# THE CONTRIBUTION OF MANUFACTURING TO LONG-TERM ECONOMIC GROWTH

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## THE POST-INDUSTRIAL PREMISE

During the 1980s, a debate emerged over the contribution of manufacturing to long-term growth rates. One viewpoint argued that a transition from manufacturing to services was natural, inevitable and no cause for concern in advanced societies. In the more sophisticated treatments of this idea such as Daniel Bell's *The Coming of Post Industrial Society,* the argument took the form that an increasing share of the labor force would work in services and would therefore have to be educated in new technologies and managerial methods. Nothing in this thesis necessarily implied that the share of total output devoted to manufacturing would inexorably decline; nevertheless, some writers and politicians later altered the argument to suit their own agendas.

Environmentalists frequently played on the post-industrial premise to rationalize the costs to manufacturers of pollution abatement. In the late 1970s low productivity growth created a misperception of secular industrial decline, despite the fact that gains in aggregate output did not mirror the productivity slump. Advocates of high technology sometimes contrasted the robust vibrancy of emerging sectors with the seemingly lackluster performance of traditional manufacturing. Finally, when political furor erupted over the massive trade deficits of the early 1980s, some government officials found it expedient to invoke the post-industrial premise in order to justify policy errors such as the overvaluation of the dollar in 1981-87.

With the advantage of hindsight, it is now apparent that virtually all these rationalizations for industrial decline were unjustified. Nevertheless, since they are still widely articulated, it is useful to rebut them on a point-by-point basis. First, while the composition of the workforce has shifted to services, new evidence compiled by the Bureau of Economic Analysis (BEA) demonstrates that the ratio of manufactured output to GNP has not declined, but rather has remained relatively constant over the business cycle. Second, a major revival took place in manufacturing productivity from 1983 onward; during the 1980s, manufacturing productivity not only surpassed its performance of the 1970s but also its average postwar trend of 1948-73. Third, much of the advance in technology stems from R&D carried out in or funded by manufacturing corporations. Lastly, once the exchange rate had fallen to more realistic levels, the boom in merchandise exports from 1987 onward was responsible for prolonging the business cycle expansion and raising the manufacturing-GNP ratio to a postwar peak. In sum, the evidence largely refutes the post-industrial premise.

## EVIDENCE ON DEINDUSTRIALIZATION

If deindustrialization were a natural and inexorable process, the ratio of industrial output to overall economic activity should have exhibited a secular decline. In reality,

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TABLE 1
**Ratio of Value Added in Manufacturing to GNP, 1948-89**

| Year | Ratio, Manufacturing Output to GNP | Year | Ratio, Manufacturing Output to GNP |
|---|---|---|---|
| 1948 | .215 | 1969 | .221 |
| 1949 | .204 | 1970 | .209 |
| 1950 | .241 | 1971 | .207 |
| 1951 | .217 | 1972 | .215 |
| 1952 | .216 | 1973 | .226 |
| 1953 | .222 | 1974 | .216 |
| 1954 | .209 | 1975 | .203 |
| 1955 | .219 | 1976 | .212 |
| 1956 | .216 | 1977 | .224 |
| 1957 | .214 | 1978 | .223 |
| 1958 | .197 | 1979 | .223 |
| 1959 | .207 | 1980 | .211 |
| 1960 | .203 | 1981 | .208 |
| 1961 | .198 | 1982 | .200 |
| 1962 | .204 | 1983 | .205 |
| 1963 | .212 | 1984 | .214 |
| 1964 | .215 | 1985 | .215 |
| 1965 | .221 | 1986 | .216 |
| 1966 | .225 | 1987 | .220 |
| 1967 | .218 | 1988 | .228 |
| 1968 | .220 | 1989 | .225 |

this has not taken place. Table 1 presents the ratio of value added in manufacturing to GNP, both measured in constant dollars, for the period 1948-89. These estimates were extensively revised following a well-publicized critique by Robert Mishel arguing that the BEA data was overstating the contribution of manufacturing the aggregate output, due to mismeasurement of deflators for imports. The result of the revisions was to suggest that the Mishel critique was of only minimal importance. As a test of whether the manufacturing-output ratio exhibits a trend, the time series was regressed on time, and subjected to a series of tests for stationarity. There was no evidence of trending behavior.

There is some indication that this ratio declined during the early 1980s, at least relative to its values during the previous decade. The slow pace of the expansion from 1983 onward and the overvaluation of the dollar until 1985 caused this ratio to initially lag behind its historical values. As recently as 1986, the ratio was lower than its average value during the 1961-69 and 1975-79 expansions. However, after the dollar declined, this ratio rose sharply, and in fact achieved its postwar peak of 22.8 percent in 1988. The implication is that there was no endemic deindustrialization. There was only some temporary weakness in this ratio during the period when the dollar overvalued, and this was corrected later on. Similarly, while some writers have argued that deindustrialization began during the late 1970s, this is not evident in the data: in 1977-79, this ration consistently exceeded 22 percent. For the postwar period as a whole, the overall growth rate of manufactured output is virtually identical to that of GNP.



TABLE 2
**Growth in Labor and Multifactor Productivity, 1948-89**

| | 1948-89 | 1948-73 | 1973-79 | 1979-89 |
|---|---|---|---|---|
| <u>Private nonfarm business</u> | | | | |
| Output per hour of all persons | 1.9 | 2.5 | 0.6 | 1.1 |
| Contribution of capital intensity | 0.8 | 0.9 | 0.6 | 0.5 |
| Multifactor productivity | 1.1 | 1.6 | 0.0 | 0.6 |
| <u>Manufacturing</u> | | | | |
| Output per hour of all persons | 2.8 | 2.9 | 1.4 | 3.6 |
| Contribution of capital intensity | 0.8 | 0.8 | 1.0 | 0.6 |
| Multifactor productivity | 2.1 | 2.1 | 0.5 | 2.9 |

Source: Bureau of Labor Statistics

## PRODUCTIVITY GROWTH

Another way of accounting for growth is through productivity. As the Table 2 indicates, productivity gains have been consistently higher in manufacturing. Stated another way, total growth in manufacturing has been based more on increases in output per manhour, while growth in overall nonfarm output has been based more on additions of labor. In 1948-89, labor productivity in manufacturing averaged a 2.8 percent increase per year, compared with 1.9 percent in private nonfarm business. Interestingly enough, this disparity grew during the 1980s. In 1979-89, manufacturing productivity grew by 3.6 percent per year, compared to 1.1 percent in nonfarm business at a whole. Even more revealing is the rate of growth in multifactor productivity (output per unit of labor and capital): in manufacturing, this grew by 2.9 percent per year in 1979-89, compared to 0.6 percent in nonfarm business.

There are two issues at stake here, accounting for the actual gains made in productivity, and for the differential between manufacturing and aggregate nonfarm output. In terms of explaining overall productivity growth, changes in capital intensity have clearly been a major contributing factor, raising output per manhour by 0.8 percent per year over the period from 1948 onward. The increase in capital intensity has, however, made a very similar contribution to productivity gains in both manufacturing and nonfarm business. Instead, the higher growth rate of output per manhour in manufacturing apparently traces back more to faster growth in multifactor productivity, which has been nearly twice the rate achieved in nonfarm business as a whole.

What factors account for the differential in multifactor productivity? The traditional interpretation by multifactor productivity is that it is comprised mainly by technological advance. More recent research indicates that it also encompasses other factors such as economies of scale.

## THE ROLE OF TECHNOLOGY

Technical progress is of course difficult to measure exactly, but one useful indicator is expenditure for R&D. Of total constant-dollar R&D spending in 1990, industry accounted for 72 percent, while about 90% of industrial R&D spending took place in the manufacturing sector.

It is not altogether clear, however, how to fit technology into the economy's production function. In the neo-classical model developed by Robert Solow in the late 1950s, technological change was assumed to be primarily disembodied, i.e., it evolved independently of the inputs, and was approximated as a simple log-linear trend in the production function residual. The possibility that a certain amount of technological advance was embodied in the capital stock and the labor force was not by any means ruled out in the neo-classical model. But the main thrust of this paradigm was to suggest that technology increased at a relatively constant rate, and was not strongly influenced by current business cycle conditions.

This representation now appears obsolete given new data on R&D spanning nearly forty years. What is clear from the R&D data is that technology is not disembodied and linear; it is a stochastic process. Further, R&D spending appears to be closely linked to conditions in the overall economy and at the firm level.

At NAM we tested two sets of investment models to gauge their causal role in R&D. Microeconomic models of investment emphasize conditions at the firm level. Using new data on the internal financial ratios of manufacturing corporations, the following variables were found to be statistically significant at the five percent level or better in causal tests for the rate of change of industrial R&D: 1] after tax rates of returns on both assets and equity, 2] the ratios of liabilities to assets and short-term debt to assets (in a negative sense), 3] the ratio of equity to total assets. In addition, lesser degrees of statistical significance were found for other factors such as profit margins, the ratio of liabilities to equity and cash flow to assets.

Since all these microeconomic factors are determined endogenously by aggregate economic activity, they do not constitute a full theory of investment, but only establish the proximate linkages from firm-level conditions to R&D spending. A more complete notion of what drives technological advance must incorporate some reference to macroeconomic factors. Our tests demonstrated three causal mechanisms to be significant. The rental price of R&D, calculated using the Jorgensonian definition (which includes the price level, the tax treatment, and the cost of funds to the firm) was the single most important factor. Also powerful was the well-known accelerator model, which links investment (here R&D rather than capital) to the rate of growth in overall economic activity. In other words, R&D spending is to some extent a function of the business cycle. This is corroborated by evidence of cointegration between the R&D stock and GNP. In other words, while fluctuations in R&D do not track short-term movements in aggregate activity, the R&D stock shares a common stochastic trend with output over longer horizons.

The implications are considerable. If the propensity to spend on R&D is a positive function of corporate liquidity, measures that raise liquidity such as lower rates of taxation or targeted R&D tax credits imply greater investment in technology and therefore, in the long run, an upward shift in the production function. Similarly, changes in the costs of research can exert powerful, lasting effects on total investment in R&D, even over extended time horizons. Simultaneously, policy makers can influence the course of technological advance through stabilization policies designed to minimize business cycle volatility and insure adequate liquidity flows to private firms.



In essence, technological progress should not be regarded as a deterministic process separate from normal economic activity. Rather, it appears to be highly sensitive to current economic interactions and more specifically to conditions at the firm level. The deeper implication is that the rate of technological advance -- and therefore the long-term rate of economic growth -- achieved by a country is to a considerable extent a function of the political willingness to create conditions necessary for investment in the research that generates the technical progress.

Another objective of our research was to ascertain the direct contribution of technological change to growth on the supply side. One way to measure this is to include R&D as a separate factor input to production. In essence, it is possible to proxy for the accumulated value of technical knowledge by calculating a stock of R&D. One finding from respecifying the production function this way is that manufacturing is found to be much more "technology intensive" than output as a whole. The input elasticity for R&D in the production function for gross nonfarm output is about 0.085, according to our estimates. By comparison, the input elasticity for R&D in manufacturing is approximately 0.18.

Using the input elasticities, it is possible to quantify the contribution of the R&D stock to output growth. Our complete model is a three factor production function, including labor, the capital stock and the R&D stock, with no prior restrictions on returns to scale. Our principal finding is as follows. Of the 3.26 percent annual growth in manufacturing output over the period 1955-89, only 0.25 percentage points is contributed by labor, while 0.73 percentage points is accounted for by the flow of services from the capital stock. Advances in technology, measured as the flow of services from the R&D stock, account for approximately 2.0 percentage points. The implication is that multifactor productivity in the manufacturing sector is primarily driven by technology.

## RETURNS TO SCALE IN THE PRODUCTION FUNCTION

It is now generally recognized that multifactor productivity does not correspond exactly with technological advance, and that other factors also contribute to the higher growth rate in manufacturing. One alternative explanation has to do with returns to scale from inputs, i.e., the value of output obtained from the inputs to production.

This is admittedly a rather new area of economic inquiry, inasmuch as in the neo-classical model returns to scale were assumed to be constant. A recent study of long-term growth rates by Harvard Professors J. Bradford Delong and Lawrence Summers, however, casts doubt on the assumption of constant returns. This study found that growth rates have differed across national boundaries primarily as a result of capital accumulation, specifically in equipment. This itself provides strong evidence of the significance of manufacturing for long-term output growth, since industry is the chief source of demand for (as well as the supply of) machine tools. DeLong and Summers compare this empirical finding with the neo-classical production function, and conclude that if constant returns are imposed, the supply equation cannot replicate the observed relationship between capital and growth. In other words, there is powerful, albeit indirect evidence the returns to scale are actually increasing.

Using the production function described above, our analysis indicates that returns to scale in manufacturing are only marginally in excess of unity. The relatively low value for returns to scale in this analysis is predicated on the corresponding high value for technology inputs. A smaller estimate for the R&D stock would be consistent with higher scale effects. In this respect, operating with assumptions of a much smaller role for technology, Robert Hall of Stanford has suggested that returns to scale may exceed 1.5 in several single-digit SIC codes. Until this research is complete, however, the more conservative figure appears preferable.

## THE ROLE OF INTERNATIONAL TRADE

One of the most important aspects of growth in manufacturing at the current time has to do with penetration of foreign markets. Over the past twenty years, since abandonment of the Bretton Woods fixed exchange rate system, the United States has been able to achieve major gains in manufactured exports. In the 1970s, this took the form mainly of penetration of Third World markets in the Middle East and Latin America. Even more significant is the fact that since the devaluation of the dollar in 1985-87, the boom in merchandise exports has led to a major rerouting of world trade. Previously, the flow of merchandise imports ran primarily from Europe and Asia to the United States. Since that time, the United States has achieved a surplus in its merchandise trade accounts with the European Community and has substantially reduced the deficit with the Pacific Basin. The ability to sell overseas has important scale implications for manufacturing industries; it also provides an explanation for why export-oriented economies have achieved higher average productivity growth rates.

The economics profession remains of two minds as to whether short-term demand conditions can influence the long-term growth rates. For a long time, the prevailing view was that the effect of demand was largely temporary, and that the economy would eventually converge back to its long-term growth path; in fact, many econometric models still exhibit this property. Recently, however, this has been challenged on two grounds. To begin with, demand conditions may affect the growth rate of the capital stock. In the well-known accelerator model of investment, capital spending is driven by the growth rate of overall activity. Secondly, if an industry is able to broaden its operations by exporting or by penetrating dense, urbanized markets, it may realize significant economies of scale which in turn will tend to raise its production function. In other words, the relationship between demand conditions and long-term supply may be closer than previously realized.

One item of evidence that supports this view is that the most successful newly-industrial countries in the Pacific Basin achieved their high growth rates not only by concentrating in industry but also by looking beyond domestic boundaries and emphasizing exports. Over the period 1960-89, the volume of exports increased by 1,925 percent in Japan and over 7,000 percent in Korea. It is therefore not accidental that industrial growth rates in these countries surpassed the average for the advanced economies. While industrial production grew 200 percent in the industrial countries during this period, the highest gain (650 percent) was achieved in Japan. Korea actually raised its industrial output by more than 6,000 percent; the similarity in magnitude to its export gain is not coincidental.

The relationship between exports and industrial output is, unfortunately, not as strong in the United States as in other countries. Export booms have of course been critical to the American economy on several occasions, notably in the latter stages of business cycles: 1973-74, 1978-80 and 1988-90. Further, the importance of exports is



much higher than their static share of GNP would suggest: the export multiplier for GNP is in the area of 2.0. Nevertheless, the benefits of concentrating on manufactured exports were delayed in this country until 1973 by the long-term overvaluation of the dollar.

While exports have historically been only a secondary factor in accounting for higher industrial than total output growth in the United States, this will not necessarily be true in the coming decade. As the U.S. economy emerges from its ninth postwar recession, trade gains are providing a significant source of countercyclical stimulus. There are two main reasons for this: the lower dollar exchange rate has led to a considerable improvement in price competitiveness, and higher growth rates overseas are keeping demand for traded goods buoyant.

During the 1990s, the United States should continue to benefit from the low dollar, and be able to raise its exports somewhat more rapidly than other industrial countries. This will, in turn, offset the anticipated slower growth rate of consumption spending. Consequently, the ability to compete effectively in export markets will be critical in maintaining industrial growth in the 1990s.

## MANUFACTURING AND LONG-TERM GROWTH

Further evidence of the significance of manufacturing for long-term growth can be seen in a cross-country comparison. Over the last century, the largest gains in overall output occurred in the countries that concentrated on industry - North America, Western Europe, and Japan. The fastest transitions from underdevelopment to newly industrial or middle income status took place in countries such as South Korea and Taiwan, which followed strategies aimed at maximizing industrial exports. By comparison, countries that were relatively rich at the end of the nineteenth century but were specialized in agriculture and primary products tended to remain underdeveloped.

The *World Development Report* for 1987 by the World Bank study echoes this thesis. In a systematic comparison of growth rates throughout the developing countries, the greatest progress was made among industrial exporters. By comparison, countries that favored autarkic developmental strategies based solely in the domestic markets or which continued to trade primarily in primary commodities achieved significantly lower growth rates.

## CONCLUSIONS

The evidence overviewed here largely contravenes the post-industrial premise. While it was fashionable in the 1980s to argue that the developmental process would, in its final stages, imply a transition away from manufacturing, this premise was mistaken at best. At worst, it was a misleading rationalization for policy mistakes that damaged industrial performance.

The reality is that industry remains critical to achieving economic growth. The evidence above suggests that much of the contribution of industry to aggregate economic activity is reflected in its faster rate of productivity growth, which in turn traces back to its greater role in technological progress. A further implication is that technological advance can be enhanced through the appropriate combination of macroeconomic policies. Investment in R&D is driven by corporate liquidity, the rate of change in costs, and business cycle mechanisms. Hence, implicit subsidies through the tax code such as a permanent R&D credit, regulatory and social policies that minimize the intermediate costs of production, coupled with stabilization policies designed to mitigate cyclical fluctuations will tend to raise R&D spending. Similarly, further penetration of export markets is critical to achieving the market deepening that will generate increasing returns to scale. Consequently, policies should be designed to facilitate exports: the exchange rate should be kept at levels commensurate with trade competitiveness, and policy makers should undertake active export promotion programs through measures such as greater Eximbank financing and removal of controls.

What is to be emphasized here is that polices aimed at maximizing the growth rate should not be limited to better management of aggregate demand, but should focus on lowering the costs of factor inputs to production. The effects of structural policies that shift the economy's production function are likely to be more lasting in the long run. This makes sense on theoretical grounds, and so far we have obtained partial corroboration from the statistics. Econometric tests indicate that the impact of shifts in the production function on overall economic activity can be very long-lived; changes in supply may exert permanent effects on the level of output. In essence, the scale effects from international trade and technological advances from industrial R&D have a major role to play in determining the economy's long-term growth rate.