# A Look at Capacity Utilization in Swedish Industry

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output given actual employment and c = capacity. Actual employment can be taken directly from the survey questionnaires and actual output can be computed as sales plus additions to product and raw materials inventories less raw materials purchases, so both $\ell$ and q can be observed for each establishment. The variables x and c can then be computed on the basis of q and the survey capacity utilization data.

There are two basic capacity utilization questions. The first asks "By what fraction could production have been increased relative to the previous year, product demand permitting but with existing employment?" Let a21 equal the difference between this fraction and the fraction by which production actually did increase, so that $x = q(1 + a21)$. The second questions asks, "By what fraction could production have been increased relative to the previous year, product demand permitting and with employment as large as needed?" Let sum equal the difference between this fraction and the fraction by which production actually increased, so that $c = q(1 + sum)$.[1]

The usual capacity utilization rate expresses q as a fraction of c, but these data express c as a multiple of q. To convert back to the familiar sort of figure, define the capacity utilization rate by $u = 1/(1 + sum)$. Likewise, define the "labor utilization rate" by $u_{\ell} = 1/(1 + a21)$. Finally, it is of some interest to look at x as a fraction of c, so let the "residual utilization rate", $u_r$, be defined by $u_r = u_{\ell}/u$ (so $u_r = (1 + a21)/(1 + sum)$). This residual utilization rate might be interpreted as a capital utilization rate conditional on full utilization of the existing work force.

Table 1 presents the sample capacity utilization rate and its two components for five basic industrial groups. The grouping is based on the "end use" of products and is common to most of SI's statistics. To get a feeling for the relative size of these groups, note that SI estimates value added in 1976 as 10.5 billion Skr for raw materials processing, as 18.9 billion Skr for intermediate goods, as 33.3 billion Skr for invest-

[1] These two questions are unique, so far as I know, in their decomposition of the capacity utilization gap. The questions were originally designed to meet the data needs of the "micro-to-macro simulation model of the Swedish economy" that has been developed at the Industrial Institute for Economic and Social Research. The decomposition is crucial to the production planning module of that model. See, for example, Gunnar Eliasson, *A Micro-Macro Interactive Simulation Model of the Swedish Economy:* Preliminary Documentation, Federation of Swedish Industries, December, 1976.

Table 1 Capacity Utilization Rates

| | | u | $u_\ell$ | $u_r$ |
|---|---|---|---|---|
| Raw Materials Processing | 1975 | 89.7 | 91.8 | 97.7 |
| | 1976 | 85.6 | 89.3 | 95.9 |
| | 1977 | 76.5 | 82.7 | 92.5 |
| | 1978 | 86.5 | 92.9 | 93.1 |
| Intermediate Goods | 1975 | 89.4 | 91.8 | 97.4 |
| | 1976 | 84.1 | 89.7 | 93.8 |
| | 1977 | 79.7 | 84.2 | 94.7 |
| | 1978 | 85.0 | 90.2 | 94.2 |
| Investment Goods | 1975 | 87.3 | 89.8 | 97.2 |
| | 1976 | 86.5 | 92.6 | 93.4 |
| | 1977 | 79.8 | 89.2 | 89.4 |
| | 1978 | 79.9 | 90.7 | 88.1 |
| Consumer Goods | 1975 | 87.2 | 91.8 | 95.0 |
| | 1976 | 88.5 | 93.8 | 94.3 |
| | 1977 | 80.0 | 91.6 | 87.3 |
| | 1978 | 83.4 | 94.6 | 88.2 |
| Building Materials | 1975 | 86.4 | 93.4 | 92.5 |
| | 1976 | 84.8 | 92.9 | 90.9 |
| | 1977 | 81.7 | 89.8 | 91.0 |
| | 1978 | 82.2 | 90.0 | 91.3 |
| Total | 1975 | 88.6 | 91.3 | 97.0 |
| | 1976 | 86.2 | 91.6 | 94.1 |
| | 1977 | 79.2 | 87.4 | 90.6 |
| | 1978 | 82.9 | 91.7 | 90.4 |

Notes:

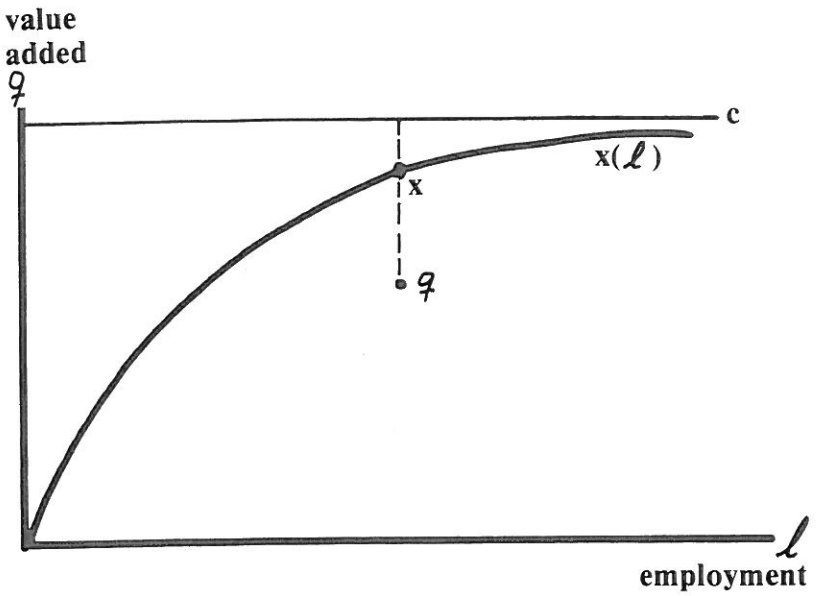
$u = 100 \cdot q/c$

$u_\ell = 100 \cdot x/c$

$u_r = 100 \cdot x/q = 100 \cdot u_\ell / u$

See Figure 1 and the text for definitions of q, x and c. Note that the 1975 figures are computed as sales-weighted averages.

**Figure 1 Short-run Efficiency Frontier**




ment goods, as 24.4 billion Skr for consumption goods, and as 5.6 billion Skr for building materials. The establishment sampled account for about ⅔ of value added in these groups.

The capacity utilization rates presented are computed as the ratios of industry output to industry capacity, or equivalently as capacity-weighted average utilization rates. The labor utilization rates are also computed as capacity-weighted averages and the capital utilization rates are derived residually. These comments do not apply to the 1975 computations. Value added cannot be computed for that year because data on raw materials purchases and inventory accumulations are lacking in the 1975 survey. Consequently, capacity cannot be computed for 1975, and I have instead presented sales-weighted average utilization rates.[2]

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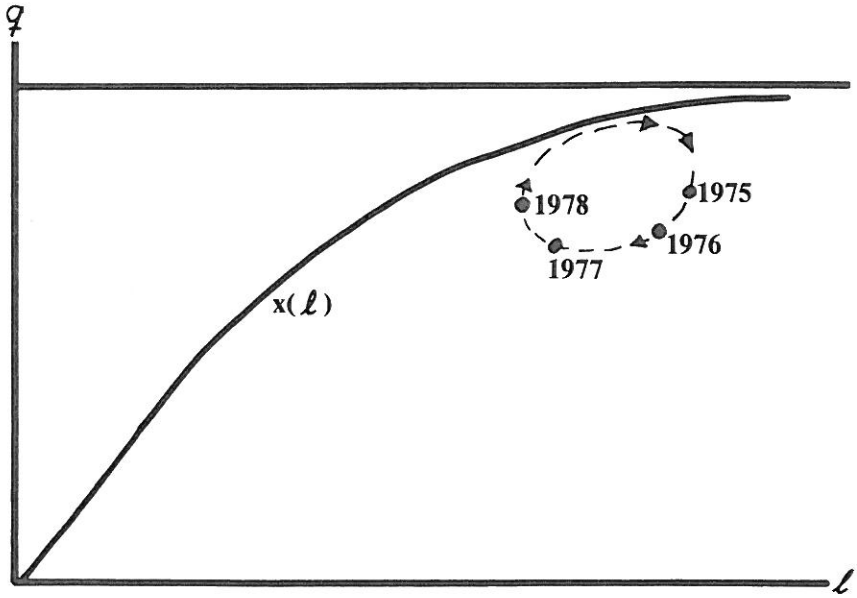
[2] It is possible to make capacity calculations for the 1975 establishments by using retrospective information from the 1976 questionnaires. However, for this chaining technique to be valid, it is necessary that the definition of the responding unit not change from year to year, and this requirement is frequently violated in these data.

Table 1 reveals that capacity utilization rates declined sharply from 1975-77 and then began to recover in 1978. Initially, almost the entire capacity utilization gap was attributable to underutilized labor; that is, almost no redundant plant and equipment would have existed in Swedish industry in 1975 had the employed labor force been fully utilized. However, over the four years the nature of the capacity gap has changed, so that by the end of 1978 the labor utilization gap and the residual utilization gap contributed almost equally to the shortfall between output and capacity.

The stylized picture of capacity utilization over the business cycle that emerges from these data can be seen in Figure 2. Abstracting from shifts in the efficiency frontier, the pattern of output-employment combinations appears to trace out a clockwise loop under that frontier. Of course, we have not yet seen the data that would confirm the top half of the loop, but the pattern indicated should follow if employers forego new hiring until the existing work force is more fully utilized. Note that this pattern is consistent with the almost universally observed tendency for productivity to fall, or rise more slowly than trend, when output

**Figure 2 Output and Employment over a Stylized Business Cycle**



stagnates and for productivity to rise faster than trend when output recovers. Further, the clockwise loop is consistent with the time paths of labor and capital utilization that have been estimated by Hans Söderström for previous Swedish cycles using different data.[3]

It is also possible to present capacity utilization figures for a finer industrial breakdown. I have done this in Table 2 for those "sub-industries" which have enough representation in the sample to ensure reasonably meaningful computations. It does not seem worthwhile to present these data for more than one year because of changes in sample composition and changes in the classification of individual establishments between years. More detective work about shifts in establishment definition would be required.

Table 2 Capacity Utilization 1978 - Finer Industrial Breakdown -

| | u | $u_\ell$ | $u_f$ | fraction of output |
|---|---|---|---|---|
| *Raw Materials Processing* | | | | |
| Iron and Steel | 83.0 | 91.6 | 90.6 | 69.7 |
| Non-Ferrous Metals | 97.0 | 97.9 | 99.1 | 13.6 |
| Forest Products | 94.5 | 95.4 | 99.1 | 16.7 |
| *Intermediate Goods* | | | | |
| Chemicals | 86.4 | 89.9 | 96.1 | 42.6 |
| Fabricated Metals | 79.5 | 89.4 | 88.9 | 32.1 |
| Paper | 90.7 | 92.1 | 98.5 | 25.3 |
| *Investment Goods* | | | | |
| Machinery | 81.3 | 89.9 | 90.4 | 54.9 |
| Electronics | 76.7 | 88.2 | 87.2 | 39.0 |
| *Consumption Goods* | | | | |
| Food/Tobacco/Beverages | 87.5 | 93.6 | 93.5 | 29.6 |
| Pharmeceuticals | 80.0 | 91.6 | 87.3 | 15.8 |
| Durables | 81.5 | 96.1 | 84.8 | 47.7 |

Notes. u, $u_\ell$ and $u_f$ as defined in Table 1.

[3] Hans Söderström, "Cyclical Fluctuations in Labor Productivity and Capacity Utilization Reconsidered," *Swedish Journal of Economics*, June 1972, pp. 220-237.

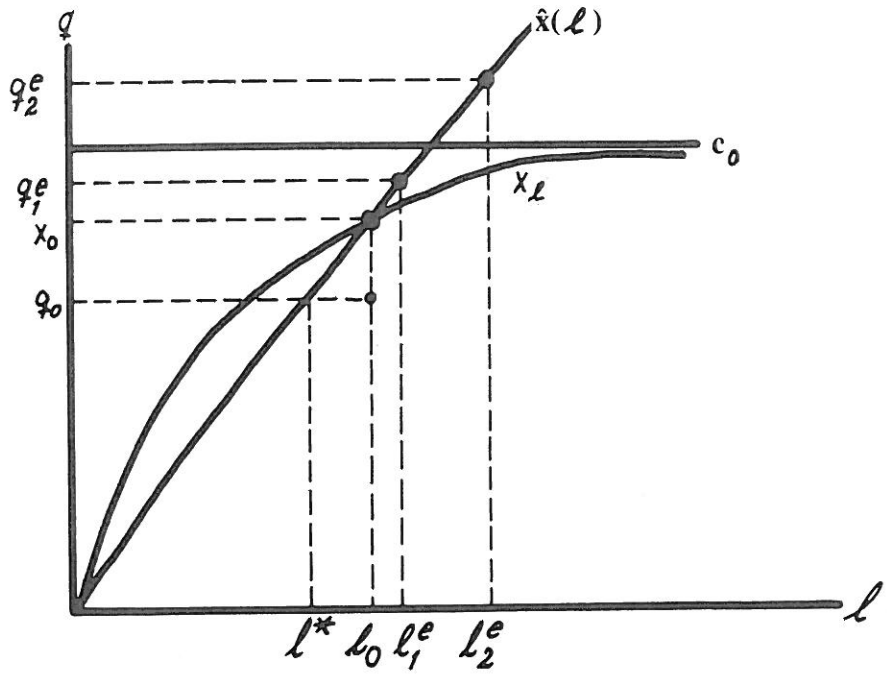
One sub-industry in the investment goods group that has been omitted from Table 2 for lack of sufficiently reliable data, but which may nonetheless be of interest, is shipbuilding. The data reported in this sector are rather dubious - the entire capacity utilization gap is ascribed to idle labor and output is asserted to equal 94.5 percent of capacity. This is despite the fact that output per worker in shipubilding may be computed as 47.000 Skr in shipbuilding as compared with 163.000 Skr for investment goods as a whole. (The output per worker ratio otherwise shows remarkably little variability around the industry-wide average of 167.000 Skr and thus gives a check on the internal consistency of the data.) However, shipbuilding accounts for only 3 percent of the investment goods sector's output, and the computed figures for that sector do not change appreciably if shipbuilding is excluded.

Tables 1 and 2 present a picture of capacity utilization in Swedish industry as it has evolved over the period 1975-78 and as it existed at the end of 1978. Of more immediate relevance is the question of what these survey data can indicate about the likely course of the economy in 1979 and beyond. Capacity utilization figures have traditionally been used as a barometer for potential inflationary pressures and for pressures to invest to increase capacity. The planning survey data can provide some help on both of these questions.

Each respondent gives its estimate of the percentage by which production (in physical units) will increase in the year following the survey. By matching expected production changes with the decomposed capacity utilization rates for each establishment, a rough estimate of the incentives to hire additional labor and to increment capacity can be computed. The technique (and the sense in which it is approximate) can be explained by reference to Figure 3.

Each establishment is observed in a given survey year at the output-labor point given $(q_0, \ell_0)$. Maximum attainable output given existing employment $(x_0)$ and capacity $(c_0)$ are computed as before using the survey utilization rates. Given the reported expected percentage increase in production, the expected level of production can be computed for the year following the survey. There are three possibilities. First, the expected level of production may be less than $x_0$. In this case, assuming that the establishment fully utilizes its existing labor force before embarking on any new hiring, no pressure to hire additional labor exists. Nor is there any immediate incentive to increase capacity.

**Figure 3 Measuring the Pressure to Hire and to Expand Capacity**




A second possibility is that expected production lies between $x_0$ and $c_0$ ($q^e_1$ in the figure). Assuming again that the establishment's first step is to fully utilize its existing work force, a movement from $q_0$ to $x_0$ at existing employment is expected. Thereafter, the establishment is presumed to move along the short-run efficiency frontier, $x(\ell)$ until the output level $q^e_1$ is attained. The implied increase in employment can then be computed (by inverting $q^e_1 = x(\ell)$. No increase in capacity is implied. The problem with this computation, of course, is that the function $x(\ell)$ is not observed. Rather only one point, $x_0 = x(\ell_0)$, is observed. The solution that I have adopted to circumvent this problem is to approximate the short-run efficiency frontier by a straight line from the origin through the point $(x_0, \ell_0)$. This approximate frontier is denoted by $\hat{x}(\ell)$ in the figure, and the employment implied by the output of $q_1$ can be read off $x(\ell)$ as $\ell^e_1$. Note that if one adheres to the notion of a convex short-run production possibilities set (ie, diminishing

returns to fully utilized labor - as I have portrayed x( $\ell$ )), the estimated increase in employment, $\ell_1^e - \ell_0$, is necessarily underestimated.[4]

The third and final possibility is that the expected level of production for the next year exceeds existing capacity ($q_2^e$ in the figure). In this case the implied level of employment, $\ell_2^e$ , is computed as before, and the implied increase in capacity is computed as $q_2^e - c_0$.

Another figure of some interest can be estimated as a derivative of these computations. This is the percentage of redundant employment in each industry, ie, the percentage by which employment could be decreased without foregoing any production. This redundancy factor is also computed using the straight-line approximation to the short-run efficiency frontier by finding the minimum employment consistent with the existing level of production. This is given by $\ell^*$ in Figure 3, and it should be clear from the figure that the straight-line approximation necessarily implies an underestimate of the percentage of employment that is redundant.

Table 3 presents these figures for the prospective years 1977-79 for the five basic industrial groups. To further explain these estimates, refer to the 1979 figures for the raw materials processing sector. First, a 7.5 percent increase in production volume is expected for 1979 in that sector ($\%\Delta q = 7.5$). This figure is the 1978-output-weighted average from the 1978 questionnaires. Based on the expected increase in production in each establishment, the expected number of new hires is computed according to the procedure described above. The figure of $\%\Delta \ell = 5.2$ indicates that the ratio of new hires projected for 1979 relative to the level of employment at the end of 1978 is 0.052. It should be understood that this projected new hires figure is gross; that is, it is *not* projected new hires within the industry net of new layoffs and quits. The figure of $\%\Delta c = 2.2$ indicates that on average establishments in the raw materials processing sector expect a level of production 2.2 percent higher than existing capacity (with those establishments not expecting to exceed current capacity counted in with a zero value). Finally, the figure of $r = 6.4$ indicated an estimate that 6.4 percent of all workers in that sector could have been laid off in 1978 with no effect on industry out-

[4] The approximation $\hat{x}(\ell) = x_0/\ell_0$ is not the only possibility. For example, in the IUI micro-simulation model mentioned in the first footnote, the function from $x(\ell) = c(1-\exp(-\gamma \ell))$ is estimated for each establishment. The simpler straightline approximation at least has the advantage of being more readily understandable.

Table 3 Labor and Capacity Pressures One Year Ahead

| | %Δq | %Δℓ | %Δc | r |
|---|---|---|---|---|
| Raw Materials Processing | | | | |
| 1977 | 2.7 | 1.4 | 0.9 | 10.8 |
| 1978 | 4.3 | 2.0 | 0.4 | 16.2 |
| 1979 | 7.5 | 5.2 | 2.2 | 6.4 |
| Intermediate Goods | | | | |
| 1977 | 5.8 | 3.2 | 2.2 | 9.4 |
| 1978 | 5.0 | 1.0 | 0.3 | 15.0 |
| 1979 | 7.3 | 2.6 | 0.8 | 9.2 |
| Investment Goods | | | | |
| 1977 | -0.4 | 1.4 | 0.3 | 6.7 |
| 1978 | -2.1 | 0.7 | 0.1 | 9.0 |
| 1979 | 6.7 | 2.6 | 0.8 | 8.6 |
| Consumption Goods | | | | |
| 1977 | -4.7 | 0.8 | 0.1 | 5.6 |
| 1978 | 3.6 | 1.7 | 0.4 | 6.7 |
| 1979 | 5.4 | 3.1 | 0.3 | 5.2 |
| Building Materials | | | | |
| 1977 | 6.4 | 3.8 | 2.7 | 6.3 |
| 1978 | -1.4 | 0.8 | 0.7 | 10.4 |
| 1979 | 3.0 | 1.7 | 1.2 | 9.2 |
| Total | | | | |
| 1977 | 0.7 | 1.8 | 0.4 | 7.9 |
| 1978 | 1.8 | 1.2 | 0.2 | 11.2 |
| 1979 | 6.5 | 3.1 | 0.9 | 7.6 |

Notes:

(1) %Δq = expected increase in production (in physical units) for the given year - taken directly from the questionnaire. The industry figures are output-weighted averages.

(2) %Δℓ = measure of hiring pressure. This measure is computed for each respondent as

$$\%\Delta\ell = \begin{cases} 0 \text{ if } q_i^e \leq x_o \\ (q_i^e - x_o)(\ell_o/x_o) \text{ if } q_i^e > x_o \end{cases}$$

The industry figures are labor-weighted averages.

put. The 6.4 percent can then be loosely interpreted as the estimated fraction of redundant labor at the opening of 1979.

In interpreting the figures presented in Table 3 for 1979, it is useful to make comparison with the previous years. Certainly it can be stated that pressures to hire and to increase capacity will be greater in 1979 than in previous years. Further, the raw materials processing sector and the consumption goods sector (hiring pressure only) appear to be two sectors in which these pressures may be particularly strong.

It is difficult to say whether the hiring pressure figures of 5.2 percent for raw materials processing and 3.1 percent for industry as a whole are ''big'' numbers or ''little'' numbers. It is worth repeating, however, that these figures are underestimates - both because of the straight-line approximation and because of the assumption that employers will feel no pressure to hire until the entire existing work force is completely utilized. It is my subjective feeling that these indicators of pressures to hire - and therefore of pressure to bid up wages - are large numbers, at least relative to the implications of an aggregate 82.9 percent capacity utilization rate.

On the other hand, it does seem quite certain that expected production increases in 1979 provide little immediate incentive to increase capacity. Instead such investment as is undertaken will likely go toward maintaining existing capacity and toward improving labor productivity. This result was to be expected since even with considerable variability in expected production rates and in capacity utilization rates, the average capacity gap is sufficiently large that few establishments are likely to exceed their capacity limits.

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(3) $\%\Delta c$ = measure of pressure to increase capacity. Computed for each respondent as $q\ \Delta c = \max(0, q_1^e - c_0)$.
The industry figures are capacity-weighted averages.

(4) $r$ = estimate of percent of employment that is ''redundant'', ie, the fraction of the work force that could be laid off without implying a decease in output. Computed for each respondent as $r = \left(\frac{1 - u_\ell}{u_\ell}\right) / u_\ell$
The industry figures are labor-weighted averages. Note that the redundancy figures refer to the situation *at the opening of* the given year.

As a final bit of information, Table 4 presents the same measures of labor and capacity pressures for 1979 for the finer industrial classification used in Table 2. By and large, there is not too much intra-industry variation in these figures, so Table 4 needs little independent comment. One thing that is interesting to note is that the greatest percentage increases in output within each industrial group are expected to occur in those component industries with the lowest capacity utilization rates (Iron and Steel in Raw Materials Processing, etc. Cf. Table 2). That is, the pressure to hire that has tentatively been observed in these data could have been more intense were the locus of expected demand shifted a bit.

In summary, I think that these data have two main points to reveal. The first is that during the recent contraction employers first cut back on production by decreasing the rate of labor utilization and only later rationalized the mix between the two components of the capacity gap.

Table 4 Labor and Capacity Pressures 1979
- Finer Industrial Breakdown -

| | $\%\Delta q$ | $\%\Delta \ell$ | $\%\Delta c$ | | fraction of output |
|---|---|---|---|---|---|
| *Raw Materials Processing* | | | | | |
| Iron and Steel | 8.8 | 5.5 | 1.8 | 7.6 | 69.7 |
| Non-Ferrous Metals | 4.3 | 5.6 | 4.0 | 1.8 | 13.6 |
| Forest Products | 4.4 | 4.2 | 2.6 | 4.7 | 16.7 |
| *Intermediate Goods* | | | | | |
| Chemicals | 6.4 | 2.1 | 0.9 | 9.2 | 42.6 |
| Fabricated Metals | 8.5 | 4.3 | 0.7 | 9.5 | 32.1 |
| Paper | 7.4 | 2.3 | 2.3 | 8.8 | 25.3 |
| *Investment Goods* | | | | | |
| Machinery | 6.1 | 4.5 | 1.1 | 6.9 | 54.9 |
| Electronics | 9.0 | 1.0 | 0.4 | 11.2 | 39.0 |
| *Consumption Goods* | | | | | |
| Food/Tobacco/Beverages | 1.3 | 0.8 | 0.5 | 5.5 | 29.6 |
| Pharmaceuticals | 10.6 | 6.9 | 1.2 | 9.6 | 15.8 |
| Durables | 7.1 | 3.8 | 0.0 | 4.0 | 47.7 |

See Table 3 and text for definitions

That is, the data reveal a tendency towards a clockwise pattern under the short-run efficiency frontier. The pattern is consistent with other, indirect evidence about productivity over the business cycle, but these data provide the only *direct* observation of this phenomenon. Second, these data can be used to construct measures of potential pressures to hire and to increase capacity. The basic idea behind this construction was to match expected production increases with labor and capacity utilization rates on an establishment-by-establishment basis. My reading of these figures is that while almost no incentive to expand capacity exists, there is some important pressure to expand the work force. This, however, is a subjective guess, and the reader is invited to supply his own interpretation.