

THE CENSUS BUREAU'S CAPACITY SURVEY: AN ANALYSIS
OF CONSISTENCY OF THE SURVEY RESPONSES

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January 1988

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This paper benefited much from the comments and suggestions of a number of people: Gaylord Worden, Robert McGuckin, Frank De Leeuw, Elinor Champion, and others. We would also like to acknowledge Mrs. Wendy DeMarco in typing and editing several verisons of this paper. Any opinions, findings, conclusions, or recommendations expressed here are those of the authors and do not reflect the views of the Census Bureau.

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INTRODUCTION AND BACKGROUND

The "Survey of Plant Capacity Utilization" differs from most Census Bureau surveys in one important respect. In it there are a number of questions that require the respondent to estimate a relation between variables, as opposed to the usual survey question that asks about the value of variables as they were in the recent past--e.g., "What was your actual output in the fourth quarter?". The capacity survey also asks for an estimate of a "preferred" or "optimal" output at which "...profits are maximized...where marginal cost is equal to marginal revenue.", and an estimate of output at "practical capacity," which is "The maximum level of production that this establishment could reasonably expect to attain using a realistic employee work schedule and the machinery and equipment in place...."

Thus the respondent is being asked to estimate what the relationship is among cost, profitability and output levels. This is somewhat analogous to asking respondents to the Consumer Expenditure Survey, in addition to what they actually spent their income on during the last quarter, what they would have spent it on if their incomes had been x percent higher.

Survey data derived from asking questions about relations between variables have some unknown amount of response error additional to those that the usual type of sample surveys are subject to. This is because individuals usually do not have perfect knowledge of the relationships they are required to estimate. Also some respondents may not fully understand the concepts the survey is trying to measure and further error will result.

For some types of relationships in the social sciences it has been possible to compare estimates of relations made via the survey that asks people what they think the relationship is to estimates of the same relationship based on various statistical or econometric methods. For example, in the late 60's the military conducted a number of surveys in which they asked young draftees how much they would have to be paid to volunteer for the military? This was an attempt to estimate the relationship between pay and volunteer rates by asking individuals. But other estimates of this relationship, based on econometric methods, were also made, and the two sets of estimates were compared and evaluated.^{1/}

However, in the case of the relationships asked about in the capacity survey--essentially cost-output relations--the econometric approach has not generated many comparable results. Most of the focus of the econometric work has been productivity analysis--trying to explain the sources of previous changes in productivity--rather than the precise measurement and estimation of cost-output relations.^{2/}

^{1/}Gates Commission on the All Volunteer Army, "Studies in the All Volunteer Force," 1971.

^{2/}For example, in their paper "The Modeling, Interpretation and Measurement of Capacity Utilization," Ernest Berndt, Catherine Morrison, and David Wood asserted that capacity measures could be determined from cost functions. However, they did not provide empirical estimates of these measures. Furthermore, other Census Bureau's sponsored research projects on capacity have not produced reliable results.

Thus estimates of very important economic magnitudes from a policy point of view--capacity, rate of capacity utilization, time to reach capacity output--are, at present, based mainly on what people think a particular relationship is.^{3/} The purpose of this paper is to try to partially fill the gap left by the absence of econometric comparisons, by subjecting the responses of the individual establishments participating in the survey to a detailed consistency analysis. The simple economic model of the firm's short run cost-output relations is used to derive "expected" distributions of the relationships between responses across individual establishments in an industry. These expected distributions are then compared with actual distributions derived from the data on individual establishments, and conclusions drawn about individual firm behavior. Judgments are also made about the usefulness of the definitions and concepts used in the current Census Bureau survey. Hopefully, this will increase our confidence about the reliability of the survey, and/or point up specific changes than can be made to improve the data.

FRAMEWORK OF ANALYSIS

Our consistency analysis is based on relations that we expect, on the basis of an economic model, should exist between the answers to the individual questions in the capacity survey questionnaire. In this paper we focus on those questions involving variables that should depend on or be related to one another in some way, as with questions about different output levels and the levels of inputs associated with them. Our unit of analysis is the individual establishment and our conclusions about consistency are based on observing the patterns of variation in the relations across all the establishments in a given SIC industry category in a given year. We also observe how these patterns of variation vary by industry category and year.

Chart 1 presents the basic economic model of the firm's short run cost-output relations. The chart is divided into two parts reflecting different market structures: part (a) shows the relations for a perfectly competitive market; and part (b) shows the relations for an imperfect competitive market.

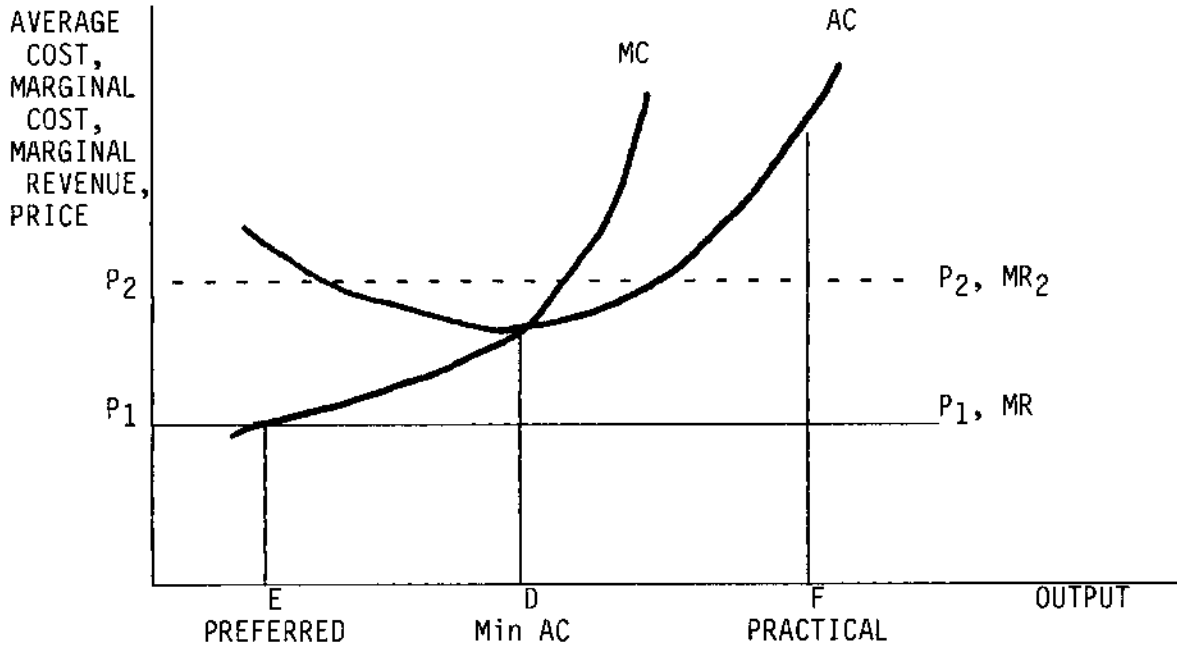
The economic theory of the firm has long postulated a short run cost-output relation (i.e., holding physical plant and equipment constant) in which a level of output corresponds to a minimum average cost, and at outputs larger and smaller than this level costs per unit of output (i.e., average cost) are higher. Chart 1 shows this type of average cost-output curve (AC). As shown in Chart 2, the extent of curvature of the average cost curve may vary among establishments depending on the particular type of production process involved.

^{3/}The Federal Reserve Board's (FRB) capacity utilization index combines data on industrial production, capital stock movements and utilization rates from a number of surveys. The FRB uses the survey utilization rates to compute an end-of-year level of capacity by dividing industrial production by the survey utilization rate. The derived series on end-of-year capacity estimates are combined with data on capital stock movements to identify and modify some cyclical anomalies that occur if only the survey utilization rates and actual output are used to estimate capacity levels. However, over long periods it is mainly the utilization rates derived from the surveys that determine the trend in the FRB's series.

The reasoning underlying this shape is as follows. With some substantial part of inputs to the production process fixed, the firm will ultimately run into rising costs per unit as it moves to higher outputs. This explains the rising portion of the curve to the right of the minimum average cost output. The declining portion of the curve is usually explained in terms of the inherent physical indivisibility of capital equipment. Thus a very low level of output may be producible at a lower cost per unit than in Chart 1, if smaller equipment were available but they are not because of physical/technical relations. Thus as output goes from very low to higher levels, costs per unit fall until some "unique" level of output (Points D and D') is reached, at which costs per unit are lower than at any other level.

CHART 1

(a) Perfect Competition



(b) Imperfect Competition

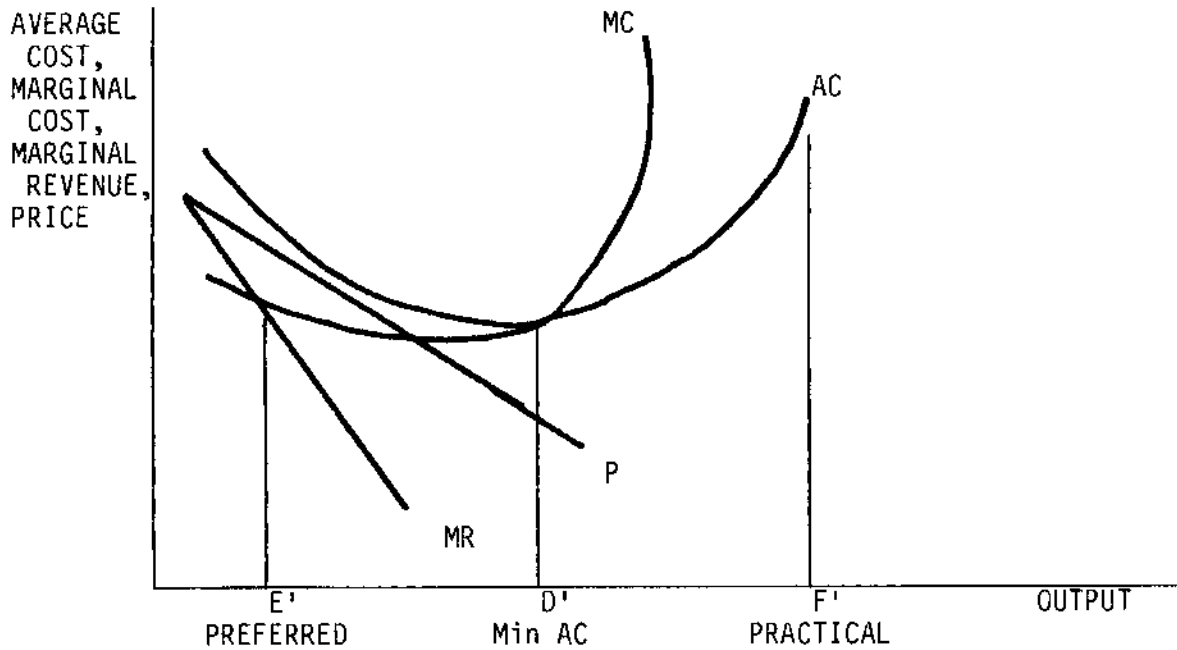
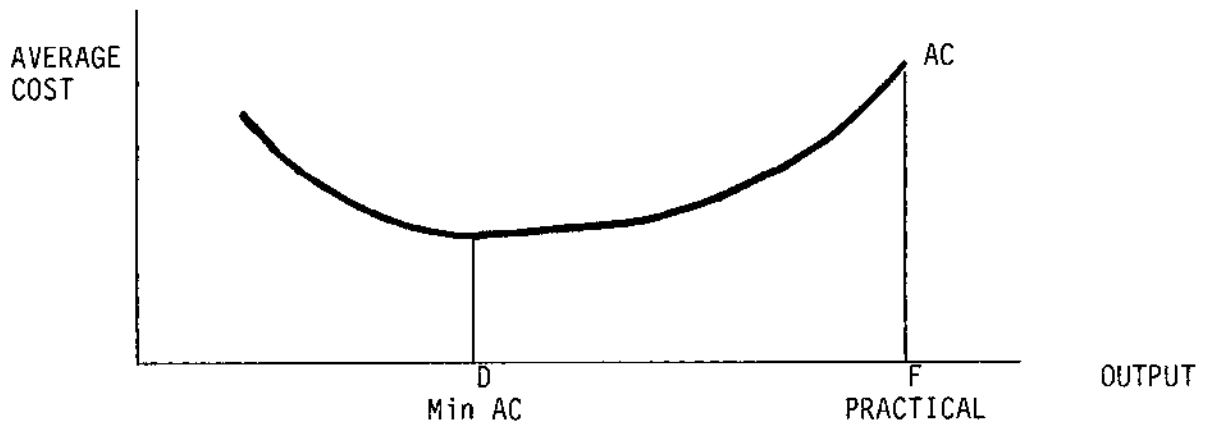
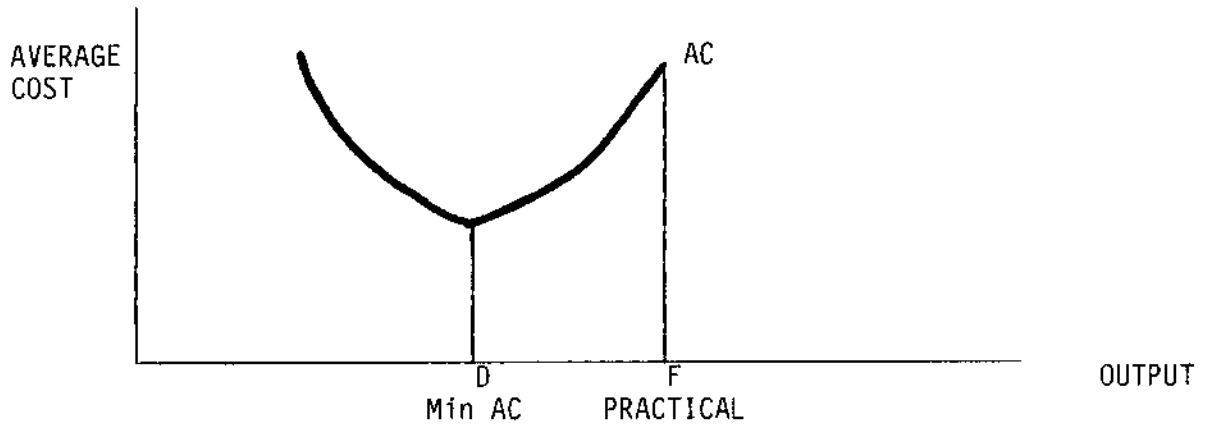
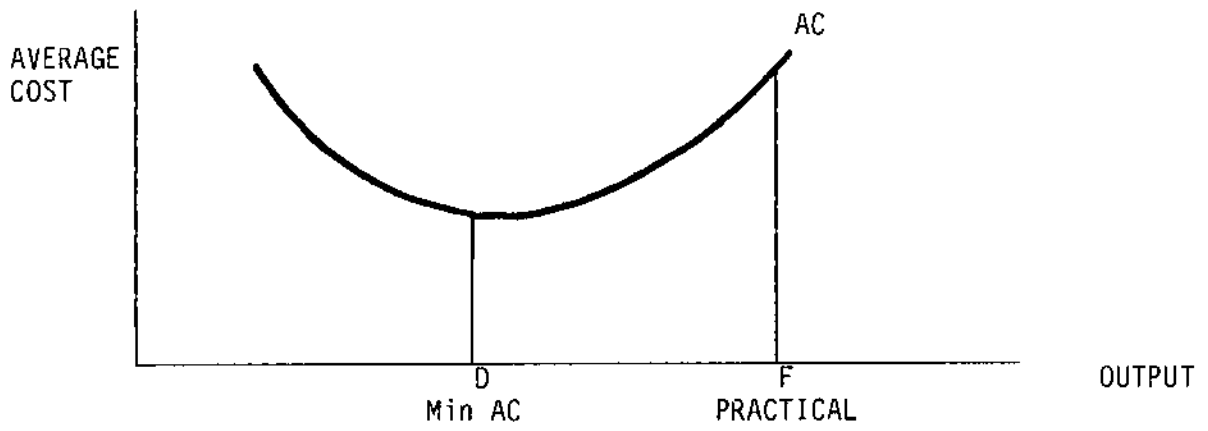


CHART 2



Point E (Chart 1) is the short-run equilibrium output for this firm (in a competitive industry) in that the marginal revenue (MR) function is a simple straight line whose height equals the market price (P). At the price shown (P_1) this firm is minimizing its losses and will leave the industry if price does not rise above minimum average total cost to P_2 .

If we did not assume a highly competitive industry then the equilibrium point is not easily determinable, until some alternative assumption is made about market structure. Point E' is a possible equilibrium output assuming some form of cartel arrangement whereby the market is shared by existing firms and the higher price for the product is maintained by some form of collusion. Under this scenario, price per unit of output declines as more products are sold, and the marginal revenue function is always less than the market price.

Do the cost output relations and alternative revenue functions shown in Chart 1 tell us anything about how the responses of the typical establishment in the Census Bureau survey will relate to one another? One immediate possibility that presents itself is that the respondent will identify his preferred output with his actual output. Since the current definition specifies that, given existing plant and equipment, the preferred level of output is one at which profits are maximized (implies also losses are minimized), firms in either the competitive market structure or the cartel situation might consider themselves in a short-run profit maximizing equilibrium, with outputs at Points E and at E'.

Actual output can of course, take place anywhere along the range of output levels. Actual data from respondents show that over 80 percent of establishments in the two industries we examined reported actual output values that were less than 90 percent of the reported preferred output level, with the modal actual to preferred percent being about 80 percent. For some reason the market structure was such that it precluded most establishments from operating where their short-run profits (losses) are maximized (minimized).

But the question should be raised at this point whether we want to use the short-run profit maximizing output as defining a "preferred" level of output? From the point of view of the society, the minimum point on the average total cost curve has an important characteristic. For minimizing the cost of producing a fixed total of industry output (assuming the stock of capital is fixed) each firm should operate at the same marginal cost, given that the marginal cost is equal or greater than the average total cost. Also ignoring the problem of rising long run average cost, it is also true that the output at which average total cost reaches a minimum represents the lowest cost per unit possible for the commodity. Therefore, from a social cost point of view the "preferred" level of output for the firm to operate at would be the output at which average total cost reaches a minimum.^{4/}

^{4/}If the industry is such that the minimum average cost rises as larger and larger plants are utilized, then it is not strictly true that the minimum point on the short run average total cost curve is the lowest possible cost for that output. Since smaller plants now have lower minimum average cost points, it must be the case that is is some output to the right of the minimum point at which that size plant produces the lowest possible cost per unit. See Jacob Viner, "Cost Curves and Supply Curves." Reprinted in Readings in Price Theory, eds George Steigler and Kenneth Boulding.

Another response pattern that is suggested by the shapes of the curves in our model is that almost all establishments should report different values for their preferred and for their practical levels of capacity output. Clearly if most establishments did interpret the minimum average cost output as their preferred output level, then if the cost model in Chart 1 held, all of them would report larger values for their practical output level. And even if many establishments used their short-run profit maximizing output (E and E') as their preferred, it is unlikely that this output would even be close to the practical level (F and F'), at which output marginal costs are rising very rapidly. Furthermore, the practical level of output is unlikely to be an output at which short-run marginal cost equals marginal revenue. This is demonstrated in the competitive market structure case and in the case of a colluding cartel. A strong prediction from the model then is most (if not all) of the establishments we examine should report larger values for their practical capacity than for their preferred capacity.

A third pattern of responses can be derived from our model by noting that the U-shaped average total cost curve implies that marginal costs will be lower the further to the left of the minimum average cost output the establishment is operating at. This relation of the marginal and the average is well known and essentially reflects the effects of indivisibilities on costs in moving from very small to larger outputs. That is, it reflects the well known economies of scale phenomenon.

A final pattern in the distribution of firms according to how their responses relate is not derived from our cost model, but we made it part of the study because of its great importance to helping with the military mobilization problem. This is the relation between the response to the question about how long (in weeks) it would take the establishment to move from its actual output rate to its preferred rate of output, and how far below their preferred output was the establishment's actual output. We would expect this relation to be positive between these two variables across individual establishments. The further from his preferred output is his actual output, the longer it should take the establishment to move from one to the other.

It is important to note before turning to the individual establishment data that useful consistency comparisons can also be made by relating our capacity survey responses to economic and other magnitudes, not measured in the capacity survey, but which they should be related to--e.g., how does capacity utilization as reported in the survey vary with unemployment and other business cycle indicators?; and do these relations vary across industries as expected? Comparisons of this type, using data at the most aggregate levels--all manufacturing, all durable goods manufacturing and all nondurable goods manufacturing industries--did show that the preferred utilization rate of all manufacturing reported in the survey was definitely negatively correlated with movements in the unemployment rate of married males, spouse present (a measure that is highly correlated with cyclical movements in aggregated demand) between 1975 and 1984. And the amplitude of the cyclical swings in the reported preferred rate for durable goods industries was much greater than for nondurable goods industries. Thus on a very aggregate level movements in the survey data on capacity utilization are consistent with movements in broad indicators of cyclical fluctuations in demand facing the firms responding to the survey.

However, it is also true that in 1979, considered a year of fairly tight labor markets, the reported preferred utilization rate for all manufacturing was still 20 percentage points below 100. This implies that the real output of the economy could be increased by a significant amount if all firms could somehow increase their labor inputs by 15 or 20 percent, i.e., there is excess capacity with regard to physical capital in the economy. Is this true? Another way of putting this issue is that we are asking if our survey estimates of capacity utilization rates are a reliable estimate of levels of utilization as well as of changes in the level? Our analysis does shed some light on this difficult question.

CONSISTENCY ANALYSIS USING INDIVIDUAL ESTABLISHMENT DATA

The records of the responses of individual establishments to the capacity survey were tabulated for two 3-digit industries--Motor Vehicles and Equipment (SIC 371) and Meat Products (SIC 201), and for 2 years, 1982 (a recession trough) and 1984 (2 years after the recovery began). The two industries were selected to maximize the difference in their production processes and raw materials requirements.

The responses we analyzed in this paper came from survey questions about the following magnitudes:

1. "Actual" output in the fourth quarter of the preceding year.
2. Estimated "Preferred" output level.
3. Estimated "Practical" output level.
4. The number of production workers and production worker hours used at the actual output level, and what would be required at the preferred and practical levels of output.
5. The number of weeks it would take for the establishment to expand from its actual level of output to its preferred level.

In the survey questionnaire, the term "output" is defined as the market value of production. Also, "actual output" is labelled "actual operations;" "preferred output" is labelled "preferred operations;" and "practical output" is labelled "practical capacity."

The appendix contains a copy of the survey questionnaire, which also contains the instructions to respondents about the meaning of the terms "preferred" and "practical levels" of operations. We have selected three relations between these magnitude for intensive analysis.

We first analyze the patterns across establishments in the relationship between responses about preferred level of operations and responses about practical level of operations. Then we take up the patterns in the relationship between responses about actual and preferred output levels and responses about the number of production workers and production worker hours used at the two levels of output. Finally we consider the patterns in the relationship between responses about how many weeks it would take to go from actual output to preferred output and the amount of difference between actual and preferred levels of output.

Responses on Preferred and Practical Levels of Output

Table 1 shows the distribution of establishments by a measure of how their answers to the two questions compared. For both industries and for both years, the distribution of establishments by the ratio of their responses to the two questions shows a very similar pattern. About half of all establishments in these industries reported that their preferred and practical output levels were the same, and only 20 to 30 percent said their practical output level was more than 10 percent above their preferred level. Is this a plausible pattern of responses to these two questions? Our above economic analysis clearly indicated that it is inconsistent with that model of short-run cost-output relation.

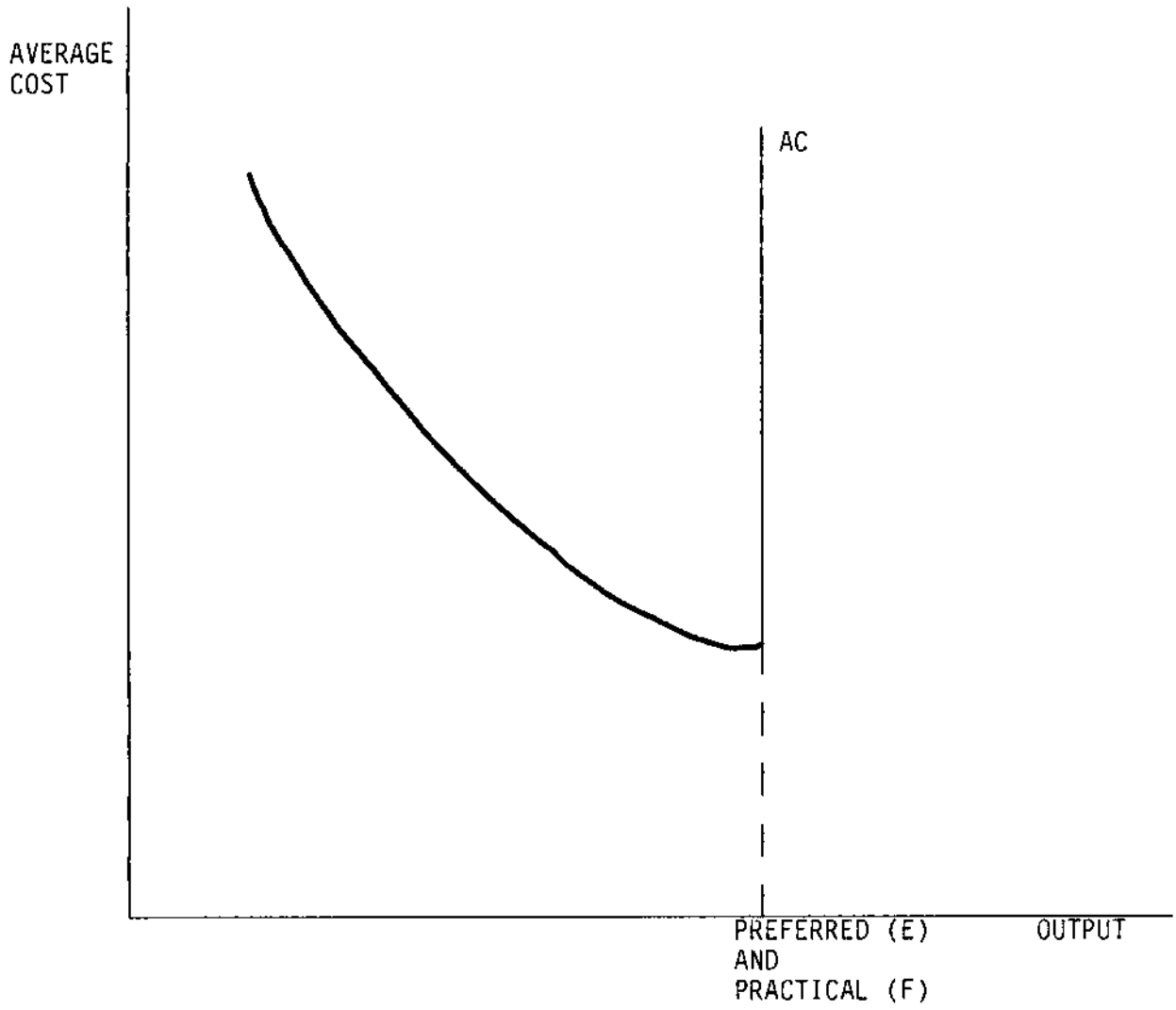
The pattern of reported relations in Table 1 could arise because the true underlying cost-output relation differed from that shown in Chart 1 and/or respondents did not identify the positions on the curve with the preferred/practical concepts as indicated in our analyses. The underlying cost-output relation implied by the pattern of relations in Table 1, assuming the concepts of preferred and practical output are identified with the cost curves as in Charts 1 and 2, is shown in Chart 3. This type of curve, although perhaps plausible for some types of production processes (e.g., transporting fluids through a pipeline) may not be applicable to most of manufacturing production processes that utilize large amounts of labor as well as physical capital and materials.

TABLE 1
 DISTRIBUTION OF ESTABLISHMENTS BY THE RATIO
 OF THEIR RESPONSES ON PRACTICAL
 AND PREFERRED OUTPUT, BY INDUSTRY AND YEAR

Ratio of Practical to Preferred Levels of Output	Distribution of Establishments							
	SIC 371				SIC 201			
	1982		1984		1982		1984	
	#	%	#	%	#	%	#	%
1.0	137	56	128	55	116	55	103	42
1.0 - 1.1	21	8	50	22	46	22	96	39
1.1 - 1.2	41	16	20	9	23	11	28	11
1.2 - 1.3	13	5	8	3	10	5	12	5
>1.3	36	14	25	11	16	8	6	2
Totals	248	100	231	100	211	100	245	100

Note: This table presents responses to the direct questions on the level of preferred and practical outputs.

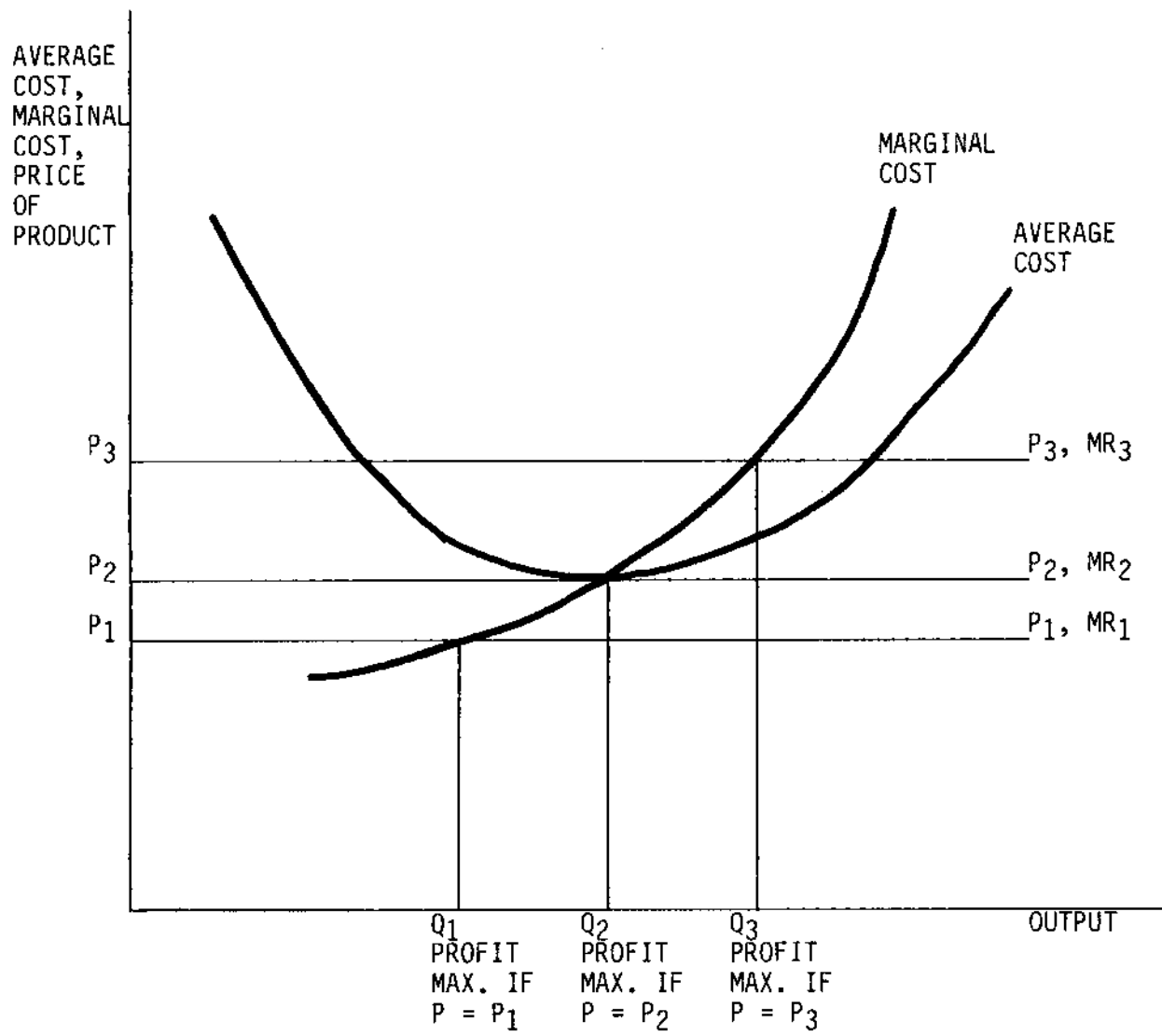
CHART 3



Another possible explanation for the pattern in Table 1 is that respondents may be associating their preferred level of operations with the minimum average cost output level rather than the level of operations at which profits are maximized. Because of its relative stability and apparent identifiability, respondents may also associate this minimum average cost output with the practical level. Unfortunately, the preferred level of operations, as required by the current official definitions may be an inappropriate way to define something that is suppose to represent a more or less fixed level of output (for a given level of plant and equipment). This is because the profit maximization criterion (marginal cost equals marginal revenue) makes the preferred level of output depend on the demand for the establishment's product. As Chart 4 shows, the profit maximizing output level will vary with the level of price which the establishment can obtain for its product, and it may or may not correspond to the output level at which average cost is a minimum. (Price (P) is equal to marginal revenue (MR) if we assume a perfectly competitive market.)

Furthermore, there are some aspects of the current official definitions of preferred and practical levels of operations that may lead many respondents to settle on the same value for these two levels of operations. For example, the definition of the preferred level is compounded by having the definitions of both preferred and practical levels contain a similar statement about what to assume about the supply of labor in the community. Under the definition of preferred output it is stated:

CHART 4



"Assume the number of shifts and hours of plant operation that can be reasonably attained by your plant in your community."

And under the definition of the practical level of operations it is stated:

"The maximum level of production using a realistic employee work schedule...."

Clearly the level of preferred output at which profits are maximized or at which average cost is minimized need not be one at which there is more than one shift, so that the phrase "...number of shifts...." probably moves the respondent in the direction of specifying his maximum output level. In addition the current definition of preferred output ends with the sentence:

"The preferred level may equal but not exceed practical capacity."
(emphasis in original)

This would also tend to push respondents in the direction of identifying their maximum output level and assuming that this satisfied the definition of preferred as well as practical. At any rate it may be more appropriate to let the respondent reveal if he has a cost curve like the one in Chart 3, rather than suggest its possibility to him.

In sum, the very large fraction of establishments reporting their preferred and practical levels as the same may reflect the ambiguity of the current definitions of preferred and practical rather than the wide-spread existence of short-run cost output relations as in Chart 3. The implications of this for survey redesign are mentioned below.

Reported Inputs at Different Levels of Output

The survey asks for the input levels that would be required to attain both preferred and practical output levels, as well as the inputs used with the output actually produced in the fourth quarter. Table 2 shows the distribution of establishments by the ratio of the percentage change in production workers to the percentage change in output in going from actual to preferred levels of output that is implied by their responses to the survey questions. Table 3 shows the distributions of the same relation but using total production worker hours in place of production workers.

The distribution of the relationship across establishments shows concentrations both at a zero value and in the range of just below and above a value of +1. In SIC 371 the dominate concentration is at the +1 value, while for SIC 201 the dominant concentration is at zero, for production workers, with the two points of concentration about equal for production worker hours. Note also the significant increase in the concentration at the zero value between 1982 and 1984 for SIC 371, which experienced a sharp increase in demand over this period.

Again we can ask if these patterns in the relationship between responses on inputs and on outputs are reasonable in terms of the short-run cost-output curve postulated by economic theory? The pattern that would be expected on the basis of the curve in Chart 1 would depend on the curvature of the U-shaped curve and also on the distribution of establishments by how far their actual output was from their preferred level. In general, if we identify the preferred level of output with the minimum average cost output, then the closer the establishment's actual output is to its preferred output the closer the ratio of input change to

TABLE 2

DISTRIBUTION OF ESTABLISHMENTS BY THE RATIO OF
THE PERCENT CHANGE IN PRODUCTION WORKERS TO PERCENT CHANGE
IN OUTPUT IN GOING FROM ACTUAL TO PREFERRED OUTPUT,
BY INDUSTRY AND YEAR

% Change in Production Workers	Distribution of Establishments							
	SIC 371				SIC 201			
	1982		1984		1982		1984	
% Change in Output	#	%	#	%	#	%	#	%
< 0	2	1	12	6	5	3	8	4
= 0	43	18	64	35	103	55	133	60
0 - .1	5	2	3	2	2	1	5	2
.1 - .2	9	4	4	2	6	3	6	3
.2 - .3	9	4	4	2	11	6	8	4
.3 - .5	27	11	15	8	5	3	10	4
.5 - 1.0	79	33	38	21	28	15	35	16
> 1.0	65	27	45	24	27	14	18	8
Totals	239	100	185	100	187	100	223	100

TABLE 3

DISTRIBUTION OF ESTABLISHMENTS BY THE RATIO OF
THE PERCENT CHANGE IN PRODUCTION WORKER HOURS TO PERCENT
CHANGE IN OUTPUT IN GOING FROM ACTUAL TO PREFERRED OUTPUT,
BY INDUSTRY AND YEAR

% Change in Production Worker Hours	Distribution of Establishments							
	SIC 371				SIC 201			
	1982		1984		1982		1984	
	#	%	#	%	#	%	#	%
< 0	4	1	14	8	7	4	13	6
= 0	36	15	47	25	61	33	95	43
0 - .1	2	1	5	3	-	-	-	-
.1 - .2	6	3	1	1	8	4	5	2
.2 - .3	5	2	3	2	5	3	4	2
.3 - .5	18	8	12	6	6	3	5	2
.5 - 1.0	84	35	42	23	44	24	54	24
> 1.0	84	35	61	33	56	30	47	21
Totals	239	100	185	100	187	100	223	100

output change should be to +1. And as the actual gets further below the preferred level the more the ratio should fall below +1. However, it should never fall to zero. A zero value implies that no reduction in inputs were made when output fell below the preferred level.

Thus the concentration of establishments at the zero value is not consistent with the standard cost-output model of economic theory. However, a well known dynamic aspect of output and input adjustment along with the discontinuous way the distributions behave between the two points of concentration, suggest a plausible explanation for the zero values in Tables 2 and 3.

It is that they reflect situations in which the establishment believed the deviation of output demand from the preferred level was only of a transitory nature and that it would soon be returning to the preferred level of operations. Therefore it did not pay to reduce the number of production workers or production worker hours in the establishment.

The observed distribution of the relationship across establishments reflects a mix of the permanent factors which call forth responses expected from the cost-output relation of Chart 1, and the transitory factors which tend to generate very little or no input response thereby producing the observed concentration of zero values. Note the dramatic shift in the distribution for SIC 371 between 1982 and 1984. This is consistent with the transitory-permanent model since we expect transitory deviations of actual from preferred to be of greater relative importance in recovery years than in the trough of a deep recession.

Table 4 shows some additional evidence for the transitory explanation of the zero values that occurred in both industries for 1984. Table 4 gives establishments distributed jointly by the value of the ratio of input (production worker) change to output change and a measure of how far below preferred the establishment's actual output level was. If we assume that transitory elements will be more predominant for establishments in which actual output is close to preferred then we would expect to find a decrease in the zero values in moving from establishments with actual outputs close to preferred to those with actual outputs further away from their preferred levels. And indeed this is born out by the data in Table 4. For example, those establishments for SIC 371 whose actual was 70 percent or more of their preferred had about 50 percent reporting zero values, while among establishments with actual outputs less than 70 percent of their preferred the corresponding percentage was between 10 and 25 percent. This pattern was more pronounced for SIC 201.

Thus it appears that the patterns in the relations between responses on outputs and inputs are broadly consistent with the cost-output relation of Chart 1, for ranges of output below the output at which average cost reaches a minimum. This conclusion depends on the validity of our speculation about transitory factors causing most of the observed zero values.

TABLE 4
 CROSS TABULATION OF ESTABLISHMENTS BY THEIR VALUE ON THE RATIO OF
 INPUT CHANGE TO OUTPUT CHANGE AND THE RATIO OF ACTUAL TO PREFERRED OUTPUT
 1984

% CHANGE IN PRODUCTION WORKERS	SIC 371					SIC 201				
	RATIO: ACTUAL TO PREFERRED					RATIO: ACTUAL TO PREFERRED				
	>.9	.7-.9	.5-.7	<.5	TOTAL	>.9	.7-.9	.5-.7	<.5	TOTAL
< 0	3(8)	6(6)	2(6)	1(9)	12(6)	1(2)	7(5)	-	-	8(4)
= 0	14(39)	45(45)	2(6)	3(18)	64(35)	20(47)	108(70)	4(25)	-	132(60)
.0 - .1	-	1(1)	2(6)	-	3(2)	-	5(3)	-	-	5(2)
.1 - .2	-	3(3)	-	1(9)	4(2)	2(5)	1(1)	3(19)	-	6(3)
.2 - .3	-	1(1)	2(6)	1(9)	4(2)	-	4(3)	1(6)	3(43)	8(4)
.3 - .5	1(3)	9(9)	2(6)	3(18)	15(8)	2(5)	5(3)	-	2(29)	9(4)
.5 - 1.0	5(14)	17(17)	12(36)	4(24)	38(21)	8(19)	19(12)	6(38)	2(29)	35(16)
> 1.0	13(36)	17(17)	11(33)	4(24)	45(24)	10(23)	6(4)	2(13)	-	18(8)
Total	36	99	33	17	185	43	155	16	7	221

NOTE: Numbers in parentheses represent column percentages.

Reported Amounts of Time to Reach Preferred Levels of Output Compared to the Size of the Gap Between Actual and Preferred Levels

Table 5 presents distributions of establishments by the ratio of their reported actual to their preferred level of output--this is the "preferred utilization rate" which is the major published output of the survey. It also shows the average number of weeks needed to attain preferred levels of output as reported by establishments.

This relationship differs from the comparative-static cost-output relationship we have been analyzing in the two previous sections. Here the survey is attempting to estimate a dynamic aspect of the production process--how long will it take an establishment to go from one output level to another? The previous relation had to do with the question--how does a change in the level of output, given the stock of plant and equipment, influence the level of cost per unit? However, we did come across one point of overlap at the end of the last section in that the data relating to the ratio of input change to output change reflected both comparative static considerations and dynamic factors in the form of whether or not the establishment perceived output declines as primarily transitory or not.

These transitory factors probably also influence the interpretation of the patterns in the relationship between reported time to go from actual to preferred levels of output and the gap between actual and preferred levels.

TABLE 5

RELATIONS BETWEEN RATIO OF ACTUAL AND PREFERRED LEVELS OF PRODUCTION AND AVERAGE NUMBER OF WEEKS FOR EXPANSION, BY INDUSTRY AND YEAR

Actual Preferred	SIC 371				SIC 201			
	1982		1984		1982		1984	
	% Plant Distribution	Average # Weeks	% Plant Distribution	Average # Weeks	% Plant Distribution	Average # Weeks	% Plant Distribution	Average # Weeks
.9 - 1	8	4.9	33	4.3	33	5.0	35	3.6
.8 - .9	7	3.5	25	6.2	26	6.6	35	7.4
.7 - .8	14	5.6	13	8.7	24	4.6	12	4.8
.6 - .7	15	7.2	14	9.9	10	5.9	6	7.6
.5 - .6	17	9.4	6	12.0	5	5.1	5	4.0
.4 - .5	11	7.9	3	18.5	2	2.7	2	6.7
.3 - .4	18	12.4	4	4.7	1	8.0	1	4.0
.2 - .3	7	16.0	1	6.5	1	2.0	1	4.0
.1 - .2	2	9.0	1	12.0	-	-	2	2.5
0 - .1	1	19.5	-	-	-	-	-	-
Totals	100	8.7	100	7.1	100	5.4	100	5.4

From Table 5 it is clear that for SIC 371 a positive relation does emerge, assuming all establishments experienced no transitory factors in the demand for their products. In both 1982 and 1984 for most of the actual/preferred intervals the mean number of weeks changes in the expected direction, especially between those class intervals containing a large percentage of establishments in each interval. However, for SIC 201 the positive relationship does not emerge in either year.

As noted the 201 industry appears to have much more transitory elements underlying the deviations of its actual production levels from its preferred. It may be that this dominance of transitory elements makes a valid statistical analysis of the relation between time to reach preferred levels and the gap between actual and preferred impossible. However, given the importance of getting accurate estimates of these dynamic response times, much more work needs to be done on this relationship. The data should be collected for a large number of industries to see if the same pattern by durable and nondurable tends to hold up.

SUMMARY AND IMPLICATIONS

Our analysis of the patterns across individual establishments in the three relations between responses to different questions indicated some degree of consistency between the survey response and our expectations as to the likely shape of the short-run average cost curve. However, we think our analysis also pointed up some possible shortcomings in the existing survey.

The most serious inconsistency, or at least potential inconsistency, was the very large fraction of establishments that report the same value for their preferred and practical levels of output. It is, of course, possible that this pattern of responses does reflect the actual state of cost-output relations, i.e., that costs per unit are relatively constant over a wide range of output and the establishments maximum capacity is reached quite abruptly (as in Chart 3). However, it seems at least as likely that the traditional short-run cost-output relation (Chart 1) is valid in most manufacturing industries, and that the shortcomings in the existing definitions of concepts leads respondents to choose the same value for preferred and practical levels.

This issue is of more than academic interest. If a minimum average cost output (or small range of outputs) really exists in most of the establishments now reporting preferred and practical levels as equal, then the existing estimates of the preferred capacity utilization rate probably understates capacity utilization relative to the minimum average cost output. This would be important to know because it relates to how efficiently our economy is utilizing its resources. Therefore it is recommended that a special subsample of establishments be used to test a different set of definitions of preferred and practical capacity. These would make minimum average cost on the basis for preferred capacity and practical capacity would be relabelled "maximum capacity" and identified with the output level at which costs per unit began to rise very rapidly, use of labor is at its physical maximum, etc.

The other potential inconsistency was the lack of a positive relationship between reported responses on time to get from actual to preferred output and the size of the gap between actual and preferred levels of output, for the SIC 201 industry. Given the importance of this factor for military mobilization planning it is recommended that this relation be tabulated for all 3-digit industries and for a number of years to see if some patterns by industry and year develops.

Appendix A. MQ-C1 Form and Instructions

DUPLICATE DATE: WITHIN 30 DAYS AFTER RECEIPT
FORM MQ-C1
O.M.S. No. 0807-0175: Approval Expires August 31, 1985

U.S. DEPARTMENT OF COMMERCE
 BUREAU OF THE CENSUS

NOTICE - Response to this inquiry is required by law (Title 15, U.S. Code.) By section 9 of the same law, your report to the Census Bureau is confidential. It may be used only by census Bureau employees and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

SURVEY OF PLANT CAPACITY UTILIZATION
FOURTH QUARTER 1984
 (October - December)

In correspondence pertaining to this report refer to the CENSUS FILE NUMBER (11 digits)

NAME ADDRESS CITY STATE ZIP CODE

INDUSTRY

REPORT

DATE

CENSUS USE ONLY

(Please correct any error in name and address, including ZIP code)

RETURN COMPLETED FORM TO

Bureau of the Census
 1201 East Tenth Street
 Jeffersonville, Indiana 47133

Name of person who prepared or verified the prior year's report

Item 1A OPERATIONAL STATUS

Mark (X) ONE box which best describes this establishment at the end of 1984.

111 In operation

112 Temporarily idle

113 Sold or leased to another company - Report new owner or operator in item 1B

114 Permanently ceased operations

Item 1B NEW OWNER OR OPERATOR

21 Name

Number and street

City State ZIP code

Employer Identification Number

IMPORTANT PLEASE READ INSTRUCTIONS AND DEFINITIONS BEFORE COMPLETING FORM

Item 2 FOURTH QUARTER OPERATIONS 1984

	FOURTH QUARTER 1984									FOURTH QUARTER 1983											
	Actual operations			Preferred operations			Practical capacity			Actual operations			Preferred operations			Practical capacity					
	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.			
a. Market value of production	211			212			213														
b. Shifts per day	221			222			223														
c. Days per week in operation	231			232			233														
d. Plant hours per day in operation	241			242			243														
e. Weeks in operation	251			252			253														
f. Production workers	261			262			263														
g. Hours worked by production workers	271			272			273														
h. Overtime hours included in g above	281			282			283														

Item 3 CHANGES IN LEVELS OF OPERATION

If your fourth quarter value of production at PRACTICAL CAPACITY has changed compared to last year EXCEPT FOR PRICE CHANGES in item 2a, indicate the major reasons for the change.

311 Building capital expenditures

312 Machinery capital expenditures

313 Building improvements

314 Machinery improvements

315 Change in method of operation

316 Change in product mix

317 Change in material input

318 Other - Specify

If value of production at your PREFERRED LEVEL has changed compared to last year EXCEPT FOR PRICE CHANGES in item 2a, for reasons other than changes in PRACTICAL CAPACITY, please explain.

Item 4 ANNUAL OPERATIONS FOR CALENDAR YEAR 1984

	TOTAL 1984									TOTAL 1983											
	Actual operations			Preferred operations			Practical capacity			Actual operations			Preferred operations			Practical capacity					
	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.	Mo.	Thurs.	De.			
a. Market value of production for 1984	411			412			413														

CONTINUE ON REVERSE

THE GREEN COPY IS FOR YOUR FILES.

Item 5 FOURTH QUARTER OPERATING RATES

1. At what percent of PREFERRED OPERATIONS did this plant ACTUALLY OPERATE in the FOURTH QUARTER? Percent
711 _____ %

2. At what percent of PRACTICAL CAPACITY did this plant ACTUALLY OPERATE in the FOURTH QUARTER? 711 _____ %

3. Indicate the major factor used to estimate operating rates in Items 1a and 1b.

801 <input type="checkbox"/> Production workers	806 <input type="checkbox"/> Quantity of materials consumed
802 <input type="checkbox"/> Production worker hours	807 <input type="checkbox"/> Subjective evaluation
803 <input type="checkbox"/> Value of production	808 <input type="checkbox"/> Other - Specify _____
804 <input type="checkbox"/> Quantity of production	

4. If during the fourth quarter this plant operated at less than 100% of PREFERRED OPERATIONS (Item 1a), indicate the principal reason your operations fell short of preferred operations.

841 <input type="checkbox"/> Insufficient orders	846 <input type="checkbox"/> Strike or work stoppage
842 <input type="checkbox"/> Inadequate labor force	847 <input type="checkbox"/> Seasonal operation
843 <input type="checkbox"/> Lack of sufficient fuel or electric energy	848 <input type="checkbox"/> Weather or natural disaster
844 <input type="checkbox"/> Lack of material or supplies	849 <input type="checkbox"/> Other - Specify _____

5. Assuming sufficient demand for output, how many workers would it require to expand actual operations to -

(1) PREFERRED OPERATIONS.....	Number of workers 851 _____
(2) PRACTICAL CAPACITY.....	852 _____

Item 6 EXPANSION OF PRACTICAL CAPACITY

1. Is there presently underway construction activity or orders for additional machinery or equipment which will increase this plant's PRACTICAL CAPACITY?

811 Yes

812 No - Complete Item 7 and return form

2. Estimate the percentage increase from fourth quarter 1964 value of production at PRACTICAL CAPACITY (Item 2a) which is expected by the end of -

(1) 1965.....	Percent increase in practical capacity 821 _____ %
(2) 1966.....	822 _____ %
(3) 1967.....	823 _____ %

3. Indicate the nature of expansion.

831 <input type="checkbox"/> Building capital expenditures	836 <input type="checkbox"/> Change in product mix
832 <input type="checkbox"/> Additional machinery	837 <input type="checkbox"/> Change in material inputs
833 <input type="checkbox"/> Replacement machinery	838 <input type="checkbox"/> Other - Specify _____
834 <input type="checkbox"/> Change in method of operation	

REMARKS

711 _____

Item 7 CERTIFICATION - This report is substantially accurate and has been prepared in accordance with instructions.

Key	Name of person to contact regarding this report - Print or type	Mo.	Day	Year
721				
722	Telephone	Signature of authorized person		
	Area code Number Extension			

INSTRUCTIONS AND DEFINITIONS

1984 SURVEY OF PLANT CAPACITY UTILIZATION

PLEASE READ CAREFULLY BEFORE COMPLETING FORM

WHO SHOULD REPORT?

This report covers the manufacturing establishment named in the address box of the form. If your company operates more than one location, **REPORT ONLY FOR THOSE ESTABLISHMENTS SELECTED FOR THIS SAMPLE SURVEY.**

WHAT PERIOD SHOULD EACH REPORT COVER?

The report form covers two periods. Items 2, 3, 5, and 6 refer to the fourth quarter of calendar year 1984. Item 4 covers the total calendar year 1984 and is the only inquiry that requests data for the entire year.

HOW TO REPORT

Figures for market value of production, hours worked by production workers, and overtime hours should be reported in thousands; for example, if value of production is 1,125,628 dollars the preferred entry is:

Mil.	Thou.	Dols.
1	125	

Although, you may report as follows:

Mil.	Thou.	Dols.
1	125	628

CHANGES TO PRIOR YEAR DATA

Selected information which was reported last year has been computer imprinted on your report form. In some instances information may have been adjusted during our review for consistency or through correspondence or telephone calls with you regarding this report.

NAME AND ADDRESS

Review the name and address of this plant printed in the top right hand corner of the report form. Line out any errors and make any necessary corrections or additions in the address box.

DEFINITIONS OF ACTUAL, PREFERRED, AND PRACTICAL

Actual Operations — The actual level of production attained by your establishment.

Preferred Operations — A level of operations that you would prefer not to exceed because of costs or other considerations. Implicit in the idea of a preferred level of operations is that there is a level of operations at which profits are maximized. This is a level where marginal revenue equals marginal costs. The preferred level may equal but not exceed practical capacity.

In reporting preferred operations consider the following:

- Assume a product mix that was typical or representative of your production during the quarter. If your plant is subject to considerable short-run variation, assume the product mix of the current period.
- Assume the number of shifts and hours of plant operation that can be reasonably attained by your plant in your community.
- Assume the availability of labor, materials, utilities, etc., sufficient to utilize the machinery and equipment that was in place at the end of the year.
- Consider only the machinery and equipment in place and ready to operate. Do not consider facilities or equipment that would require extensive reconditioning before they can be made operable.
- Assume normal downtime maintenance, repair, and cleanup.
- Do not assume increased use of productive facilities outside the plant (such as contracting out subassembly work) in excess of the proportion that would be normal during the time periods covered by this survey.

Practical Capacity — The maximum level of production that this establishment could reasonably expect to attain using a realistic employee work schedule and the machinery and equipment in place during the time periods covered by this survey. In addition to the considerations under preferred capacity above, do not consider overtime pay, added costs for materials, or other cost increases to be limiting factors in estimating practical capacity.

Item 1A — OPERATIONAL STATUS

Report the status of operations at this plant at the end of 1984.

Idle Plants — If this plant was temporarily idle during the entire period covered by this survey, this report should still be completed in its entirety. Actual operations for the various items should be reported as zero where appropriate, and preferred operations and practical capacity should be reported as instructed.

Sold or Leased Plant — If this plant was sold or leased to another company to operate, indicate the month and year this action took place, report the new owner or operator in item 1B, complete item 7, and return form.

CONTINUE ON REVERSE

Item 2 — FOURTH QUARTER OPERATIONS 1984

a. Market value of production — Report the value of production for the fourth quarter 1984. This is the market value (sale price) of what was produced during the fourth-quarter 1984, not fourth-quarter sales. If the market value is not available, estimate markup over cost sufficient to cover overhead and profit and add this sum to the cost value of production. Also estimate the value of production for preferred operations and for practical capacity.

If book figures for actual value of production are not available, value of production may be estimated by taking fourth-quarter value of shipments F.O.B. plant (including intracompany transfers but excluding resales and miscellaneous receipts) plus any additions to the finished stock of inventories or work-in-process inventories minus any shipments from inventories (excluding materials or supplies). Inventory changes should be valued at market and confined to the fourth quarter only.

b-e. Shifts, days, plant hours, and weeks in operation — In reporting shifts, days, plant hours, and weeks of operation, use the most typical pattern during the period. If your plant has departments or assembly lines which operate at varied periods of time, report the shifts, days, plant hours, and weeks in operation for the production department operating the greatest number. Also estimate these figures for preferred operations and practical capacity.

b. Shifts per day — Most shifts are assumed to be of 8 hours duration so that a 3-shift operation is usually maximum. Do not consider maintenance, administrative, or support operations as additional shifts. Do not consider overtime hours as fractional shifts.

d. Plant hours per day — Report the typical number of hours the plant was in production during a single day, and not the number of person hours worked.

f. Production Workers — Include workers up through the working foreman level engaged in fabricating, processing, assembling, inspecting, receiving, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial, watchman services, auxiliary production for plant's own use (e.g., powerplant), recordkeeping, and other closely associated services. Include truckdrivers delivering ready-mixed concrete. Exclude proprietors and partners and all other employees considered to be nonproduction personnel, including those engaged in the following activities: supervision above working foreman level, sales (including driver salesmen), sales delivery (truck drivers and helpers), advertising, credit, collection, installation and servicing of own product, clerical and routine office functions, executive, purchasing, finance, legal, personnel (including cafeteria, etc.), professional and technical.

g. Hours worked by production workers — Include all hours worked or paid for, except hours paid for vacations, holidays, or sick leave. Estimate these figures for preferred level of operations and practical capacity.

h. Overtime hours — Report the number of overtime hours included in item 2g. Overtime hours should be reported as actual hours worked and not as straight-time equivalent hours.

Item 3 — CHANGES IN LEVELS OF OPERATION

a. If the fourth quarter 1984 value of production at practical capacity has changed for any reason other than a change in the prices for your products from fourth quarter 1983, indicate the most important reasons for the new figures.

b. Report any reason for changes in value of production in 1984 at your preferred level of operations as compared to 1983 that are not:

- The result of price changes in your products.
- For reasons identified in item 3a above.

If the reasons for a change in your 1984 preferred levels of operation are the same as for practical capacity, leave item 2b blank.

Item 4 — ANNUAL OPERATIONS FOR CALENDAR YEAR 1984

The definition of market value of production is identical to that supplied in item 2a. It may be calculated by using total 1984 value of shipments F.O.B. plant plus additions to the finished stock of inventories or work-in-process inventories minus shipments from inventories (excluding materials and supplies). Inventory changes should be confined to the time period from January 1, 1984 through December 31, 1984.

Items 5 and 6

Refer to the specific instructions provided with each item on the report form.

If you have any questions concerning the definitions or instructions, please contact the Special Projects Branch of the Industry Division at (301) 763-5915.

Appendix B. Qualifications of the Data

DEFINITIONS AND CONCEPTS

A. Practical Capacity—Although survey respondents were provided detailed instructions for estimating practical capacity (see appendix A), it is extremely difficult to translate the concept of plant capacity into a working definition which is applicable to all industries and situations. A host of problems are inherent in any attempt to measure capacity. Following are some of the more significant:

1. Visits and telephone conversations with respondents have revealed that there are a variety of methods by which plants can measure their capacity. For example, it is customary for petroleum refineries to use an engineering concept of capacity based on maximum throughput during around-the-clock operations, with allowance made for maintenance or other necessary downtime. Other industries use different methods. They might base capacity on the maximum number of workhours of their labor force, on a past peak performance period, or on any of a number of other methods. In the past, the Bureau of the Census made no attempt to prescribe a standardized method for calculating utilization, such as total shipments or employment at capacity, although standard definitions were provided. Instead respondents used their own methods to determine capacity and to report utilization as a percentage of capacity (See item 2 of the report form).
However, the form also asked respondents to report, if possible, several other measures that might be used to determine capacity, such as total production worker hours, value of production, quantity of production, and quantity of materials consumed. These input and output data were requested for actual operations, preferred level of operations, and practical capacity. Value of production data are now used by census to develop utilization rates. All data (1973 to 1984) have been calculated on this basis.
2. Respondents were asked to assume a normal product mix and a realistic work pattern. Many plants produce a variety of products which may change considerably with demand or with the seasons. These variations made it difficult for some respondents to determine what is normal or realistic.
3. Respondents were instructed to "assume an availability of inputs (i.e., labor, materials, etc.) sufficient to utilize

their capital stock" but not beyond "an expansion of operations than can be reasonably attained in your industry and your locality." Some respondents appear to be unrealistic in setting the limits of their operations. For example, some establishments defined practical capacity as continuous operations (7 days a week, 24 hours a day) even though they were currently operating a single shift and admitted they could not expect realistically to operate continuously with their present plant and equipment or within their industry or locality. Census staff have discussed the most questionable estimates with respondents and adjusted the reports where appropriate; however, there is a distinct element of subjectivity, and it is apparent that not all plants have defined practical capacity in realistic terms.

- B. Preferred Level of Operations Compared to Practical Capacity**—Implicit in the idea of a preferred level of operations is the theory that plants have a level of operations at which profits will be maximized. This is a level at which marginal revenue equals marginal costs. Nevertheless, most establishments report that they would prefer to operate at their practical capacity. While a majority of individual plants do not differentiate between their preferred level of operations and practical capacity, many do. Furthermore, many plants which appear to have made unrealistic assumptions in estimating their practical capacity (as discussed in item 1 above), reported substantially lower—apparently realistic—preferred levels of operations.
- C. Year-to-Year Variations in Reported Data**—There is considerable year-to-year change in reported capacity and capacity utilization for individual plants. Some of this reflects real change in capacity due to additions or retirements of plant and equipment, change in product mix, or change in productivity. Other changes, however, are the result of response variations which are part of the nonsampling errors described below. These variations, which often result from different personnel completing the form, include different judgemental decisions about work patterns and what plant and equipment to include in estimating capacity. At the summary levels, the individual establishment changes (either up or down) have a tendency to cancel each other.
- D. Shifts Per Day**—Respondents were requested to report the number of shifts worked per day. The survey instructions indicated that most shifts are assumed to be of 8 hours

APPENDIX B

duration, so that a three-shift operation is usually maximum. In previous survey years the reporting of fractional shifts resulted in the exclusion from publication data on shift operations and hours per day in operation because of questions concerning the validity of these responses.

In an attempt to address the problem of fractional shift reporting, respondents were additionally instructed to (1) report the maximum number of shifts if the plant had multiple departments or assembly lines which operate an unequal number of shifts, (2) attempt no calculation of an average number of shifts, and (3) exclude overtime hours as a fractional shift.

SAMPLING AND NONSAMPLING ERRORS

The survey estimates are subject to both sampling and nonsampling errors. Nonsampling errors include various response and operational errors: errors of collection, reporting, transcription, and bias due to nonresponse, etc. These errors would also occur if a complete canvass were to be conducted under the same conditions as this survey. It is believed that most of the important operational errors were detected and corrected in the course of the review of the data for reasonableness and consistency.

However, because of the definitional and conceptual problems associated with this survey, it is likely that the response errors are greater in magnitude than for other manufacturing surveys in which respondents are asked to report data that are generally kept as a matter of record. Explicit measures of the nonsampling errors are not available. As derived, the estimated standard errors, which are discussed below, include part of the effect of these nonsampling errors. The total error, though, will exceed the standard errors shown and, for particular estimates, may exceed the standard errors by a considerable amount.

The particular sample selected for this survey is one of a large number of similar probability samples of the same size that could have been selected using the same sample design. Each of the possible samples would yield somewhat different sets of results. The sampling errors—the differences between the esti-

mates obtained and the results theoretically obtainable from a comparable complete canvass of the same target universe—is unknown. Guides to the potential size of the sampling errors, however, are provided by the estimated standard errors of the estimates.

In conjunction with its associated estimate, the estimate of standard error may be used to define confidence interval ranges which could be expected to include comparable complete coverage values for specified percentages of all possible samples. The complete coverage value would be included in the range:

1. From one standard error below to one standard error above the derived estimate for approximately two-thirds of all samples of the size and type used for this survey.
2. From two standard errors below to two standard errors above the derived estimate for about 19 out of 20 samples.
3. From three standard errors below to three standard errors above the derived estimate for 99 out of 100 samples.

An inference that the comparable complete coverage results would be within the indicated ranges would be correct in approximately the relative frequencies shown. Those proportions, therefore, may be interpreted as defining the confidence that the estimates shown would differ from the complete coverage results by no more than one, two, or three standard errors, respectively. For example, if an estimated utilization rate is shown as 80 percent, with an associated standard error of 3 percent, there is approximately 67 percent confidence that the interval 77 percent to 83 percent includes the complete coverage rate, about 95 percent confidence that the interval 74 percent to 86 percent would include the complete coverage rate, and approximately 99 percent confidence that the interval 71 percent to 89 percent would include the complete coverage rate.

Note that estimates of the standard error are derived from the sample and are also subject to sampling error. The estimates of standard errors for the years 1981 through 1984 are less than one percentage point for each industry.