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On the Demise of the Long Run

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John Maynard Keynes observed that, "In the long run we are all dead," but in terms of economic analysis, the long run also may be dead. The culprit is new technology that is wiping out many of the distinctions between the long and short run.

As pointed out by Alfred Marshall a century ago, the amount of time needed to adjust to changed circumstances has been what distinguished the two runs. Thus, with respect to the ability of a manufacturer to respond to a shift in demand, economists traditionally have spoken of the elasticity of supply, delineating three time periods (Samuelson, 1976; McConnell, 1987). The first, the momentary or immediate market period, is too short to evoke any response and, since the supply is fixed, we say that it is inelastic; the supply curve is vertical. In the second, the short run, existing resources (plant, equipment, and labor) can be utilized more or less intensively, and so some degree of elasticity is introduced; the supply curve bends slightly toward the horizontal. (Although it may be easier to cut production, by shutting down a line and laying off workers, it also can be increased somewhat, by, for example, double shifting, whereby both fixed resources, plant and equipment, and the variable labor are used more intensively.) Only in the long run, which historically amounted to anywhere from six months to a few years depending upon the industry involved, was there sufficient time to make all the desired resource adjustments; in the long run, therefore, supply becomes very elastic as the curve moves toward the horizontal.

New technology—computer-aided design (CAD) and computer-aided manufacturing (CAM)—is likely to telescope the long run into the short run, and possibly even into the immediate market period. CAM includes robots, which are reprogrammable

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manipulators that move materials, parts, or specialized devices to perform a variety of tasks; numerically-controlled machine tools (NC) that shape or cut metal according to programmed instructions or the more recent, computer numerical control (CNC); and automated materials handling, storage, and retrieval systems. Flexible manufacturing systems combine work stations, such as CNC machines with robots, to move materials from one station to another. They operate under central computer control, and, according to the Office of Technology Assessment (1984), when the programmable automation ties together design, manufacturing, and management in an integrated system, it becomes computer-integrated manufacturing. True computer-integrated manufacturing remains more concept than reality, due to the inability of the various parts of the system to communicate with each other, but the problem is being addressed, as through General Motors' manufacturing automation protocol (MAP), and the bottleneck to flexible manufacturing will be overcome in time.

The key to the new technology, of course, is that it can be reprogrammed to perform a different operation, and this versatility of the new "programmable" automation distinguishes it from the old "hard" automation, in which a machine could perform only a single function. We found (Helfgott, 1988) that, while computer-based technology results in increased productivity, reduced production costs, improved product reliability, lowered inventory on hand, and enhanced workplace safety, its greatest benefit will be that it will provide the flexibility with which to respond quickly to market shifts. Designs can be turned into prototypes and the prototypes into finished products in a fraction of the time formerly required. For example, a General Electric facility reports (The Business Month, 1984), "it used to take seven to eight weeks for our people to manufacture a prototype... But now... we can design the same prototype within a week's time." Similarly, at a batch operation that we visited, CNC machines with robot arms for feeding had replaced automatic screw machines, and the set-up time for machining a different size part had been reduced from 30 hours to 30 minutes of reprogramming. (As a library of programs is built up, it won't take even that long.) In fact, instantaneous switching of production may be possible, for, according to *Business Week* (Bluestone, 1989), Intellico, Inc. has devised a computerized motor that can be reprogrammed while the factory floor machinery is running, eliminating the need to first shut down the line.

Indeed, the new technology is being introduced because U.S. manufacturing industries have been in serious economic difficulty. In many industries, markets are no longer growing rapidly enough to meet the worldwide expansion of productive capacity, with the result that domestic and foreign competition has become intense. Thus, steel mills, both in the United States and abroad, have been permanently shut down to bring capacity more in line with demand; American steelmaking capacity was cut 20 percent, from 160 to 128 million tons, between 1977 and 1986. Excess capacity may be developing in the automobile industry as Japanese manufacturers open new plants in the U.S. and Europe. Not only have U.S. exports been curbed, but imports have gobbled up large shares of domestic markets. The nature of demand also has been changing, with consumers seeking new and differentiated products, as evidenced by the shorter product life cycle. While the rationale for heavy investment in the special purpose technologies of mass production was that they provided economies of scale with which to cater to mass markets, Piore and Sabel (1984) claim that rapidly changing demand sometimes does not provide enough time in which to recoup those investments.

Manufacturers in many industries, therefore, are turning to computer-based technologies, whereby machines and processes can be quickly reprogrammed to perform new tasks, allowing quicker response to shifting markets. This greater flexibility is of immense importance to the ability of U.S. industry to compete, because, as Vernon (1986) has pointed out, "It is plausible to assume that the rapid rate of industrial change in the world will continue, requiring frequent changes in product lines." In terms of economic theory, that greater flexibility may spell the end of the distinction in elasticity of supply between the short and long runs.

Not all industries benefit equally in terms of greater flexibility. If consumers start to favor small widgets as against large ones, a manufacturer of the latter who is using computerized technology could rapidly switch production rather than suffer declining sales. There are limits to flexibility, however. With computerization, an automobile plant can shift from one model to another and varieties within a given model, but it cannot make products other than automobiles. In this and other manufacturing industries, however, the flexibility provided by the new technology allows them to engage in virtual customized production or, more precisely, flexible specialization.

These developments carry many implications for economic theory and practice. The declining importance of traditional economies of scale should encourage "the small is beautiful" movement, without wiping out mass production or making a dinosaur of the large corporation; to survive, however, giant firms will be forced to decentralize further and to manufacture in smaller plants. As we have contended (Helfgott, 1986), mass production and programmable automation are not necessarily antithetical. For example, at an electronics products plant, a flexible manufacturing center encompassing numerous forms of programmable automation was turning out 1,000,000 parts a year. Flexibility exists in the ability to change codes and set-ups and components in hours rather than days, and even to change production equipment in weeks, not months.

The new technology may mean that, instead of every company in an industry trying to compete in a broad array of products, many will seek specific market niches. While this would seem to be a factor in reducing competition, it will be counterbalanced by the ability of companies to quickly shift production into expanding markets, as, for example, our large widget manufacturer.

Another implication is greater price stability. This would flow, of course, from the fact that supply can increase more quickly to meet a rise in demand. Price stability also would be aided by the increased multi-purposeness of resources, which would avoid the classic problem of "increasing cost" to meet a shift in demand. It would no longer require coaxing resources out of alternative uses and, in the process, bidding up their prices, for the firm could use its current resources to make the product for which demand has risen, while reducing its output of that for which demand has declined.

Labor market implications also emerge: to the degree that reprogrammability stabilizes production, it also stabilizes employment. Not only is the time period of adjustment shortened, but we avoid the problems stemming from one firm laying off workers, while another is seeking new ones. Companies, thus, may find it easier to assure employment security in return for employee commitment and managerial flexibility in human resource deployment.

There are even political implications, particularly with respect to reactions to foreign trade developments. A drop in sales by American producers of good A, due to imports taking a larger share of the market for A, today generates lobbying for the imposition of quotas or higher tariffs, plus retraining of displaced workers. Such actions might be avoided if the American manufacturers of A could shift quickly to the production of other items.

This, of course, is simply another example of how the greater flexibility provided by reprogrammable automation contributes to the more rapid equilibriation of the economy. Although we focus on manufacturing, the computer has many other applications, especially the provision of information much more quickly, allowing business firms in all industries to speed up decision-making and respond more rapidly to changed circumstances. Many of these changes have been in motion for some time, as, for example, the enhanced ability to control inventories, insuring that they do not get too far out of line with sales.

Obviously, no one can predict all the possibilities emerging from reprogrammability, but I hope that these examples stimulate thought and research along these lines. The economics profession must begin to revise its teaching of economics to take account of the demise of the long run.

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