closer to the real world, however, a number of potential interpretation problems are encountered.

While output prices will rise as firms produce beyond their capacity, the extent and persistence of the increase depends on the shape of industries’ cost curves, on the sensitivity of factor prices to increases in demand, and on the willingness of firms to invest in new plant and equipment. In addition, changes in government regulation or in trade policy over time may increase (or possibly decrease) bottlenecks in the economy, limiting (or abetting) firms’ ability to expand output without price increases.

Furthermore, this measure of capacity utilization will not have consistent implications for investment, as firms may be less inclined to purchase new equipment if they do not expect a permanent increase in the demand for their products, or if rising input prices reduce the profitability of new capital.

Because of these ambiguities, the potential inflationary pressure represented by any level of capacity utilization is unclear. Although measures of capacity utilization are informative, they contain conceptual difficulties.

In the next Economic Commentary in this two-part series, we will discuss how the Census Bureau and the Federal Reserve construct their indexes of capacity utilization.

Footnotes
1. Inputs that cannot be varied in the short run, such as machinery, are called fixed inputs, while those that can, such as materials or labor, are called variable inputs.
3. The firm increases production until the cost of producing additional units is greater than the price those additional units will bring, that is, until the level of output where unit price equals marginal cost is reached. Even if the cost of producing extra output is very high, net profits will still rise if the output price is even higher.

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Measuring the Unseen: A Primer on Capacity Utilization

by Paul W. Bauer and Mary E. Deily

How much wood could a woodchuck chuck if a woodchuck could chuck wood?

According to several available measures, a large number of U.S. industries are now operating at historically high levels of capacity utilization. Many analysts believe that further increases in demand, fueled by continued growth and especially by the expansion in exports, could result in higher output prices. This is particularly a concern if firms hesitate to expand their capacity by investing in new plant and equipment.

As a result, there has been considerable interest in understanding what the terms “capacity” and “capacity utilization” mean when referring to firms and industries. Two basic types of measures exist. The engineering, or war mobilization, measure attempts to represent the maximum physical output that a plant can produce, and is probably closest to the layman’s idea of capacity. But economists find that a better indicator of industry price pressures and future investment is one that incorporates changes in production costs as output increases.

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For example, suppose an airline wants to increase the number of miles it flies with its current number of planes. The airline can fly each plane faster, with its current number of planes. Thus, the cost of producing the extra miles will be greater than the current cost per mile.

Note that this cost increase is not caused by increases in the prices of the variable inputs (in this case, fuel). The increase occurs because more fuel per mile is necessary to produce extra miles when the airline is using the same number of planes. In sum, we can think of firms as able to expand production over some range in which the extra units will cost about the same. At some point, however, more than proportional increases in labor, materials, or energy will be required to increase output further, thus raising both marginal and average costs.

So far we have assumed that the firm is working with a fixed amount of capital, but over time the firm can vary this amount. If the airline, for instance, is able to add planes to its fleet quickly it could increase the number of miles flown without increasing its average total cost. In terms of the cost curves discussed above, a change in the amount of fixed inputs the firm employs will move the firm onto an entirely new set of average total cost and marginal cost curves.

This process is illustrated in chart 2. When a firm adds capital, for instance, it moves to a new set of short-run cost curves (from AC1 and MC1 to AC2 and MC2), because the added capital allows it to produce greater amounts of output at lower cost. The set of all possible short-run cost curves traces out the long-run average cost curve (LRAC), which is the lowest unit cost the firm can attain at each level of output after it has adjusted all of its inputs.

**An Economic Definition of Capacity Utilization**

Economists generally define a plane’s capacity as the output level at which average total cost is lowest (again, the point at which marginal cost intersects average cost). If capacity is measured in this way, a plant producing at point A on chart 1 is producing at 100 percent of its capacity. But as demand increases in the product market, and as firms respond to higher prices by increasing output, firms will begin to produce at levels above capacity in order to maximize profits. Capacity-utilization figures greater than 100 percent would thus be associated with above-average profits and rising production costs. If firms expect demand to remain strong, then capacity-utilization figures greater than 100 percent will also be associated with increased incentive to invest, as firms attempt to move to a more favorable set of cost curves by increasing their capital stock.

In contrast to this cost-based measure of capacity, an engineering measure is the maximum output that may be produced, ignoring all cost changes, with the equipment in place. This output level would be at the extreme right side of chart 1, where the average and marginal costs rise sharply. Measured in this way, a plane's capacity is likely to be beyond the point at which the firm could produce profitably. In order to obtain an estimate of engineering capacity, the firm must thus evaluate its production capabilities at output levels with which it has little or no experience.

In addition, the potential for a given capacity-utilization rate to create output price pressure would be difficult to evaluate because the distance between the minimum of the average total cost curve and engineering capacity would differ from industry to industry. This makes it hard to determine from a particular capacity-utilization rate whether firms in an industry have moved beyond the minimum of their average total cost. For the same reason, the engineering capacity concept would also be more difficult to use than the cost-based measure as an indicator of increases in future investment.

**Forward-Looking World Measurement**

So far, measuring capacity as the minimum point of a firm's current average total cost curve appears quite reasonable. Any firm producing above capacity will experience rising costs and will have an incentive to invest. But even when using a cost-based concept to evaluate capacity-utilization implications, several complications arise.

First, a given level of capacity utilization will have different meanings depending on firms’ expectations for the future. Operating above capacity is a good indicator of future investment only if the firm expects the current output price to stay the same or increase. Also, industries protected from import competition, for instance, might not expect this protection to continue in the long run, and thus might not invest.

Second, if firms can quickly adjust their fixed inputs, and if the long-run average cost curve is as pictured in chart 2, a high capacity-utilization rate does not necessarily imply the existence of output price pressure. A firm that is able to adjust its capital quickly can moderate its cost increases by moving to a more favorable set of short-run curves. The faster a firm can adjust its inputs, the more moderate will be the cost and price increases as the firm expands its production to meet rising demand.

Third, we have so far assumed that the firm can expand production without paying higher input prices for additional labor, materials, or energy. But at all the firms in an industry respond to increased demand by expanding production, input prices may rise, particularly if the industry is a large purchaser of an input in limited supply.

An increase in input prices shifts all of the cost curves up, and firms might now reach minimum average cost at a different level of output. While firms might be producing at a level above their old capacity, they might be at or below their new capacity. In this situation, firms operating at or above a capacity measured at old factor prices may have less incentive to invest in new equipment, since rising factor prices reduce the profitability of additional investment.

**Aggregate Capacity-Utilization Measures**

Aggregate capacity-utilization figures must be interpreted carefully. As more sections of the economy increase production, prices are likely to rise even for less-specialized inputs. Thus, high aggregate capacity-utilization should at least be a good barometer of rising input prices, and thus of rising costs. But the relationship between aggregate measures and investment is less clear.

Furthermore, relationships between aggregate measures of capacity utilization, inflation, and investment may not be stable over time for at least three reasons. First, changes in government regulations or foreign supplies may abruptly alter an industry's capacity. Consider, for instance, the semiconductor agreement between the United States and Japan, which has significantly reduced the supply of some silicon chips, a vital input in computer manufacture. Production increases in this industry will consequently result in more rapid costs increases, as firms bid up the price of the available chips.

Second, changes in firm strategy may alter the relationships between capacity utilization, cost increases, and investment. For example, some firms now handle intermittent periods of very high demand by intensifying their use of the existing plant and equipment, rather than maintaining excess machinery that sits idle in periods of normal demand.

Third, aggregate measures reflect different compositions of utilization among industries. As shown above, high capacity-utilization measures in different industries have different implications for prices. Thus, the same numerical measure of aggregate capacity utilization may reflect different potentials for aggregate price pressures, depending on the slowly rising costs are rising in the industries with high utilization rates.

**Conclusion**

Capacity is fundamentally a cost concept most appropriately defined as the ratio of the short-run average cost curve. In moving this clear, concise economic concept...