services.⁷ Therefore, technological improvements may influence both the SPC respondents' assessments of capacity as well as the FRB calculation of measures of capital services.⁸ There are two principal effects of technological changes on the capital available to firms, a first-order effect and a second-order effect. The first-order effect arises from shifts in investment toward high-tech capital and away from low-tech capital. For example, as firms purchase more computers and fewer boilers, this effect is reflected in the BEA's quarterly measures of asset-level investment, which are used in the calculation of industry-level capital services. Thus we can observe shifts in investment toward shorter-lived, high-tech assets. The second-order effect arises from changes in the *pace* of obsolescence of *existing* capital. In general, the FRB *capital measures*, like the BEA and BLS measures of capital stocks, cannot capture this effect, because they are constructed using the perpetual inventory method that assumes depreciation is

the mean absolute revision to the manufacturing operating rate for the quarter corresponding to the SPC benchmark is just 1/4 percentage point.

⁷ See Morin and Stevens (2004) for a detailed discussion of the methods used to construct the FRB measures of capacity and capacity utilization.

⁸ Capital services, or capital input, measures the potential flow of services derived from existing stock of physical capital. Real net capital stocks in a wide variety of asset categories are aggregated using asset-specific rental prices or user costs (see BLS, 1983).

independent of the business cycle.⁹ However, even if the capital measures fail to adequately reflect obsolescence of existing assets, the effects on the FRB capacity utilization rate measures are greatly obviated by the annual benchmarking of the FRB rates to the SPC.

What can the business cycle tell us about the relative behavior of the two measures?

Because the ISM only began to publish an average utilization rate in 1989, cyclical comparisons of the two measures are limited.¹⁰ In contrast to the recent experience, the movements of the ISM and FRB operating rates did not diverge fundamentally during the early stages of the recovery from the 1990–1991 recession. A likely reason for the difference is that the character of the two episodes differed substantially, particularly in the industrial sector. As shown in the panels of chart 2, the depth and duration of the 1990–1991 downturn in IP was much less severe than the most recent episode, and the subsequent recovery from the 1990–1991 episode was more rapid, both in terms of production and capacity utilization. Furthermore, although employment continued to decline during the early stages of the recovery in 1991, the cumulative job losses were significantly less than in the extended period from early 1998 to early 2004. Even after production began to stabilize, manufacturing firms appeared unusually reluctant to hire—likely the result of the combined effects of uncertainty about the durability of the nascent recovery and the continued ability to use new technologies and improved business practices to increase productivity at a substantial rate.

In a period of consistent gains in production, hiring, and capital spending, the ISM and FRB should not have noticeably different patterns in their published operating rates. More precisely, movements in operating rates should track each other well even if a level

⁹ If the scrapping of capital was counter-cyclical, the measured percent change in capital input would be too large in recessions and too low in expansions. Mismeasurement of capital input can also work in the other direction if asset depreciation rates are procyclical: the equipment is worked more intensively in expansions, depreciating more rapidly, and work less intensively (and stands idle) more often in a downturn, depreciating less rapidly.

¹⁰ Prior to December 1989, respondents only reported whether the utilization rate was less than 50 percent, between 50 and 74 percent, between 75 and 90 percent, between 90 and 100 percent, or above 100 percent. Unfortunately, the “less than 50 percent” category is too large to construct an artificial average that is reliable in a sharp downturn like the 1981–1984 period when the share of respondents in the under 50 percent category jumped.

difference exists for reasons of sample design and composition. However, following a prolonged downturn, such as the latest cycle in which manufacturing employment contracted significantly, the difference between the SPC definition of capacity, which explicitly excludes labor as a limiting factor, and the ISM's concept of "normal capacity," which does not preclude respondents from treating labor as somewhat fixed, may lead to very different pictures of manufacturing slack. All else equal, utilization rates will rise more quickly if firms come to view the significantly lower level of employment as "normal," than if firms do not treat labor as a constraint. Indeed, implicit in the sharp rise in the ISM utilization rate recently is an outright contraction in manufacturing capacity. Between 2001 and early 2004, the Federal Reserve capacity index for manufacturing did increase at its slowest pace in the history of the series, but the aggregate measure did not decline. As a result, although production increased at a significant clip since the last half of 2003, the rise in operating rates was not steep.

The ISM supplier deliveries index, which has a lengthy history, exhibits cyclical behavior akin to the ISM utilization rate and can be used to shed some light on the likely behavior of average utilization rates in earlier cycles. This index measures vendors' performance—slower deliveries of goods are registered as an increase in the diffusion index. As shown in chart 3, movements in the supplier deliveries index and the FRB manufacturing operating rate track very well—rising operating rates are associated with periods in which deliveries are slowing. However, since 2001, the FRB manufacturing utilization rate has remained low while the supplier delivery index has risen significantly (i.e., delivery times have lengthened). A similar gap between the FRB operating rate and the ISM supplier deliveries index prevailed from 1982 until 1984—a period during which manufacturing was approaching the end of a protracted and substantial downturn and beginning to recover. In both the early 1980s episode and the recent period, the divergence between the ISM measure and the FRB utilization rate occurred when the supplier deliveries index rose for nearly a year before the FRB utilization measure began to recover. The increase in supplier delivery lead times likely reflects constraints on labor and materials (neither of which enter into the FRB definition of capacity) resulting from the cumulative declines in employment and inventories over the downturns. In the early 1980s, as manufacturing production recovered and the FRB utilization rates rose in

earnest, the supplier deliveries index actually declined. This reversal reflected increasing employment and inventory accumulation, the same short-term factors that had previously slowed vendor performance.

What do the responses to other ISM questions tell us about the increase in the ISM utilization rate?

The respondents to the ISM survey are asked about their operating rates relative to the level of “normal capacity.” In the April semi-annual report, survey results for related questions support our contention that the primary reason for the recent widening of the gap between ISM and FRB rate is that a significant share of respondents assumed that something near their current level of labor was a binding constraint on capacity. Indeed, the most direct explanation for the survey results is that some respondents considered their current labor force, which was likely noticeably diminished relative to its pre-recession level, as “normal.” First, respondents reported that the principal means of achieving increases in production capacity in 2004 would be “more hours worked with existing personnel” and “additional personnel (permanent, temporary, or contract)”; adding plant or machinery was listed third. According to the ISM survey, capacity was, on net, expected to rise 5.2 percent in 2004—a very large increase in nominal terms—while capital spending is slated to rise a modest 6 percent. Furthermore, employment is expected to rise nearly 3 percent, which would be the largest annual increase in manufacturing jobs since 1984. Because capital spending in the manufacturing sector has dropped to very low levels in recent years, a 6 percent increase in capital spending would be barely enough to offset retirements and efficiency declines of the existing stock of capital. Thus, the large increase in capacity expected by the ISM respondents would likely have to be driven by projected increases in hours worked (more employees and more hours per employee, according to the survey) as well as by the labor productivity gains derived from new capital investment and from improved business practices.

The FRB measures of capacity, however, indicate a much more modest increment to capacity during 2004. Manufacturing capacity is estimated to increase only 1.7 percent (measured from fourth quarter to fourth quarter), and excluding the high-technology industries—whose enormous increases in real capacity are dominated by

technological change—capacity in manufacturing is expected to edge up only 0.1 percent in 2004. The essentially unchanged level of capacity outside high-tech reflects differing crosscurrents: Durables capacity is expected to increase 0.8 percent in 2004, while nondurables capacity is estimated to fall about 1/2 percent (excluding the fast-growing pharmaceuticals industry, nondurables capacity is estimated to fall about 1-1/4 percent). Because the definition of capacity used by the Federal Reserve and the Census Bureau assumes that labor inputs are fully available, these estimated changes in capacity primarily reflect increases or decreases in industry capital.

Manufacturing employment declined a cumulative 17-1/4 percent—3 million workers—between July 2000 (the peak in industrial production) and January 2004 (the trough in manufacturing employment). After such a protracted and fairly deep downturn, a survey in which a significant share of respondents, who have pared down their payrolls, consider the current, smaller, workforce as “normal” will yield a lower level of capacity than a definition that assumes sufficient labor is available to operate the equipment in place. Therefore, one would expect that a faster rise in operating rates would be reported in the early stages of recovery after such an extended downturn, particularly when, as in the current episode, employment continued to decline. As hiring among manufacturers accelerates, one would expect the gap between the ISM and FRB operating rates to narrow.

Conclusion

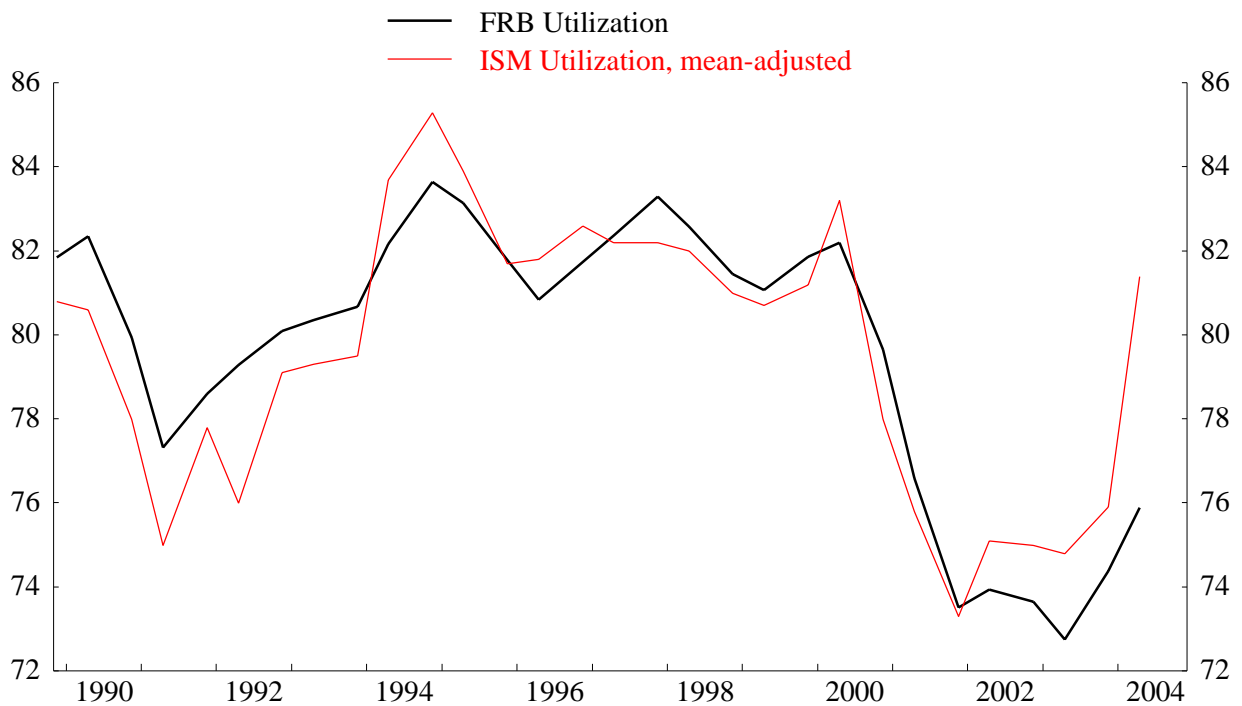
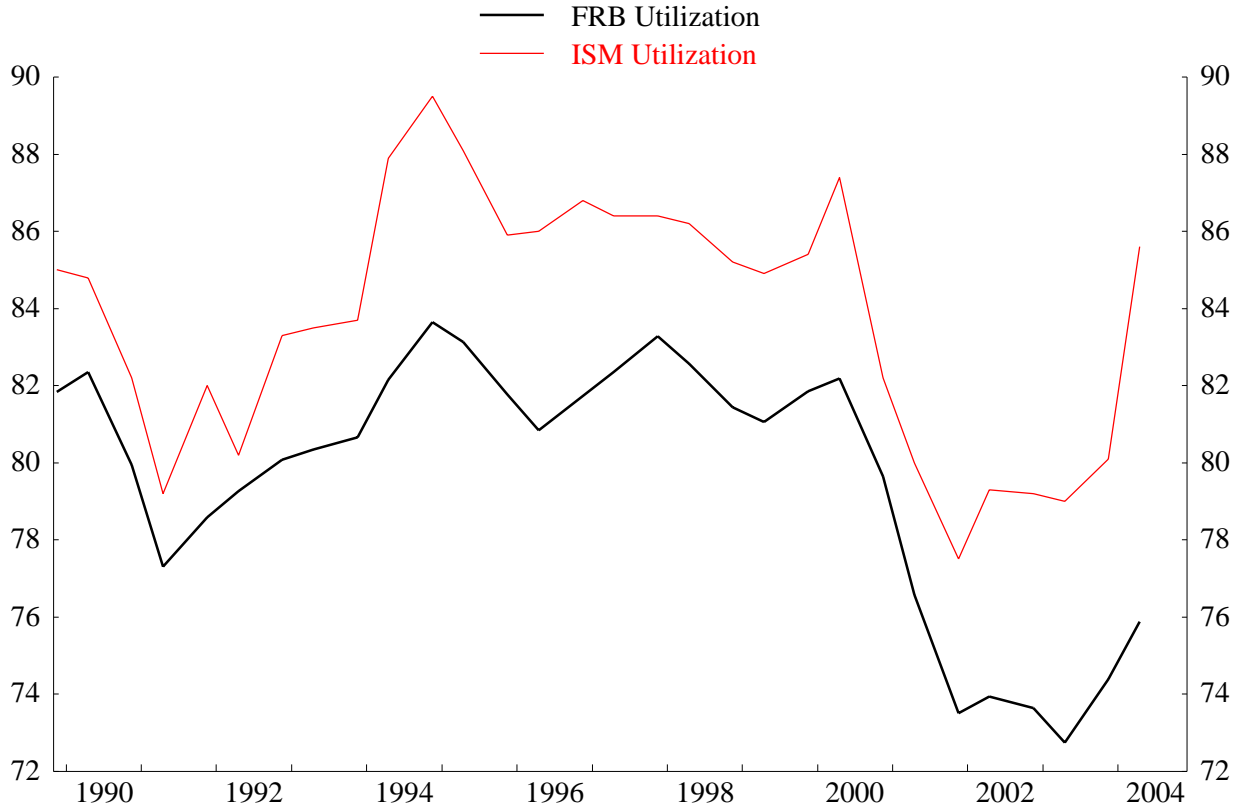
The different picture of manufacturing slack painted by the relative behavior of the FRB and ISM measures of capacity utilization have been aptly questioned by various observers of the U.S. economy. Nonetheless, our analysis suggests that the recent gap between these measures is likely to close as hiring resumes and as the margins of adjustment related to employment become less binding. The answers to the ISM questions about capacity expansion, investment, and employment are consistent with this explanation, and the behavior of manufacturing employment in the two cycles for which the measures overlap lends further credence to this view. Finally, the relative behavior of the FRB utilization rates and ISM supplier deliveries diffusion index, which can be

compared over a much longer history, suggests that such divergences are not unprecedented and that they tend to realign themselves as the economy recovers from a particularly deep or protracted downturn.

References

- Bureau of the Census (various years), "Survey of Plant Capacity" Current Industrial Reports, MQ-CI.
- Bureau of Labor Statistics (1983). "Trends in Multifactor Productivity, 1948-1981," BLS Bulletin No. 2178.
- Kohn, Donald L. (2004), "The Outlook for Inflation," Speech given at the National Economists Club, Washington D.C, June 4.
- Morin, Norman J., and John J. Stevens (2004), "Estimating Capacity Utilization from Survey Data," FEDS Working Paper #2004-49.
- Perry, George L. (1973), "Capacity in Manufacturing," Brookings Papers on Economic Activity, Vol. 3, 701 - 742.

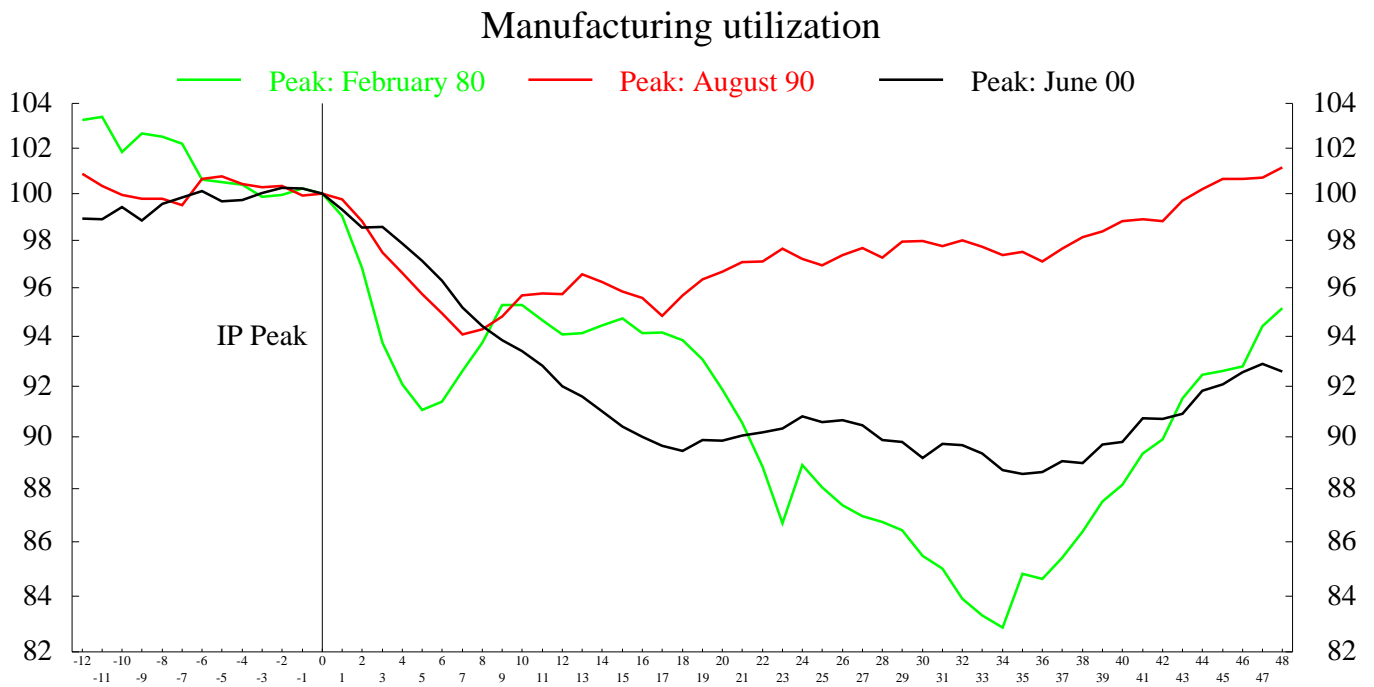
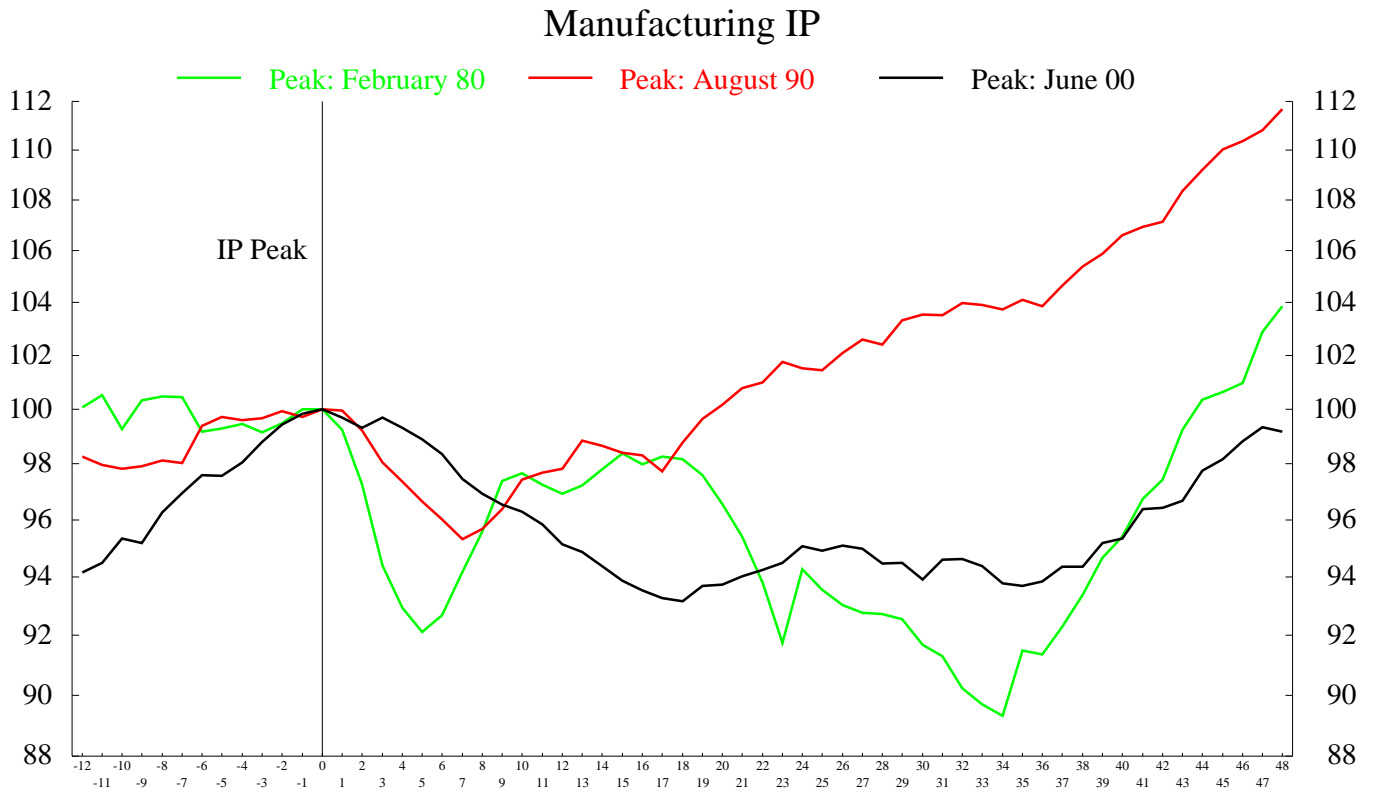
Chart 1. Measures of Capacity Utilization



Note: Mean difference calculated from 1989m11 to 2004m4.

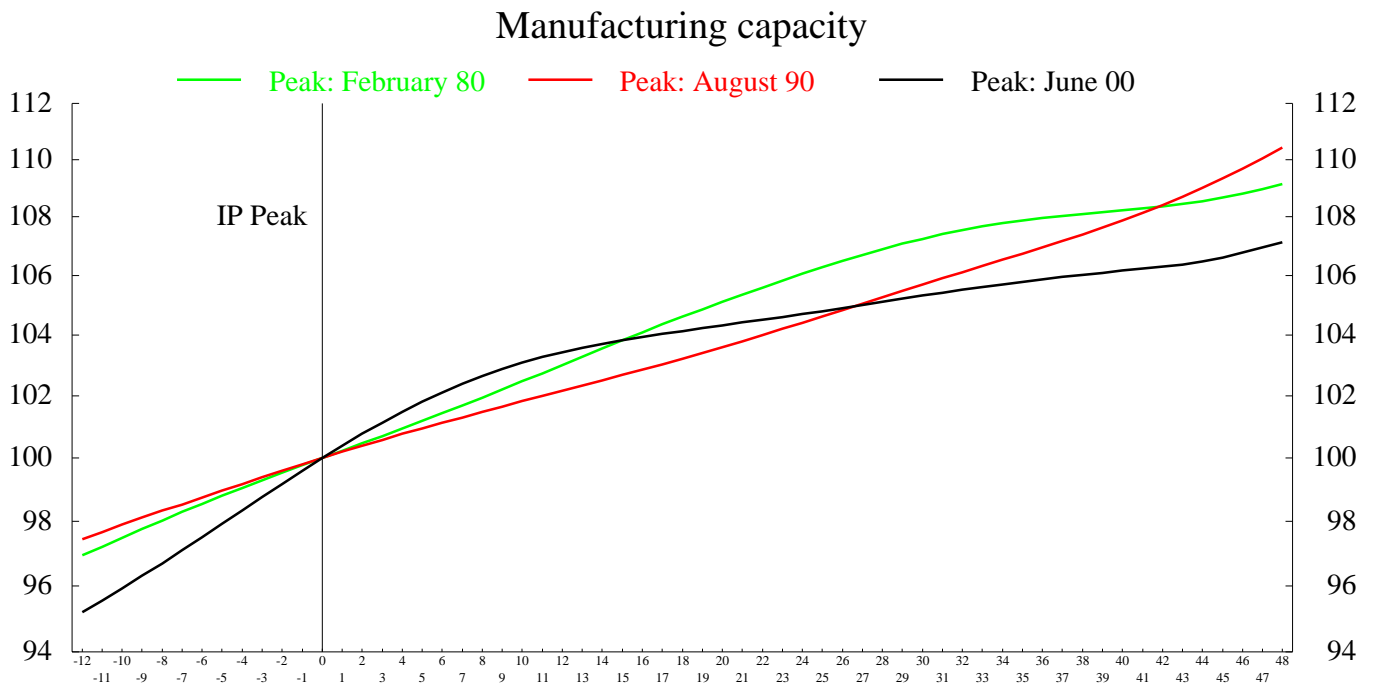
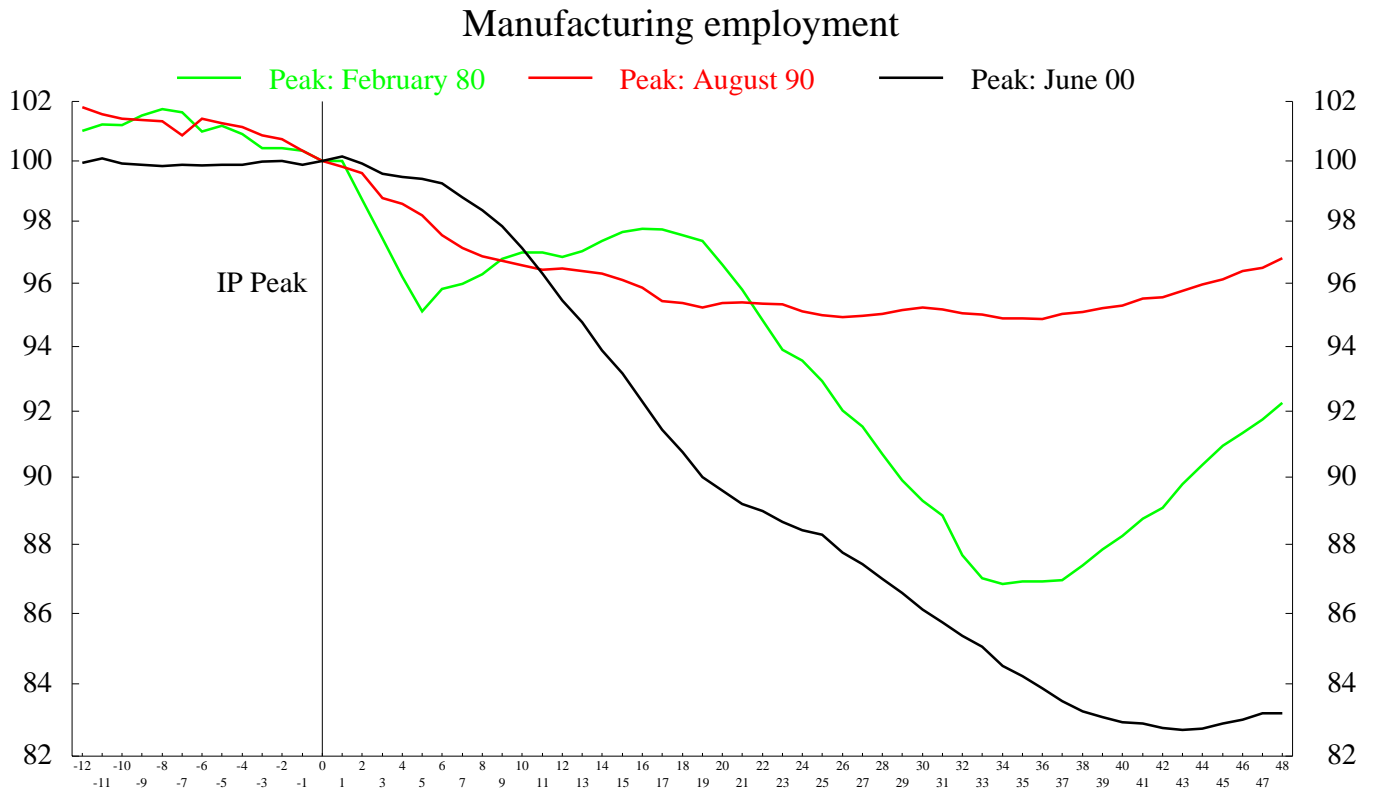
Source: Federal Reserve Board and the Institute for Supply Management.

Chart 2. Recent Cycles in Manufacturing
 Series reindexed for comparison: date of IP peak = 100



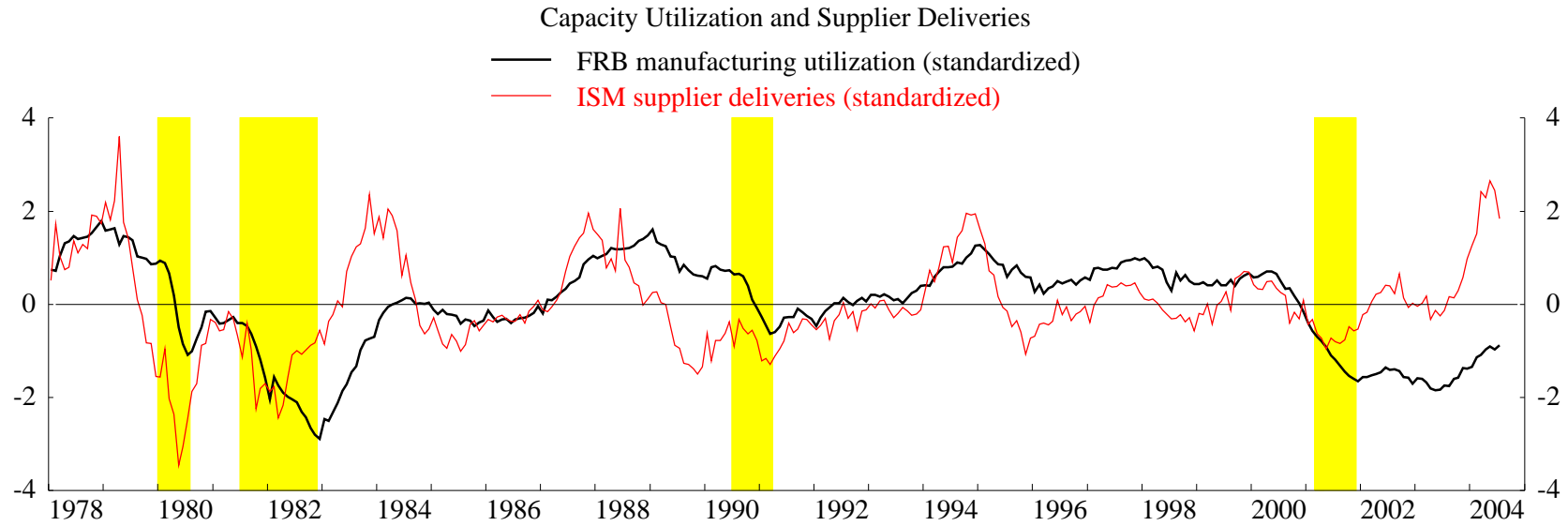
The numbers on the x-axis refer to the months before/after the peak in industrial production
 Source: Federal Reserve Board.

Chart 2 (cont.). Recent Cycles in Manufacturing
 Series reindexed for comparison: date of IP peak = 100

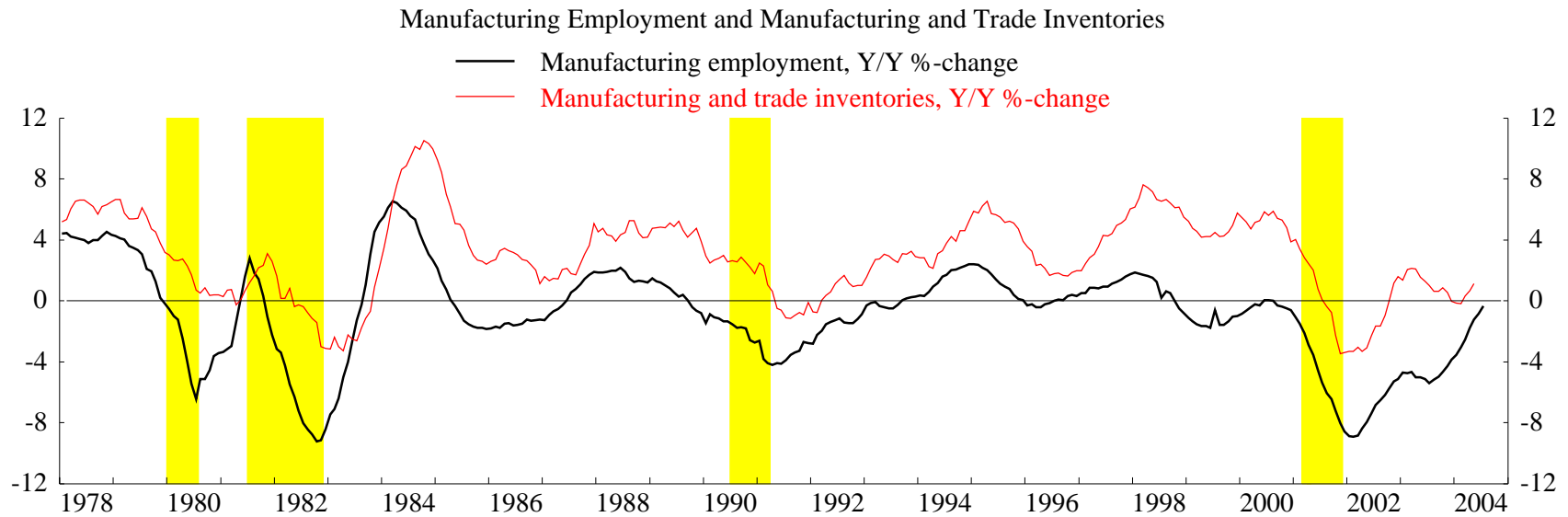


The numbers on the x-axis refer to the months before/after the peak in industrial production
 Source: Federal Reserve Board and the Bureau of Labor Statistics.

Chart 3. Capacity Utilization and Supplier Deliveries



Source: Federal Reserve Board and the Institute for Supply Management.



Source: Bureau of Labor Statistics and the U.S. Census Bureau.