

ISSUES CONCERNING THE DEFINITION,  
MEASUREMENT AND FORECASTING OF  
PRODUCTIVE CAPACITY

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It would be difficult to identify a more important macroeconomic issue (and one about which there was more disagreement) than recent developments affecting the level and rate of growth in the nation's productive capacity. Knowledge of the gap between actual and potential output is of immediate relevance to the design of short-run stabilization policy and recent projections of slower growth in productive capacity and the possible relation to slower growth in capital stock appear to have heightened the interest of both the Administration and Congress in tax reform keyed to expanding incentives for capital spending. The Perry, Clark, and Rasche-Tatom papers are attempts to provide the empirical evidence on the level and anticipated rate of growth of potential output that is essential to designing such policies. However, their approaches leave the question of the level of potential output quite unsettled and their projections of future growth rates are mostly conjectural.

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Three Issues Concerning the Definition,  
Measurement, and Forecasting of Potential Output

It is useful to identify at the outset three separate issues concerning the definition, measurement, and forecasting of productive capacity. Each of the three papers deals at least to some extent with each of the three issues:

1. The determinants of the level of potential output:
2. The cyclical behavior of actual relative to potential output-- i.e. the analysis of the cyclical pattern of participation rates, hours per worker, and productivity which along with cyclical pattern in employment explain the cyclical pattern in production.
3. The determination of the rate of growth of potential output in the past and the projection of rates of growth over the next five years.

The papers are most concerned with the level and rate of growth issues.

The Level of Potential Output

There are three problems relating to the determination of the level of potential output that arise in connection with the three papers.

- a. The first problem is identifying "potential" levels of factor inputs. Employment, hours, and participation rates vary with unemployment rates. To define the potential level of factor input, we need to know the "full employment" level of the unemployment rate. If capital is explicitly treated in the analysis, we must also define a potential level of capital input.
- b. The second problem is the possibility of a once and for all shift in the level of productive capacity in 1973-5 due, for example, to a once and for all change in the relative price of energy. This must be picked up by dummy variables unless energy developments are explicitly integrated into the model.

c, The third problem is the possibility of incompatibility between potential levels of labor and capital inputs; i.e., the possibility that full utilization of the capital stock may occur prior to full utilization of the labor force and that the capital stock, not the labor force, is the real binding constraint that determines potential output. This view seemed to be prevalent in much of the recent discussions of capital shortage. It seems to me that such an incompatibility can arise only under the assumption of a putty-clay technology, but the Clark and Rasche-Tatom papers identify separate and conceivably conflicting measures of potential labor and capital inputs in a putty-putty model.

Projecting Rates of Growth of Potential Output

The second issue--the cyclical behavior of actual relative to potential output, while interesting in its own right and the issue that motivated early research in this area, is most important in the three papers as part of the methodology for providing evidence on the third issue, the trend rate of growth in potential output. The basic approach used to isolate the secular trend in the rate of growth of potential output is to purge the actual data of cyclical influences and then to fit a time trend (with appropriate dummies) to determine ex post rates of growth. When time trend dummies play such a critical role, projections of future growth rates become treacherous. Should we assume the time trend relevant to the next five years will be the same as that over the most recent homogeneous period, revert to that of a still earlier period, or be different from either? Plausible stories can be told to rationalize each possible choice but the econometric evidence in the papers often doesn't help in making the choice.

### Specific Comments on the Three Papers

The Clark, Rasche-Tatom and Perry papers are closely interrelated. The Clark paper, for example, follows the approach Perry employed in earlier papers to measure potential output, except that Clark introduces capital explicitly and therefore investigates weighted factor input productivity rather than labor productivity. And the Rasche-Tatom paper introduces energy as well as capital as an explicit factor input in the analysis. Finally Perry discusses the role of capital and energy in the measurement of potential output and concludes his simpler method remains capable of a more reliable estimate of potential output.

### The Clark and Perry Papers

The Clark paper provides evidence that the level of potential output, if appropriately set in relation to a 4% aggregate unemployment rate in 1955, now should be defined in relation to a 4.9% unemployment rate, considers some possible explanations of the unexpectedly poor performance of productivity in 1973-4, and provides a range of estimates of the growth of potential output that reflects the inability to isolate the source of the unusual behavior of productivity in 1974. Perry simply excludes 1974 and reports small residuals in 1973, 1975 and 1976. Clark tries alternate dummies which involve a downward shift in potential output in 1974 and a more intense cyclical pattern of productivity in the 1974-5 recession. Clark is unable to choose between the two explanations (although they have very different implications for the current level of potential output) and the evidence presented in the Clark and Perry papers does not permit a definitive evaluation of Clark's dummies relative to Perry's dummy. The approach used in both the Perry and Clark papers

suffers from inadequate attention to the selection of potential levels of labor input and provides little solid evidence on which to base projections of future growth rates.

1. The full employment unemployment rate. When the CEA designated 4% as the target unemployment rate in 1962, they rationalized the choice in terms of a simple (nonexpectational) Phillips Curve trade-off model. The trade-off model doesn't yield a unique choice for the full employment-unemployment rate ( $U_f$ ) but if we assume that model is valid, it at least represents a well defined methodology for selecting  $U_f$ . Since that time, there has been a great deal of additional theoretical and empirical research on the relation between inflation and unemployment, including the development of the natural rate model. This research raised the possibility of a vertical Phillips Curve and an (in principle) well defined natural, or if not so natural, at least unique noninflationary (or nonaccelerating) rate of unemployment. Yet studies like Clark, Rasche-Tatom and Perry's continue to key the full employment level of labor input to the 4% unemployment rate in 1955 and then to translate this via changing demographic composition of the labor force to a 4.9% rate in the 1970's. Clark and Perry tell us that this unemployment rate series represents a constant degree of labor market tightness, but does not bear a direct relation to the noninflationary rate of unemployment and is not the outcome of a study of inflation dynamics. If their potential unemployment rate should not be confused with the noninflationary rate of unemployment, should their measure of productive capacity be confused with the traditional concept of potential output? Until a more serious effort is made to introduce a meaningful concept of potential labor input, the level of potential output estimated by such studies must be

treated with skepticism. Having identified their potential level of labor input with a constant degree of labor market tightness, these studies may still be able to yield meaningful insights about cyclical behavior of output relative to employment (e.g. as in Okun's Law) and the trend rate of growth in output, but the level of potential output remains arbitrary as long as there is no rationale (aside from historical continuity) for the specific constant degree of labor market tightness employed in the analysis.

## 2. Explaining and forecasting growth rates of potential output.

The methodology used to determine growth rates of potential output is to purge the data on actual output of its cyclical component (by relating participation rates, hours per worker and productivity to cyclical variables) and then to extract the secular trend via estimation of a time trend. Ex post, this method seems capable of reasonably determining historic trend rates of growth of output. However, changes in the trend rate of growth can only be observed ex post and corrected for by time trend dummies. And projections of future growth rates involve extrapolation of recent historic growth rates plus conjectures about whether recent rates are likely to continue, the recent slowdown will worsen, or future rates will rebound. There is typically little direct support for such conjectures in the econometric analyses themselves.

## 3. The explicit treatment of capital stock data in projections of potential output.

What differentiates Clark's paper from earlier studies and from Perry's paper is Clark's explicit treatment of the capital stock as an input rather than capturing its influence via time trends in the labor productivity equation. My initial reaction was that this was a

reasonable extension, although the whole history of debate over the baffling problem of developing a meaningful measure of the aggregate capital stock made me a bit wary. My initial favorable reaction was quickly cooled by the arbitrary way in which capital was included--by imposing fixed weights on labor and capital to form an index of total factor inputs. Perry's discussion of the difficulty in obtaining statistically significant coefficients on capital in aggregate production functions both provides a rationale for Clark's procedure and reinforces my distrust of the imposition of the arbitrary weights and my concern that problems of measuring capital may indeed make Perry's approach more reliable. Clark's defense of his treatment of capital seems to be that it does not make a great deal of difference so that using labor input and labor productivity would not have altered his results. I don't know whether this is a defense for using or not using capital!

#### The Rasche-Tatom Paper

The Rasche-Tatom paper employs a methodology which allows for explicit treatment of one of the alleged villains in the mystery--the influence of the sharp rise in the relative price of energy since 1973. By including the relative price of energy to proxy the input of energy in production, Rasche and Tatom find that they can explain recent developments through 1975 without resort to special dummies for the 1973-5 period. Their results also suggest a lower level of potential output in recent years even without any allowance for such factors as the increasing proportion of capital spending devoted to pollution abatement and the slowdown in the trend rate of growth in productivity after 1967 or 1969.

An increase in the relative price of energy should induce substitution out of energy into labor and capital thus increasing the labor and capital requirements per unit of output and decreasing the energy requirements per unit of output. Both Perry and Clark accept this as a plausible response to a change in the relative price of energy but attempt to capture it in their productivity equations with either dummies for a given year or time trend dummies. The issue then is the magnitude of this effect on the level of potential output and the duration of its effect on growth rates. Given the fixed levels of potential labor and capital inputs at the point of change in the relative price of energy, the increase in capital and labor requirements per unit of output translates into a decline in potential output. The greater the substitutability of capital and labor for energy, the greater the resulting decline in potential output.

This procedure raises a number of questions:

1. The results can be heavily influenced by the form of the production function and the constraints imposed in estimating the coefficients. How did the Cobb Douglas form and restrictions imposed on the parameters influence the sensitivity of potential output to the change in the relative price of energy? I share Perry's view that the Rasche-Tatom methodology has led to a serious overestimate of the resulting decline in potential output. Yet I do not find their general approach, that of including the relative price of energy as a proxy for energy input, unreasonable. Additional research with less restrictive assumptions about the production function would be useful.

2. No allowance is made for an influence of the relative price



of energy on either the "potential" level of capacity utilization or the rate of obsolescence. Both factors are treated as technical constants rather than choice variables subject to influence by changes in relative prices. Yet one of the most important channels through which the sharp increase in the relative price of energy might be expected to operate is by affecting the optimal rate of replacement investment. The theory or nontheory of replacement investment is an important gap in our conventional macro treatment of investment.

In contrast to the Rasche-Tatom paper, a 1975 paper by Myers and Nakamura<sup>1/</sup> on the effects of energy on productivity explicitly models the influence of a rise in energy prices on the optimal rate of replacement. They use a "vintage" (putty clay) model, and their vintage production function includes energy along with labor and capital. An increase in the price of energy is shown to effect the condition which determines the shutdown point for a given vintage. Increased energy prices result in an accelerated obsolescence of existing plant and equipment; the increase in the rate at which old vintages are replaced with new (higher technology) vintages tends to increase labor productivity. On the other hand, the increased energy prices induce a substitution to labor and capital from energy so that the amount of labor and investment required per unit of output tends to increase, reducing labor productivity. The net result on productivity is ambiguous and therefore must be determined empirically. Thus the effect of energy on productivity may be more complicated than the Rasche-Tatom analysis suggests.

3. Another questionable feature of the Rasche-Tatom analysis is the failure to allow for a gradual response of production decisions to changes in the relative price of energy. The discussion of their projections of future growth rates, on the other hand, makes reference to a gradual response to energy developments. This seems to involve conjectures quite unrelated to the explicit econometric analysis of the paper.

#### Summing Up

Of the three issues we identified at the outset--the level issue, the cyclical issue, and the rate of growth issue--the papers do the best job on the cyclical issue. But the main focus of the papers is on the level and rate of growth issues and their approaches to these issues have serious shortcomings. The level issue is simply unanswered due to failure to identify an appropriate potential level of labor input. In addition, the effect of the increase in the relative price of energy on the level of potential output remains unsettled. Rasche and Tatom have probably overstated the effect, but Clark's results also suggest the possibility of a substantial once and for all decline in potential output. As for the projection of future growth rates in three papers, at least in this case, time will permit us to judge whose conjectures were most accurate.

#### Footnotes

- 1/ J. G. Myers and L. Nakamura, "Energy and Pollution Effects on Productivity: A Putty Clay Approach," National Bureau of Economic Research (mimeo), 1976.