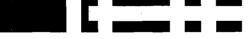
Indiana Manufacturing Productivity:

The Midwests' Best Kept Secret





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Indiana Manufacturing Productivity: The Midwest's Best Kept Secret

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Introduction

Until recently, it seemed that whenever the U.S. economy caught a cold, the Indiana economy, along with its neighbors in the Midwest, caught pneumonia. In 1974-75, and again in 1980-82, the U.S. economy was slowed by recessions that hit durable goods manufacturing states like Indiana doubly hard. Indeed, the term "rust belt" was coined during these periods to refer to the Midwest's presumed overabundance of obsolete capital and low levels of productivity.

Since the mid-1980s, however, there have been profound changes in Midwest manufacturing. Payrolls have fallen drastically and scores of older facilities have been shut down, while at the same time billions of dollars have been invested in new plants and equipment. As a result of these changes and a few other factors, most notably a weak dollar, the manufacturing sector has remained competitive during the most recent recession, and the Midwest states, including Indiana, have fared better.

The data that allow us to identify and measure the sources of Midwest productivity growth in manufacturing are now becoming available. In a recent study conducted at the Federal Reserve Bank of Chicago, Israilevich, Kuttner and Schnorbus (1993) found that investment in Midwest (Wisconsin, Illinois, Iowa, Indiana and Michigan) manufacturing industries, measured by average capital expenditures per worker, was 9 percent above the amount for the rest of the nation during the years 1986-1990. They estimate that efficiency gains for key Midwest industries, including steel and transportation, have been substantially higher in the Midwest than in the rest of the U.S. for this period.

This paper focuses on productivity investments that have been made in the state of Indiana. Our principal

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finding is that the effects of the downsizing and modernization process in manufacturing has been even more pronounced in Indiana than elsewhere in the Midwest. Since 1985, capital investment per worker in the state was 26 percent higher, on average, than U.S. investment during the same period. As a result of these investments, Indiana facilities have reaped sizable efficiency gains.

The most dramatic changes have been in the state's Transportation Equipment sector, consisting primarily of autos and trucks. Productivity in this sector, as measured by real (inflation-adjusted) value added per manhour, has increased from \$20.86 per man-hour in 1986, to \$27.09 in 1991, a 30 percent increase. Sizable productivity gains were also posted in the state's Metals and Consumer Products industries. The Machine and Chemical industries recorded mixed results.

The remainder of this paper presents our findings in greater detail. In the next section, we review the annual data on productivity and capital investments for five major sectors of Indiana manufacturing. The third section describes the method used to estimate the efficiency gains in Indiana manufacturing over the 1986-91 period that accrued to state businesses as a result of their new investments. Our conclusions are presented in the final section.

Investment and Productivity, 1972-91

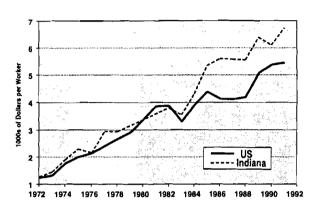
There have been at least three processes at work that have major impacts on Indiana manufacturing productivity. First, older plants and facilities have been closed, and old equipment has been scrapped. Removing less efficient capital raises the overall productivity of the remaining stock. Similarly, investment in new plants and equipment tends to increase overall productivity, since the new equipment is typically more efficient than the equipment it replaces. Finally, as mechanization of work processes displaces workers, manufacturing payrolls shrink, and the productivity of the remaining workforce tends to rise.

While it is difficult to find measures of the amount of plant and equipment that has been taken out of

production, we do have some data on expenditures on capital and equipment by Indiana manufacturers, as well as manufacturing payroll employment. If we measure business spending by capital spending per worker, we can compare investments made by Indiana manufacturing firms with those made by firms in the nation as a whole.

As can be seen from Figure 1, new capital investments made in Indiana manufacturing facilities closely followed that for the nation for the years 1972-1984. Measured in thousands of dollars per worker, investment in both Indiana and the U.S. grew fairly steadily during this period, suffering some modest declines in the recession recovery years of 1976 and 1983.

U.S. and Indiana Capital Expenditures Per Worker, 1972-91



Composition of Manufacturing Sectors

Manufacturing sector	Industry (SIC code)
Transportation	Transportation (SIC 37)
Metals	Primary Metals (SIC 33) Fabricated Metals (SIC 34)
Machinery	Industrial Equipment (SIC 35) Electric Equipment (SIC 36) Instruments (SIC 38)
Chemicals	Chemical Products (SIC 28) Rubber & Misc. Plastic (SIC 30)
Consumer	Food Products (SIC 24) Furniture (SIC 25) Printing & Publishing (SIC 27)

Since 1985, however, Indiana capital expenditures per worker have diverged significantly from the national average. During the years 1985-91, capital investment in Indiana manufacturing was 26 percent higher, on average, than U.S. investment during the same period. By contrast, capital investment for the midwest region, as reported in the Chicago Fed study, was 9 percent higher than the nation for the years 1986-90. These figures suggest that the downsizing and modernization processes which were underway in midwest manufacturing companies were much more pronounced in the state of Indiana.

The next question is, what has been the effect of these expenditures on Indiana manufacturing productivity? To examine this question, we have divided Indiana manufacturing industries into five sectors: Transportation, Metals, Machinery, Chemicals, and Consumer Goods. The correspondence between these sectors and the 2-digit industry SIC codes is shown in Table 1.

Output for each sector is measured by real (inflation-adjusted) value added. Value added from manufacture, obtained from the Census of Manufacturers for the 1972-91 period, was deflated by the producer price index most closely corresponding to the sector. The

resulting series is measured in constant dollars. Data were not available for the years 1979-81.

The ratio of real value added to manhours, for each sector, gives a measure of productivity. These ratios are displayed for each manufacturing sector in Figure 2 for the years 1972-91. As can be seen from the Figure, productivity did appear to go up dramatically in the late 1980s for Transportation and Metals. For the Machine sector, no upward trend in productivity is apparent. In Chemicals, where the level of productivity is highest, output per manhour did appear to jump up in the mid-1980s, but has behaved erratically since then. The situation is similar in the consumer goods sector, where a steady upward trend did appear to accelerate in 1985, only to slow down again shortly thereafter.

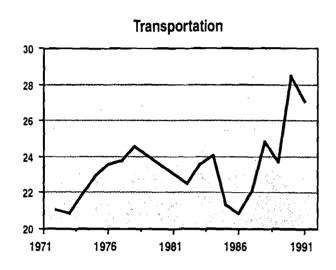
It is apparent from Figure 2 that manufacturing productivity, while appearing in some sectors to respond dramatically to higher levels of capital investment, is nonetheless influenced by a variety of other factors as well. In the next section we use a simple statistical model to derive what are hopefully better estimates of the precise changes in Indiana manufacturing productivity that are due to increased capital investment.

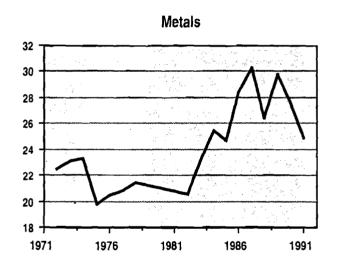
Real Value Added Per Manhour:

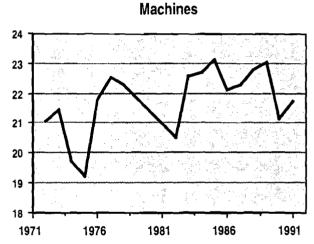
Indiana Manufacturing Industries

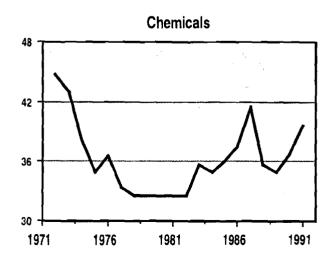
(1982 Dollars Per Manhour)

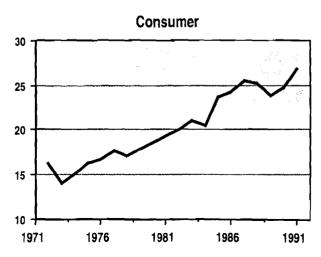
Source: Bureau of the Census, Census of Manufacturers











Estimating Efficiency Gains

Following the authors of the Chicago Fed study, we have carried out a two-stage process to attempt to measure the change in Indiana manufacturing productivity brought about by the increased levels of capital investment since 1985. In the first stage, simple production function models are fitted to the data for the years 1972-85, when capital investment per worker in the state more closely resembled that of the entire nation. These models represent the "old" or "pre-investment boom" relationships between manufacturing output and the various inputs used to produce that output.

In the second stage of the analysis, we compare (a) the predictions made by these "old technology" models estimated in the first stage, for the years 1986-91, with (b) actual Indiana manufacturing output for the same period, for each of the five major sectors. We call the difference between these two an efficiency gain, which is due to the technological changes brought about by the increased capital spending during these last six years.

For the first stage, we have fitted a set of models of the form

$$\begin{aligned} \log(Q_t) &= a_1 \ t + a_2 \ \log(MH_t) + a_3 \ \log(K_t) + e_t, \\ \text{where:} &\quad Q_t &= \text{real value added,} \\ MH_t &= \text{man-hours, and} \\ K_t &= \text{electricity usage, KwH.} \end{aligned}$$

. . . at least three out of the five sectors studied experienced efficiency gains, enabling them to produce more output than was predicted by the "old" production technology.

In this equation, the notation "t" indicates that each variable is indexed by time. The symbols a_1 , a_2 , and a_3 stand for the coefficients of the relationship, which will be estimated by regression analysis, and e_t is an error term.

Students of economics will recognize this as a "Cobb-Douglas" production function model, with the estimated coefficients a₁, a₂ and a₃ representing the rate of (disembodied) technological change, the return to labor, and the return to capital, respectively. Electricity use is used as a proxy variable to measure the capital stock.

These models were fitted using data for the years 1972-85, for each of the five Indiana manufacturing sectors. The results are displayed in Table 2. All of the models fit the data reasonably well. In all sectors except Chemicals, the signs of the estimated coefficients of man-hours and electricity use variables were positive, in agreement with economic theory.

Table 2

Estimation Results Indiana Manufacturing Output, by Sector

	Coefficient Estimates			Regression Statistics	
Sector	Time Trend	Man-Hours	Electricity	S.E.E.	F Value [†]
Transportation	0029	.7855**	.4888	.0523	53.47**
Metals	0035	1.1390**	.4209	.0796	15.65**
Machinery	0066**	.6317**	1.1310**	.0389	27.88**
Chemicals	.0009	2.3853**	8827*	.0630	18.14**
Consumer	0050*	.5966	.9569**	.0495	27.04**

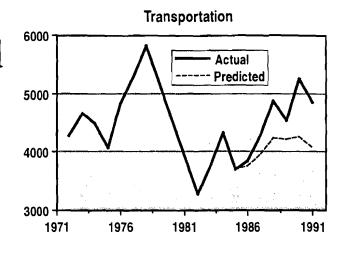
- † Joint significance of man-hours and electricity coefficients
- * significant at the 5 percent level
- ** significant at the 1 percent level

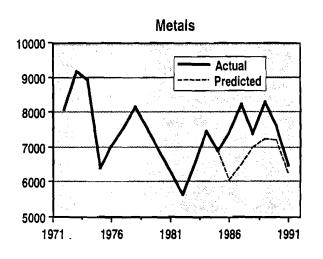
Actual vs. Predicted Value Added:

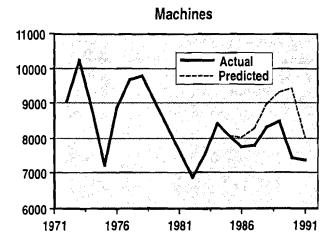
Indiana Manufacturing Industries

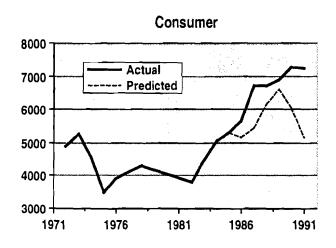
(Thousands of 1982 dollars)

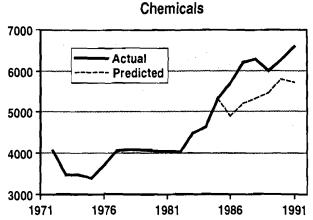
Source: Bureau of the Census, Census of Manufacturers











Using actual data on man-hours and electricity use for the years 1986-91, each of these models was used to generate predicted values for output. These predictions were, in turn, compared to the actual output values for these six years. The results, shown graphically in Figure 3, show that in four of the five sectors studied, actual output exceeded predicted output for each of the six years. The one exception is the Machine sector, which had output lower than what was predicted by the model based on 1972-85 data.

Table 3

Estimated Efficiency Gains in Indiana Manufacturing, 1986-1991

Manufacturing sector	Efficiency gains (percent)
Transportation	12.4
Metalworking	2.9
Machinery	-9.3
Chemicals	17.8
Consumer Products	14.1
Total	7.6
Total, excluding chemicals	5.3

Most of the graphs in Figure 3 show a widening of the gap between actual and predicted output early in the six year period 1986-91, with a somewhat smaller discrepancy towards the end of the sample. In the Metal sector, there have been practically no efficiency gains observed for the last two years. The exception to this general pattern is Chemicals, but results for this sector should probably be discounted, since its estimated production function has a coefficient with a sign opposite that suggested by economic theory.

Based on these results, we conclude that at least three out of the five sectors studied experienced efficiency gains, enabling them to produce more output than was predicted by the "old" production technology. The average annual increase for the 1986-91 period, expressed as a percent of predicted output, is shown for each sector in Table 3. With the exception of Machinery, the size of these gains is significant.

As a point of comparison, using the same methodology, the Chicago Fed study found Midwest efficiency gains as large as 7.9 percent for Transportation, compared to 3.8 for the U.S., for the 1986-90 period. The Indiana efficiency gain of 12.4 percent for Transportation is clearly even more dramatic than the Midwest figure. For all five manufacturing sectors, efficiency gains reported in the Chicago Fed study were 1.4 percent for the Midwest, compared to 1.3 for the nation. Excluding the Chemicals sector, the efficiency gains we find for Indiana are 5.3 percent for the 1986-91 period, a nearly four-fold increase over the U.S. results.

Conclusion

The resurgence of Midwest manufacturing as an increasingly competitive player in the global markets for manufactured goods has only recently been noticed by the national business community. This study has found that the state of Indiana has enjoyed an even more dramatic turnaround in its manufacturing sector than its neighbors in the Midwest. Indiana's attractive business climate and its locational advantages have

induced companies to invest comparatively more in their facilities here than elsewhere, and as a result, the productivity of Indiana's manufacturing labor force has increased dramatically. Given the real potential for the state to increase its share of U.S. manufacturing output, the outlook for the state's manufacturing base has significantly benefitted from these investments.

References

Israelevich, Philip R., Kenneth N. Kuttner, and Robert H. Schnorbus, "Tracking Midwest Manufacturing and Productivity Growth," Federal Reserve Bank of Chicago, Economic Perspectives, Vol. 17, No. 5, September/October 1993, pp. 2-11.

U.S. Department of Commerce, Bureau of the Census, Census of Manufacturers, Washington, DC.

