The Economic Impact of Manufacturing Extension Centers

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A recent U.S. Census survey indicates that two Illinois manufacturing extension centers affiliated with the national Manufacturing Extension Partnership have improved the performance of small Illinois firms and the Illinois state economy. During a 2-year period, the centers directly helped client firms create $22.5 million in sales and create or retain 483 jobs. These benefits, through their direct and indirect effects on the state economy, generated an estimated $119 million in new state output and 450 new state jobs during a 4-year period. State and local tax revenues increased by $9.5 million during the same period, comparing favorably with the $6 million 2-year funding for the two centers. These client-firm impacts occurred in industries important to state economic growth, high-wage employment, and competitiveness relative to the rest of the nation.

State economic development programs use a variety of strategies for improving the performance of their manufacturing industries. These strategies include working with existing firms to increase business retention and expansion; recruiting out-of-state firms to relocate in state; funding R&D in target technologies and industries; providing education, training, and other human resources activities; and providing financing options such as industrial revenue bonds. One interesting strategy is to participate in the Manufacturing Extension Partnership (MEP), a national network of more than 400 state manufacturing extension centers and field offices. Parallel in function to agricultural extension, state MEP centers provide outreach services to small[1] regional manufacturers. MEP neither funds R&D nor targets industries; rather, it serves as a vehicle for accelerating the diffusion of existing manufacturing technologies to small manufacturers, thereby making them more competitive.

Each state extension center provides three specific technical and business modernization-assistance services: assessments of a firm's operations, technical assistance with new products and processes, or staff training. Assistance areas include process improvement, plant layout, quality improvement, financial planning, and electronic commerce. Each center is funded by its state government, sometimes by its local government, and by the federal government (in a 50-50 cost share agreement), and all are coordinated by the national MEP office at the National Institute of Standards and Technology. To date, MEP centers have serviced more than 62,000 firms.

The day-to-day task of each MEP center is to respond to the technical and business needs of manufacturing firms that seek assistance. The centers do, however, have specific long-run performance goals at the center, city, state, and national levels. For example, the goal of each center is to

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increase the sales, profitability, and growth of its client firms. The goal of a center's state government—which typically provides half of center funding—is to increase state output, high-wage employment, and the price competitiveness of in-state firms. Nationally, the MEP network of centers is mandated to increase the global competitiveness of small U.S. manufacturers.[2]

Part of MEP's function is to evaluate the performance of its centers and the firms they assist. MEP has conducted project case studies (e.g., see Manufacturing Extension Partnership, 1998), firm productivity analysis using the U.S. Census Longitudinal Research Database manufacturing data (Jarmin, 1999), state macroeconomic analyses (Ehlen & Weber, 1997), and data envelope analysis of centers (Chapman, 1998). A new MEP survey, conducted by the U.S. Bureau of the Census under contract from the National Institute of Standards and Technology, provides information on how effective centers are improving the economic performance of MEP client firms. Individual MEP client firms are telephoned and asked a series of questions about how their sales, production costs, and labor changed as a direct result of MEP services.

This study uses the census survey data to evaluate the performance of the two Illinois MEP centers: the Chicago Manufacturing Center (CMC) and the Illinois Manufacturing Extension Center (IMEC). CMC is located in Chicago and services firms in the six-county Chicago area; IMEC services the non-Chicago area of Illinois through three regional offices in Peoria, Rockford, and Carbondale and 13 field offices. The study seeks answers to two questions. First, have the center projects helped small Illinois firms in industries that are important to Illinois state growth, high-wage employment, and competitiveness? Second, what are the total state impacts of assistance and how do they compare with CMC and IMEC funding?

Our analysis is based on 24 contiguous months of survey data and an analytical framework for estimating state impacts. After describing the survey process and the framework, we present the economic results of the MEP census survey of CMC and IMEC client firms. We first characterize the types of projects that generated impacts and the types of firms assisted. We then describe how the two centers affect the state economy by characterizing how client-firm impacts affect the state goals of growth, high-wage employment, and competitiveness and by estimating the total macroeconomic impact.

ANALYTICAL FRAMEWORK

Our methodology uses census survey data, manufacturing industry data, and a regional input-output model purchased from Regional Economic Modeling, Inc. (REMI) to answer the two questions about industry and state impacts. Figure 1 illustrates the overall methodology. Starting on the left, each center submits monthly to the census a log of completed projects. Each record in the log contains, for example, the client firm's primary standard industrial classification (SIC) code and number of employees, the start and end dates of the project, the type of assistance given (i.e., technical, assessment, or training), and the business area (e.g., CAD/CAM, process improvement, or quality and/or inspection). For each project, the census telephone-surveys the client firm approximately 9 months after the project is completed and asks questions regarding the quantifiable and nonquantifiable economic impacts directly attributable to the MEP project. The quantifiable impacts concern changes in sales (in state, out of state, and foreign), employment (new and retained jobs), capital investment, materials costs, inventory costs, and labor costs.[3] Bias in the survey results should, on balance, be minimal. Given the 70% client response rate, nonresponse bias should be small. Whereas a client firm may overstate impacts, it likely experiences additional project impacts not captured in the survey that should counterbalance any overstatement.

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Methodologically, the client firms' responses are our measure of center impacts on firms. Center impacts on the state economy are measured by (a) their effect on the state goals of growth, employment, and competitiveness and (b) their total macroeconomic impact on the state economy. The macroeconomic impacts are estimated by first converting the firm impacts to industry impacts (by two-digit SIC code) and then using the REMI macroeconomic model of Illinois to estimate the total state impact of these industry impacts. REMI is a regional input-output model in which labor, capital, and other resource markets clear over time. This model was chosen because it is dynamic

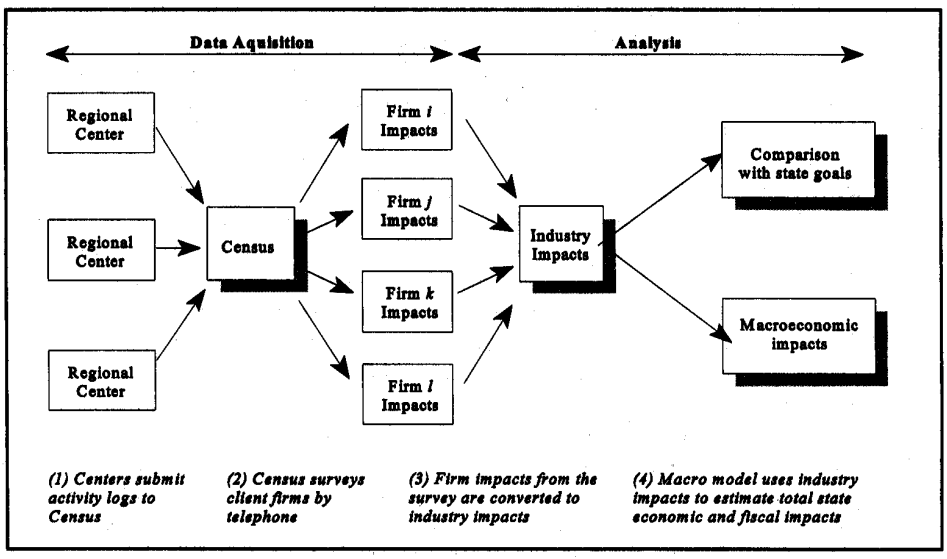

Figure 1: Analytical Framework

(it can use a time series of inputs to generate a time series of impacts), it is open source (all equations and data sources are documented), and it is widely used and accepted in analyses published in refereed journals. Similar to other input-output–based models, however, REMI requires that firm-level sales, labor, and capital impacts be input as industry-level impacts.

Specific methodological assumptions are therefore made about how client impacts affect industries. Client impacts are assumed to begin 9 months after project completion and to last for 3 years.[4] Client sales impacts are modeled as changes in industry output, with the specific formula depending on whether sales are in state or out of state. We assume that total in-state demand does not change as a result of client impacts. New in-state sales, therefore, displace the existing sales of in-state and out-of-state firms. The real increase in state output then is the displacement of sales from out-of-state firms (imports). This proportion of real output increase to in-state sales increase is assumed to be equal to the current industry-level ratio of imports to demand. Equation 1 converts the reported in-state sales to an increase in state industry output.

$$O_i = \sum_{f=1}^{F}\left[O_i^f \times \left(\frac{\text{imports}_i}{\text{demand}_i}\right)\right], \tag{1}$$

where O_i is the total industry-i change in output, O_i^f is the reported change in in-state sales for firm f in industry i, and imports_i and demand_i are state imports and demand in industry i. New out-of-state sales, on the other hand, are assumed to constitute changes in industry output—that is, $O_i = \Sigma_{f=1}^{F} O_i^f$.

When a firm reports no sales impact but either a job or capital impact (or both of these), the impact is modeled as a change in the value added created in the firm's industry. The assumption is that the firm is now producing in-house what it used to purchase from other firms. As with the in-state sales, a proportion of these employment or capital changes displace state imports, thereby creating new state products. The change in industry value added is calculated then as the reported factor (job or capital) increase times the average value produced per factor times the state ratio of imports to demand. Equations 2 and 3 calculate the change in industry-i output O_i caused by a change in firm-f employment E_i^f and capital K_i^f.

$$O_i = \sum_{f=1}^{F}\left[E_i^f \times \left(\frac{\text{output}_i}{\text{employment}_i}\right) \times \left(\frac{\text{imports}_i}{\text{demand}_i}\right)\right], \tag{2}$$

$$O_i = \sum_{f=1}^{F}\left[K_i^f \times \left(\frac{\text{output}_i}{\text{capital}_i}\right) \times \left(\frac{\text{imports}_i}{\text{demand}_i}\right)\right], \tag{3}$$

where variables also in Equation 1 are defined the same, and output_i, employment_i, and capital_i are the levels of state output, employment, and capital in industry i. To prevent the double counting of impacts, projects that resulted in sales impacts and either employment or capital impacts are modeled as sales impacts only.[5] Changes in materials costs and labor costs are modeled as changes in industry production costs by summing these costs, for example, $P_i = \Sigma_{f=1}^{F}(M_i^f + L_i^f)$, where P_i is the total change in industry-i production costs, and M_i^f and L_i^f are the reported changes in material and labor costs for firm f in industry i. Inventory cost savings are converted to industry production costs by summing 10% of the inventory impacts (to reflect interest expense, warehousing, spoilage, and insurance).

The state and local fiscal impact is measured as the change in state and local tax revenues and is calculated using published tax tables from the Federation of Tax Administrators (1998), and the change in state personal income is estimated by the REMI state macroeconomic model. The annual funding costs of the two centers were obtained from center personnel.[6]

CENSUS SURVEY DATA

The census conducted surveys using CMC and IMEC logs of projects completed between June 1, 1995, and May 31, 1997. The logs contain a total of 334 projects. Of these projects, the census was able to contact client firms regarding 249 of the projects (75%) and complete 234 surveys (70%). Of the completed surveys, 121 (52%) indicated at least one type of economic impact directly attributable to a CMC or IMEC project.[7] The most commonly reported impact was a change in capital investment (68 responses), followed by a change in employment (65) and sales (51). Table 1 lists totals for the reported economic impacts. A closer look at the data indicates that the projects and their impacts were generally with small firms in durables manufacturing sectors, covered a wide range of business areas, and took relatively few center hours to complete. Figure 2 illustrates these characteristics for all projects and for projects with economic impacts.

Most of the projects were with firms in SICs 34 (fabricated metals), 35 (nonelectric machines), and 36 (electric equipment), as illustrated by Panel 1. Most client firms were small: 52% had fewer than 50 employees, 26% had between 50 and 99 employees, and the remaining 22% had between 100 and 499 employees (Panel 2). The majority of projects, as illustrated in Panel 3, were in the areas of business systems and management (17%), market development (16%), and process improvement (13%).[8] Process improvement projects generated a slightly higher proportion of impacts (17%). Finally, as illustrated by Panel 4, the majority of all projects and projects with impacts were completed either in less than 25 hours (43%) or between 25 and 49 hours (22%). Further analysis of the data shows that 75% of these hours were spent by third-party consultants hired by the center to carry out part of the project. The four panels in Figure 2 suggest that the CMC and IMEC projects generated impacts for all sectors, firm sizes, business areas, and project durations, generally in proportion to the projects completed.

CENTER IMPACTS ON THE STATE ECONOMY

We measure the CMC and IMEC impacts on the state economy two ways: (a) by how well their projects support the three state goals of growth, high-wage employment, and price competitiveness and (b) by how the state-total economic and fiscal impacts compare to center funding. Projects that support these goals would create sales in important (high-wage) sectors; create jobs in high-wage sectors, especially those losing jobs to productivity gains or to imports; and increase the price competitiveness of industries less competitive than the rest of the nation. We measure the support of state goals by comparing firms' sales, employment, and production cost impacts with Illinois

TABLE 1
Client-Firm Impacts Resulting From CMC and IMEC Projects Completed Between June 1, 1995, and May 31, 1997

Impact	*Number of Firms Reporting*	*Percentage of Firms Reporting*	*Survey Total*
Sales	51	22	$22,485,000
Employment	65	28	483
Capital investment	68	29	$16,046,000
Material costs	19	8	$346,000
Inventory costs	27	12	$3,396,000
Labor costs	51	22	$1,996,000
At least one of the six impacts	121	52	NA

NOTE: CMC = Chicago Manufacturing Center; IMEC = Illinois Manufacturing Extension Center.

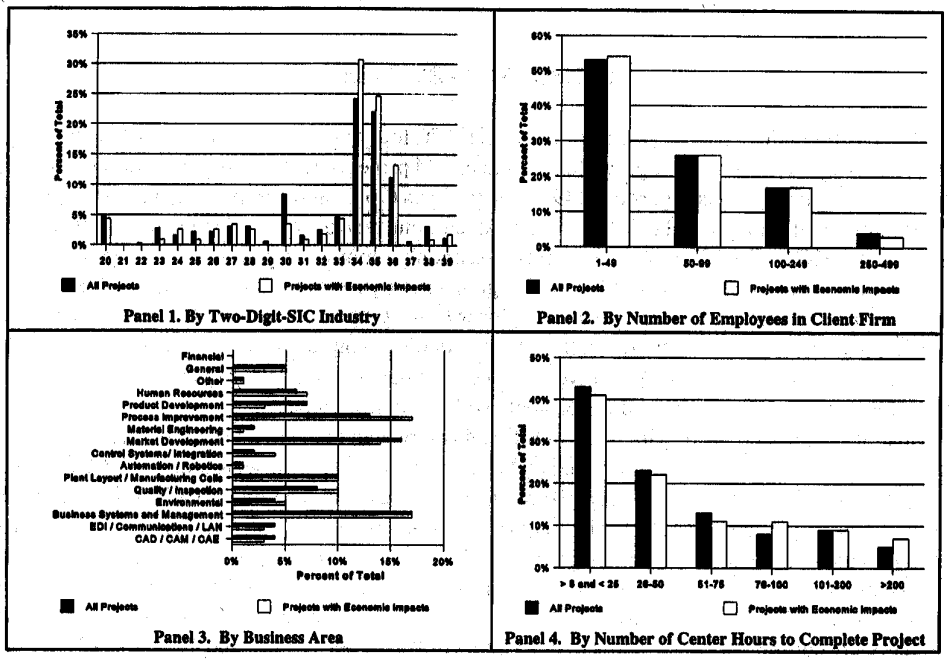

Figure 2: Distributions of All Projects and Projects With Economic Impacts

industry data. Economic and fiscal impacts are compared to funding after estimating total state impacts.

Figure 3 compares the center impacts with state goals by manufacturing industry. The figure has four panels. Panel 1 displays the relative size of each industry, showing manufacturing output and wage rates by two-digit-SIC industry. SIC 35 had the highest 1996 output ($29 billion) and highest 1996 annual wages ($45,000) among durables manufacturing industries (indicated by asterisks), followed by SICs 36 and 34. These three sectors are vital to the state because they account for two thirds of 1996 Illinois durables manufacturing output.

The latter three panels each compare project impacts with data relevant to one of the three state economic goals. Because the underlying data in Panels 2 through 4 vary significantly in both measurement units and magnitudes, each data series is normalized to the largest value in the series. For

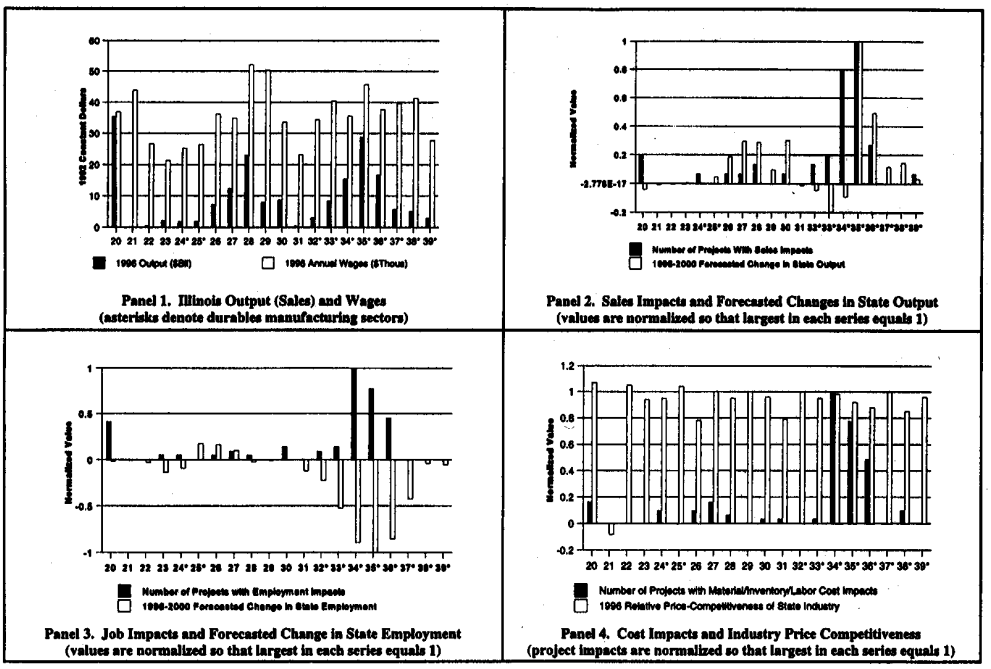

Figure 3: A Comparison of Project Impacts and the State Economy, by Industry

example, each sales value in Panel 2 is divided by the largest sales value, and each forecast change in state output is divided by the largest output-change value. Both data series are now bounded by −1 and 1, greatly facilitating comparison.

Looking at Panel 2, one sees that most projects with sales impacts were with firms in SIC 35 (nonelectric machines). This not only is the largest and highest wage durables manufacturing sector in Illinois (Panel 1) but also has the highest forecast 1996-2000 growth. The sector with the second highest number of sales impacts was SIC 34 (fabricated metals), which although being the second largest durables manufacturing sector, is forecast to decline in output. SIC 36 (electric equipment) had the third largest number of sales impacts and the second highest forecast growth. Panels 1 and 2 suggest that CMC and IMEC are being sought out by small firms in important, high-wage sectors, some of which are forecast to decline.

Panel 3 addresses whether the centers are supporting growth of high-wage employment. It compares the sectoral distribution of job impact projects with the 1996-2000 forecast employment change. Most of the job impact projects were with firms in SICs 34, 35, and 36 sectors that are high wage and are forecast to decline in employment. (Total Illinois manufacturing employment is forecast to decline by 38,000 jobs.) The panel suggests that CMC and IMEC are being sought out by small firms, which ultimately create jobs in important large, high-wage industries, many of which are forecast to lose high-wage jobs.

Finally, Panel 4 addresses how well CMC and IMEC are increasing the price competitiveness of Illinois firms. It compares the sectoral distribution of projects with material, inventory, or labor cost impacts with 1996 Illinois industry relative profitability, a measure of industry price competitiveness. If the relative profitability of a state industry is less than one, it has higher prices than the nation as a whole (i.e., is less competitive); a relative profitability greater than one means it has lower prices (i.e., is more competitive). The values for the cost impacts are normalized in a similar fashion as impacts in Panels 2 and 3; the relative profitability values are already normalized to national industry prices.

Panel 4 indicates that the majority of production cost savings, which generally increase firm competitiveness, occurred in SICs 34, 35, and 36. All three sectors are large, and their prices are

TABLE 2
Timeline of State Impacts Resulting From CMC and IMEC Projects Completed Between June 1995 and May 1997

Item	*1996*	*1997*	*1998*	*1999*	*Total*
Output (gross state product, $ million)	25.9	40.3	39.7	13.0	118.9
Manufacturing ($)	15.1	22.6	22.6	7.2	67.6
Durables ($)	13.9	20.8	20.8	6.6	62.1
Nondurables ($)	1.3	1.8	1.8	0.5	5.4
Nonmanufacturing ($)	10.8	17.7	17.1	5.8	51.3
Employment	408	610	592	185	NA
Manufacturing	186	260	252	70	NA
Durables	171	240	234	65	NA
Nondurables	14	19	18	5	NA
Nonmanufacturing	222	350	340	115	NA
Personal income ($ million)	19.0	31.7	33.7	11.1	95.5
Tax revenues ($ million)	4.4	7.3	7.8	2.5	22.0
Local ($)	0.7	1.2	1.3	0.5	3.7
State ($)	1.1	1.9	2.0	0.7	5.8
State and local ($)	1.9	3.2	3.4	1.1	9.5
Federal ($)	2.5	4.1	4.4	1.5	12.5

NOTE: Dollar values are in constant 1998 dollars. CMC = Chicago Manufacturing Center; IMEC = Illinois Manufacturing Extension Center.

higher than the national average. The panel suggests that IMEC and CMC are increasing the price competitiveness of firms, especially in industries that are less competitive than the nation. Individually and together, the four panels suggest that small Illinois firms in important but often uncompetitive and declining sectors are approaching MEP for assistance. Because the assistances increase sales, high-wage employment, and competitiveness, they are consistent with the state economic goals.

The second part of our state-level analysis estimates the total center impact on the state and local economy. It uses the REMI macroeconomic model of Illinois and the modeling assumptions described in the analytical framework. Table 2 presents the results of our analysis. The Total column displays the total 4-year impact of the projects from June 1995 to May 1997. If one looks at the 1996 column of figures, the projects increase state output by a total of $25.9 million and state employment by 408 jobs (the average employment increase during the 4-year period is 450 jobs).[9] Personal income increases by $19.0 million, and state and federal tax revenues increase by $4.4 million. Looking at the Total column, note that the $9.5 million, 4-year total of new state and local tax revenues compares favorably to the $6 million total cost to fund CMC and IMEC for 2 years. In addition, the $12.5 million, 4-year total of federal tax revenues compares favorably to the $3 million federal cost share to center funding. These suggest that the centers are a cost-effective means for the state and federal governments to address the needs of the small Illinois manufacturing firms.

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Table 2 may understate macroeconomic impacts for several reasons. First, the census was able to complete surveys for only 249 of the 334 projects completed during the 24-month period, often because the client firm could not be contacted. Additional completed surveys could increase the reported impacts. Second, the study assumes that client benefits start 9 months after completion of the project and persist for only 3 years; they may start earlier and last much longer. Finally, to prevent double counting, projects that generated more than one economic impact were modeled using only one of the reported impacts. A firm's set of economic impacts could, however, be independent and thus additive.

SUMMARY

Each of the MEP industrial extension centers responds to the technical and business needs of small manufacturers in its area. In doing so, the centers and their state governments anticipate

that the centers will benefit the firms, the states in which they operate, and the nation as a whole. This article presents, as a case study, an analysis of how two MEP centers—the CMC and the IEMC—are affecting their client firms and their state economy. Our study suggests that during a 2-year period, the two centers have affected the economic performance of the small Illinois manufacturers they assist, have benefited manufacturing industries central to the Illinois economy, and have done both in a cost-effective manner.

At the firm level, during a 2-year period, the two centers helped small firms create $22.5 million in new sales and create or retain 483 jobs. Most projects took fewer than 50 hours to complete and were carried out largely by third-party consultants. Most firms had fewer than 50 employees and were in durables manufacturing industries. At the state level, the impacts benefited the Illinois economy by enhancing growth, high-wage employment, income, and the price competitiveness of Illinois industries. Most client-firm sales impacts occurred in the three largest durables manufacturing sectors, one of which is forecast to decline in size during the 1996-2000 period. Most employment impacts occurred in the same three durables sectors, all of which are forecast to lose a substantial number of jobs during the same forecast period. Finally, most production cost savings—a means for increasing the price competitiveness of a firm—occurred in Illinois industries whose prices are higher than the national average.

The Illinois program has been effective in terms of both its impact on the state economy and its cost. Including the indirect effects of projects, during a 4-year period the projects generated an estimated $119 million in additional state output, $96 million in personal income, and $9.5 million in additional state and local tax revenues. This latter figure compares favorably with the $6 million in 2-year funding for the centers. Overall, considering the small amount of local, state, and federal investment, IMEC's and CMC's assistance is generating significant positive impacts on the Illinois state and local economies and doing so in a cost-effective manner.

NOTES

1. The term *small* denotes firms with fewer than 500 employees.

2. This Manufacturing Extension Partnership mission is consistent with the mission of the National Institute of Standards and Technology: to promote U.S. economic growth by working with industry to develop and apply technology, measurements, and standards.

3. Each question is a set of stepwise questions. For sales, the firm is first asked, "As a direct result of the assistance you received, have sales been at a different level from what they would have been without assistance?" If the firm answers "yes," it is then asked, (a) "Are sales higher or lower?" (b) "How much higher (or lower) have sales been than they would have been if you had not received assistance (cumulatively, to date)?" and (c) "What percentage of the change was accounted for by foreign customers (exports), out-of-state U.S.–located customers, or customers within your state?" The questions on other quantifiable impacts are structured in a similar fashion. One of the nonquantifiable-impact questions is, "Did your establishment experience any other positive or negative impacts of the center's assistance?"

4. Modeling impacts as occurring 9 months after assistance is a conservative assumption. It is used because the survey questions are worded to identify impacts achieved by the time of the survey (which is 9 to 12 months after assistance). Impacts could actually be occurring as early as the first day of assistance. The 3-year duration is also a conservative assumption because new investment in capital equipment can result in employment and sales impacts that could last for 10 to 20 years. Our simulation forecast spans 4 years due to the 2 years of project data: The first year of project impacts is modeled in Forecast Years 1 through 3, and the second year of impacts is modeled in Forecast Years 2 through 4.

5. We then verified, by industry, that the ratio of the reported employment increase (or capital increase) to sales increase was consistent with the ratio of total industry employment (or total industry capital) to total industry sales. This prevention of double counting is a conservative assumption because client sales and other impacts may actually be independent of one another and thus additive.

6. Based on interviews in August 1998 with Bob Weinstein of the Illinois Manufacturing Extension Center and Natalie Davila of the Chicago Manufacturing Center.

7. Of the completed surveys, 144 (58%) indicated at least one economic or noneconomic impact directly attributable to their center.

8. Because a project can have more than one business area designator, we used the primary designator given for the project. A consulting arrangement between the center and a firm may consist of a bundle of projects, in which case the last project is used as the representative project for the bundle. Because projects that are parts of a bundle constituted less than 5% of all projects in the 2-year data set, misdesignations caused by bundles are assumed to be negligible.

9. Separate Regional Economic Modeling, Inc. analyses indicate that the majority of the output increase comes from the projects with sales impacts (70%), followed by the projects with employment impacts (15%).

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