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Summaries of NBER Studies in This Issue:

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Supply-Stagflation

The world's developed economies have not yet recovered from the extraordinary macroeconomic events of the early 1970s. The decade began with a dramatic spurt in inflation in the industrial world that has persisted in many countries. More dramatic is the general decline in output growth that started with the worldwide recession of 1974–75; GNP growth of the OECD economies during 1973–78 has been at about half the rate of the preceding decade. In a recent study, NBER associates **Michael Bruno** and **Jeffrey Sachs** argue that these price and output developments cannot be understood in purely Keynesian aggregate demand terms or monetary terms. Their study, **Supply vs. Demand Approaches to the Problem of Stagflation** (*Working Paper No. 382*), shows that real, aggregate supply disturbances, such as the oil and raw materials price rises of 1972–74, have played a crucial role in the acceleration of inflation and the decline in real output growth.

As in the typical, Keynesian explanation of the deep recession of 1974–75, write Bruno and Sachs, the oil price hike is seen as an excise levied by OPEC on the industrial world, not enough of which was spent to keep economic activity at earlier levels. According to this view, the resulting slack could be eliminated with a sufficient boost to demand on a coordinated world scale. Such a demand-side view might seem all the more plausible, the authors suggest, given the restrictive fiscal and monetary policies pursued in most countries during 1974–75. But the Keynesian analysis provides an incomplete explanation of events because it fails to account for the very sluggish recovery in most countries other than the United States since 1977. In many countries, expansionary monetary policies have provoked inflation rather than led to increases in real output.

Moreover, the Keynesian model is not consistent with the behavior of industrial firms. In their study, Bruno and Sachs show that an increase in the price of oil (or other intermediate inputs) will reduce the firms' desired levels of output and employment unless real wages and other input prices adjust downward. If real wages (wages adjusted for inflation) only decline slowly, which by and large they do, unemployment results. The oil price shock is but one of the factors in the 1970s that has required a downward adjustment of real wages throughout the industrial world. Slower growth of capital stock and a decline in the growth of total factor productivity have caused aggregate supply effects just like the oil price rise.

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As the authors point out, one may believe that supply shocks reduce output in the short run without being convinced that the 1973 oil price rise played a major role in the world recession that followed. To test their views, they provide a simulation model and some econometric estimates of important relationships for seven major industrial economies. The simulations convey a clear message: fuel inputs are sufficiently important in production, and the rise of oil prices in 1973 was of such magnitude, that a large part of the worldwide recession may be attributed to the change in the relative price of oil. While monetary policy was contractionary in most countries in 1974, the simulations suggest that the 1974–75 recession would have been severe, with significant classical unemployment, even with accommodative macroeconomic policy.

Bruno and Sachs repeatedly stress that countries

differ in their response to supply shocks and macro policies because of differences in key structural relationships, particularly in wage determination. For example, the United States is characterized by money wages that are slow to adjust to demand changes, and aggregate output is responsive to monetary policy. The U.S. recession was determined more by demand than supply; real wages did decelerate as required after the price spurt of 1974–75. Many European countries are better described in terms of real wage sluggishness and are therefore more likely to translate a money supply increase into a price rise. The European cycle in 1974–75 was determined more by supply, for rates of growth of real wages failed to decline for two years after the oil price hike.

Bruno and Sachs conclude by noting that serious aggregate supply shocks continue to affect the developed economies. The 1973 oil price shock has had persisting relevance through its depressing effect on capital accumulation throughout the OECD while, in 1979, the industrialized world faces another significant oil price increase. An enlightened policy response to these disturbances requires a better appreciation of the role of aggregate supply in price and output determination.

Return on R and D

A new NBER study has found that the private rate of return on investments in research and innovation may be substantially lower than previously believed. Earlier estimates placed the rate of return on research during the late 1950s and early 1960s in the 30 to 45 percent range. Those estimates presented a paradox: despite such seemingly high returns, corporations made substantial cutbacks in the share of resources devoted to R and D in the late 1960s and early 1970s. From 1963 to 1974, the share of net sales of manufacturing companies devoted to R and D dropped from 4.6 percent to 2.9 percent.

The new study suggests that the answer to the paradox may be that research is not unusually profitable after all. The actual rates of return appear to be about the same as those earned on investments in traditional capital equipment. The new findings were made by NBER associates **Ariel Pakes** and **Mark Schankerman.** Their results are reported in **The Rate of Obsolescence of Knowledge, Research Gestation Lags, and the Private Rate of Return to Research Resources** (*Working Paper No. 346*).

The private rate of return on innovation is a matter of concern because it is possible that market incentives give rise to a lower amount of investment in research than is socially desirable. That could be the case because of the special characteristics of knowledge, the direct product of research. The cost of reproducing knowledge is virtually zero, and it is extremely difficult to prevent others from exploiting it. Those qualities give knowledge the character of a public good and make it difficult for innovators to capture the full returns from their discoveries. Thus, returns to innovators from their discoveries (the private return) may be substantially lower than the returns that society reaps (the social return), and there may be less investment in research than is desirable from the viewpoint of society as a whole. Pakes and Schankerman's results apply only to the private rate of return.

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There are two critical factors in estimates of the private rate of return. One is the rate of decline in revenues accruing to innovators—the "decay" rate. The other is the average lag between the time that research expenditures are made and the time that revenues start coming in. In the past, researchers have simply assumed that the decay rate is similar to the rate of decay of the physical productivity of traditional capital equipment. But the rate of decay in revenues from innovation is not a function of the productivity of knowledge. Instead, revenues diminish because of those public-good characteristics that make it difficult to prevent others from using knowledge without paying for it and because some innovations are soon made obsolete by new ones.

Pakes and Schankerman's estimates of the returns from innovation are so much lower than previous ones because they based their calculations on the first empirical estimates of the decay rate. Other researchers usually have used decay rates of 4 to 7 percent, but never higher than 10 percent. In contrast, Pakes and Schankerman estimate that the decay rate is *at least* 18 percent—nearly double the highest decay rate used in earlier studies.

Pakes and Schankerman arrived at their decay rate estimate by applying an analytic model of patent renewal to data from a 1958 study of the percentage of patents of various ages that were renewed in five European countries during the years from 1930 through 1939. In the simplest terms, the model assumes that companies will pay an annual renewal fee only if the revenues gained by holding a patent exceed the fee. The data from the 1958 study yielded an estimated decay rate of 25 percent (with 95 percent confidence that the true rate falls between 18 and 36 percent).

It is possible, of course, that the decay rate on patented innovations differs from the decay rate on all research. However, there are two reasons to believe that any bias from using patented innovations is on the low side. First, the fact that patents create property rights in knowledge may result in a lower decay rate for all innovations that can be patented. Second, innovators will take out a patent on a discovery only if the patent lowers the decay rate.

Whatever the case, it is likely that any bias in the estimate from patent data is small. Pakes and Schankerman also estimate the decay rate using data from a 1968 survey on applied R and D expenditures. The survey, which covered thirty-five companies with R and D experience in thirty-three product areas, included a question on the life span of innovations. Life span was defined as the period after which innovations are "virtually obsolete." Although the decay rates implied by the survey responses vary according to the definition of virtual obsolescence, the range of rates is nearly identical to the one Pakes and Schankerman estimated from the patent data.

Pakes and Schankerman also used data from two earlier studies to estimate the mean R and D lag—the average time between research expenditures and the initial revenue inflows. They conclude that the average lag is between 1.2 and 2.5 years.

The final step in estimating the rate of return on research was to incorporate the range of estimates of average lags and decay rates into a production function, and to compute the excess returns to research (that is, the returns above and beyond the normal returns on traditional capital investments). Using the 25 percent decay rate, the excess rate of return is between 3.3 and 4.7 percent. In view of the highly uncertain payoffs on research expenditures, a risk premium of that amount would appear to be modest. That is, after allowing for the special risks involved in research and development, it would appear that investing in R and D is no more profitable than investing in traditional capital goods. AE

Unions and Productivity

Unionization may lead to changes in management practices that can raise productivity, according to a recent study by NBER Research Associate **Kim Clark.** In *Working Paper No. 332,* **Unionization, Management Adjustment, and Productivity,** Clark analyzes the experience of six cement plants that changed union status between 1953 and 1976. Using industry data collected by the Portland Cement Association and interviews with union and management officials, Clark focuses on the behavior of productivity before and after unionization.

The cement industry is a good one in which to analyze productivity because its output is homogeneous and measured in physical units. Comparison of productivity therefore need not be made in terms of value. Product classifications and quality standards used in the industry permit comparison of output in different establishments in physical terms alone. Moreover, the technology within the industry is fairly standard between union and nonunion plants.

In his analysis, Clark estimated the effect of unionization when a variety of other factors, including capacity utilization and the scale of operations, are controlled. He concludes that "unionization increases productivity after controlling for capital-labor substitution, technological change, and individual firm effects."

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He then considers the problem of labor quality. Productivity within an enterprise depends partially upon the quality of the workers. Unionization, by raising wages, induces the firm to hire workers of higher quality. Therefore, the effect of the union on productivity may reflect differences in the quality of labor as well as organizational changes in the enterprise.

Clark shows that the gain in productivity from increased labor quality depends on how much turnover takes place. However, the evidence he obtains from case studies of the six cement plants indicates that the extent of worker turnover is not sufficient to explain the observed improvement in productivity. Clark concludes, therefore, that correction of the estimates of the union effect for changes in labor quality leaves the basic findings intact.

The case studies used in the analysis of worker quality provide evidence of the unionization experience in the six plants and are used to determine why increased productivity occurs. Clark first examines changes in the labor contract that accompany unionization and then considers the responses of workers and managers. The case studies indicate substantial changes in the plants' rules governing exit, entry, and internal promotion. Before unionization, management had had broad discretion over job mobility. There were fewer explicit or specific rules on the subject and no evidence of formal evaluation systems. Thus job mobility depended largely on the decisions of the foreman or plant manager.

With the unions came plant-wide job posting and bidding, and explicit job selection criteria. Additional-

ly, plant-wide seniority became more important than ability in the job-changing process. In sum, the introduction of the union eliminated personal considerations in job mobility and reduced the role of management judgment. The unions also brought formal grievance procedures and outside arbitration; none of the six plants had previously maintained regular communication channels for the expression of grievances or complaints.

On the other hand, Clark finds little evidence of a substantial change in the behavior of workers. He observes a decline or no change in the quit rate in five of the six unionized plants, although in one plant quits rose. There was some evidence of increased absenteeism, but also a decline in major discipline problems. Overall, Clark does not find reductions in turnover and other forms of exit behavior to be a principal link between unionization and productivity.

Based on the case study evidence, Clark tentatively concludes that one of the key adjustments to unionization was an improvement in plant management. It has long been recognized that collective bargaining fundamentally changes the task of management. The case studies suggest that successful management in the union context required both new managers and new management practices. In all six cases, a new plant manager was hired, and in some instances, new supervisors were introduced. New management meant new methods and procedures. As one manager remarked, "... before the union, this place was run like a family; now we run it like a business." In most of the studies, Clark finds significant changes in the style and substance of management. "Observed changes," he comments, "ranged from introduction of staff meetings to on-line time standards for equipment maintenance."

In sum, Clark concludes that unionization may lead to productive changes. His evidence suggests that much of the observed gain in productivity is due to the changes in management personnel and procedure that take place in response to the changes in the employment contract that follow unionization.

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