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The National-Level Economic Impact of the Manufacturing Extension Partnership (MEP): Estimates for Fiscal Year 2019

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EXTENSION PARTNERSHIP

The National-Level Economic Impact of the Manufacturing Extension Partnership (MEP): Estimates for Fiscal Year 2019

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I. EXECUTIVE SUMMARY

Study Overview

The Manufacturing Extension Partnership (MEP), part of the National Institute of Standards and Technology (NIST), contracted with Summit Consulting and the Upjohn Institute (the Team) to analyze the overall effect of MEP projects on the U.S. economy in Fiscal Year 2019 (FY2019). MEP Centers deliver technical assistance to primarily small and medium-sized manufacturing businesses to help them improve their productivity and competitiveness. The Centers provide services such as assistance with product development; tools and resources for business expansion and business continuity planning that contribute to cost savings; new investments; and improved products and processes. These improvements increase the productivity, profitability, and competitiveness of client firms, which in turn improves the economy by creating jobs, increasing earnings, and expanding the tax base.

Each year, NIST MEP surveys their clients using an independent third-party vendor (Fors Marsh Group) to gather information and data on the impact of the services provided. The survey asks clients to estimate the effects of MEP services on the following business outcomes:

- Jobs created and retained
- Sales created and retained
- Cost savings
- Investments

The study's purpose is to use client-reported outcomes to estimate the overall effect of NIST MEP on the U.S. economy. Using a model developed by Regional Economic Models, Inc. (REMI), the study estimates the indirect and induced effects of the reported increase in jobs, sales, cost savings, and investments by MEP clients.

This study updates the May 2019 report that estimated the economic impact analysis of MEP using survey results from FY2018 with survey results from FY2019.¹ The Team used the same methodology for FY2019 that Upjohn used for previous estimates.² The study uses the REMI model to estimate the induced and indirect effects of the impacts reported by MEP clients on the surveys administered. It takes the self-reported outcomes of MEP clients at face value, without attempting to validate the reported outcomes.

Three scenarios are presented to estimate the impact of the NIST MEP:

1. **Scenario 1** is the unconstrained approach in which it is assumed that an increase in sales of one firm does not affect or reduce the sales of another firm. This scenario does not consider the

¹ Robey, Jim, Randall Eberts, Brian Pittelko, and Claudette Robey. 2019. "The National-Level Economic Impact of the Manufacturing Extension Partnership (MEP): Estimates for Fiscal Year 2018." Prepared for National Institute of Standards and Technology (NIST) and Manufacturing Extension Partnership (MEP). <https://research.upjohn.org/cgi/viewcontent.cgi?article=1242&context=reports>

² The methodology for this report was developed by the Upjohn Institute and used in three previous [reports](#) for NIST on the national-level economic impact of the Manufacturing Extension Partnership. This report builds on these previous efforts and was completed in consultation with the Upjohn Institute.

displacement effects of competition among businesses on sales and employment, and is included to serve as an upper bound on the estimates.

2. **Scenario 2** is more realistic yet conservative. This scenario assumes that competition among firms mitigates the overall effects of the estimated increase in sales and employment since firms that do not benefit from the services rendered by MEP may lose market share to those that do, and thus grow less quickly than they would have otherwise and perhaps even lose sales and jobs.
3. **Scenario 3** estimates the fraction of reported outcomes required for the program to break even, as measured by the projected tax increases covering the annual cost of the program for FY2019 (\$140 million). This allows the study to determine whether the cost of the MEP is justified by the benefits it generates.

This MEP Economic Impact study showed lower aggregate impacts from the MEP National Network in FY2019 compared to FY2018. This likely reflects several factors, including the mix of industries served and how Center projects affected new and retained jobs and sales. While jobs are the primary driver in this analysis, other monetary measures, including lower production costs, investments, and other benefits of Center-client relationships, are important to creating the estimates of impacts. Each fiscal year, the benefits to clients change, as do the estimates of impacts.

This study finds the investment of federal dollars into the MEP Centers—\$140 million in FY2019—yields, in the most conservative model, a return to the Treasury of \$1.87 billion. This results in a calculated return on investment (ROI) of 13.4:1 (see **Table 1**). FY2018’s NIST MEP investment of \$140 million generated an economic and financial return of nearly 14.4:1.

Table 1: Estimates of NIST MEP Impacts for FY2019

Forecast	Jobs	GDP*	Output*	Personal Income*	Returns to Treasury*	Return on Investment
Unconstrained Model Using Industry Variables	674,257	\$80.2	\$149.7	\$43.9	\$5.93	42.3:1
Constrained Model Using Firm Variables	217,646	\$22.9	\$41.3	\$14.0	\$1.87	13.4:1
7.47% of Reported Impact	16,173	\$1.7	\$3.03	\$1.04	\$0.14	1:1

*Dollars in billions



II. MODELING THE NET IMPACT OF MEP ACTIVITIES

Modeling the Net Impact

The Hollings Manufacturing Extension Partnership (MEP), part of the National Institute of Standards and Technology (NIST), contracted with Summit Consulting and the Upjohn Institute (the Team) to estimate the economic impacts of the collective activities of its MEP Centers on the U.S. economy. The estimates are based on an independent survey of manufacturing clients sponsored by NIST MEP and conducted by the Fors Marsh Group. The survey asks clients to provide their estimates of the effect of MEP services and activities on their businesses with respect to jobs, sales, investments, and cost savings. The results used in this analysis covered projects completed in Fiscal Year 2019 (FY2019).

The Team made no attempt to validate the outcomes reported by MEP clients in the survey beyond the MEP verification process. The values were entered in an econometric model to forecast the overall impact of the MEP Centers. The method is consistent with established approaches estimating impacts of a given establishment on the local economy.

The study presents three scenarios and associated estimates of economic impact, as shown in Table 1.

The first scenario uses an unconstrained approach, which assumes that an increase in sales of one firm does not affect or reduce the sales of another firm. This assumption, while not entirely realistic, is the best one to estimate the impacts at the state level but likely less so at the national level. This scenario, and the use of industry variables, assumes that all product is exported out of the study region. Since this is unlikely as it applies to the macro economy, the findings are likely over estimated. Further, we do not recommend this scenario for the national estimates because it does not account for competition among firms and the displacement effects from competition across firms. We include the unconstrained scenario as an upper bound on the results.

The second scenario is more conservative and assumes that competition among firms reduces the outcomes. This scenario uses firm variables in Regional Economic Models, Inc. (REMI). It assumes that some production remains in the region (i.e., is not exported), which displaces competitors' production. While this scenario is more applicable to the macro study, it serves as a lower bound to the set of estimates.

The final scenario also uses firm variables to indicate the break-even point, or at what point the returns (based on the survey outcomes) would generate enough personal tax revenue to equal the MEP funding, which was \$140 million in FY2019. While it would be difficult to attribute all changes in firm behavior to the MEP Center-client relationship, the calculated break-even point suggests that if the MEP causally contributed to only about 7.5% of firm behavior, it would pay for itself and be revenue neutral.

The core of the analysis is the outcomes of MEP Center clients. The survey asks clients to quantify in dollars or numbers the following outcomes:

- Sales created or retained
- Jobs created or retained



- Investments in products or processes
- Investments in plants and equipment
- Investments in information systems and software, workforce practices, and employee skills
- Investments in other areas of business
- Production cost reduction through cost savings

Over 10,000 clients from across the country were surveyed. MEP Centers are in all 50 states and Puerto Rico. Each jurisdiction with a MEP presence obtained survey responses from their respective clients. The survey observations not identified with a North American Classification Industry System (NAICS) code and surveys from Puerto Rico are not included in this analysis, resulting in 228 observations included in the summary data but not in the economic impact estimates.³

This analysis does not construct a control group of randomly selected companies to compare the performance of creating new and retained jobs and sales or on cost savings and investments. This limits the causality that can be assigned to MEP efforts in assisting firms. Because of self-selection bias, firms opting to use MEP services may also be more inclined to invest in workforce training and plant, equipment, and other technology on their own. Similarly, MEP Center clients may be growing and better able to leverage MEP-based services in adding jobs and sales. Because the Team did not attempt to validate the accuracy of the outcomes reported in the survey, we present these caveats when interpreting results. These caveats are consistent with estimating the net impact on the local economy of a company that reports that it plans to expand its employment. In estimating the net impact of such an exogenous shock to a local economy, we typically take the company's plans at face value.

To be consistent with the methodology of prior net impact analyses, Upjohn followed a guide created by Mark Ehlen and M. Hayden Brown (2000), "A Guide for Estimating and Reporting Macroeconomic Impacts of MEP Centers."⁴ The guide provided a methodology to estimate economic impacts on a state, based on the collective outcomes of the client surveys served by each MEP Center. The guide also recommended the use of an economic impact model from REMI for creating estimates. Informed by the guide, Upjohn made several decisions regarding the use of the survey data and assumptions in the REMI model about the dynamics of the U.S. economy.

Decisions Regarding Data Elements

Although the survey captures both employment and sales outcomes, both cannot be used in the REMI model at the same time without double counting the effects of the outcomes associated with MEP activities. Either employment or sales should be used consistently when aggregating the responses. Contrary to the guide's suggestion, we chose to use the reported estimates of the number of jobs created or retained, when available, instead of sales. Our decision assumed that businesses are better able to estimate the impact of MEP activities on employment rather than sales. The reasoning is that firms typically keep close tabs on head count and are more likely to be able to attribute a change in the number of personnel to MEP projects. Sales, on the other hand, are more volatile and depend on

³ The REMI model only applies to the 50 states, not to U.S. territories.

⁴ Ehlen, Mark A., and M. Hayden Brown. 2000. "A Guide for Estimating and Reporting Macroeconomic Impacts of MEP Centers." NIST Interagency/Internal Report (NISTIR) – 6499, U.S. Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD. Last modified July 6, 2009.
<https://www.nist.gov/publications/guide-estimating-and-reporting-macroeconomic-impacts-mep-centers>

outside market factors beyond a firm's control. However, if employment change is not identified in the survey, sales are used and the model then calculates the number of additional workers required to generate the observed increase in sales.⁵

Another issue is the decision when to use investment data from the survey in the model. The REMI model allows either the model to determine the amount of investment that would be commensurate with employment (or sales) increase, or that feature of the model can be turned off and the amount reported from the survey can be used as an input in the model instead.

There are pros and cons to each approach. Using the investment estimated by the REMI model may overestimate the amount of capital expenditure induced by MEP activities, and the model would generate additional indirect and induced effects on employment and other outcomes based on the overestimate of the investment expenditures. Using the investment expenditures from the survey assumes that the firms have accurately attributed additional investment expenditures to MEP projects and that these are consistent with what is needed to accommodate increased sales and additional personnel. Neither approach is completely satisfactory. We view the results from entering reported investment expenditures as a more conservative approach since it is possible that firms that do not report investment expenditures (investment expenditures that are less than needed to accommodate sales or employment increases) may have excess capacity due to prior investments or slack demand.⁶

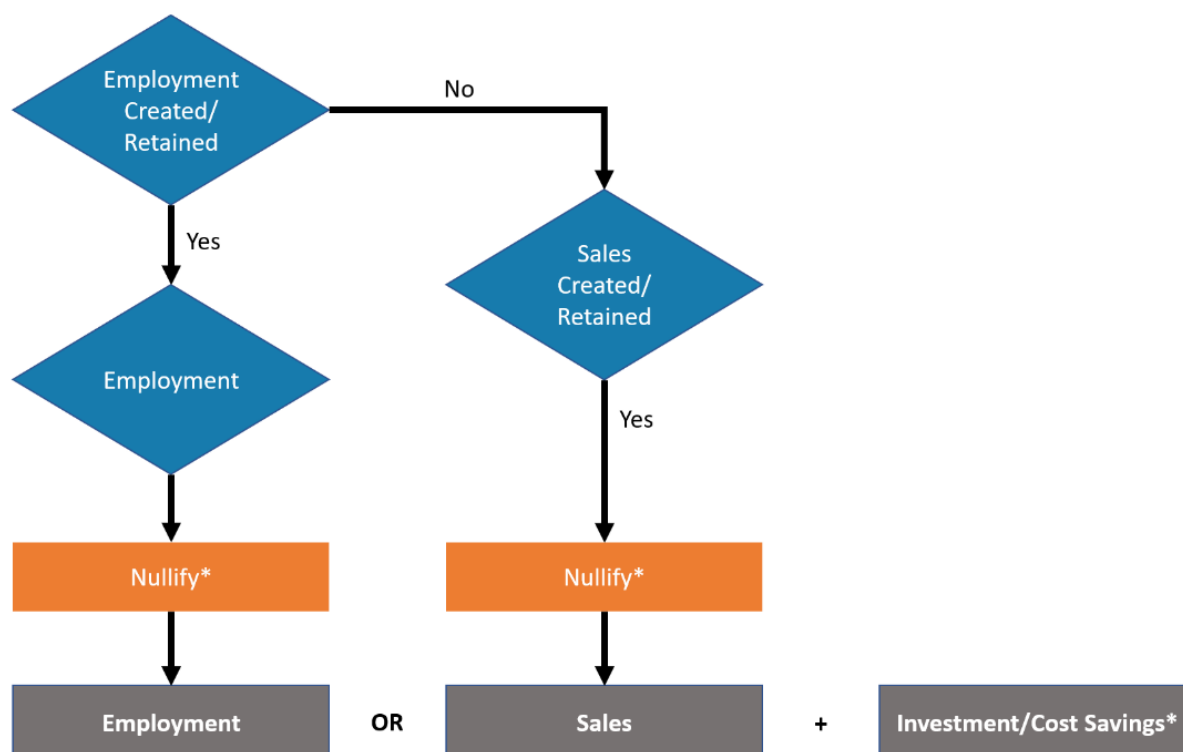
In Upjohn's version of the REMI model, it is possible to "nullify" capital investment caused by changes in sales and employment, assuming new jobs and sales use existing capital stocks. Within the MEP survey and as noted above, data on several production-related investments were collected and were used in place of the assumed changes in capital stock. This change in methodology provides a more realistic view of impacts on the national economy.

Figure 1 provides a graphical representation of the decision tree.

⁵ Appendix C provides further analysis of the decision to backfill sales when employment was missing.

⁶ Appendix D provides further analysis of the decision to include investment survey outcomes in the model.

Figure 1: The Team's Decision Tree for Using Survey Data



Assumptions Regarding Market Dynamics

Since Ehlen and Brown's (2000) development of the guide, REMI has added some policy variables that are helpful in estimating impacts at the macro level. Part of the dilemma with this research is in attempting to estimate the effect that helping one company has on others who do not receive help from a MEP Center. Ehlen and Brown refer to this as "beggar thy neighbor" and define it as "in the course of improving one's own condition, making a neighbor worse off" (2000, p. 39). They continue with "[R]elevant to state impacts, the sales increases that MEP clients report may only be displacing the sales of other in-state firms ..." (p. 39). While this is true at the state level, it is exacerbated at the national level when the only mitigating factors that do not affect other companies are when there is either import substitution and/or increases in exports for that firm. REMI offers a solution by allowing sales and employment to be placed in a number of policy variables, including ones that assume all new output is exported and ones that assume more productive firms will "crowd out" their less productive competitors. The "crowding out" or competitive scenario is more realistic and yields a more conservative estimate of the outcomes than the unconstrained or noncompetitive approach.

III. SURVEY RESPONSES FROM MEP CLIENTS

Survey Responses

This section summarizes the survey responses of MEP client firms collected by Fors Marsh. MEP clients were asked to indicate whether they believed that MEP activities affected each element of possible business outcomes. If they responded “yes,” the respondent was asked to provide a quantitative estimate of the MEP impact for that specific outcome, such as the number of jobs created or the dollar amount of cost savings. Of the 10,262 clients surveyed in FY2019, 8,424 (82.1%) responded to the survey.

In **Table 2**, the percentage of “yes” responses ranged from 19.8% (other investments) to 53.5% (investment in workforce training). Only 312 clients responded “yes” to all 11 elements and provided a quantitative estimate of the impact. Fifty-seven percent of clients who responded to the employment questions indicated creating jobs, retaining jobs, or both as a result of the program. Twenty-five percent of clients who responded to the sales questions indicated a positive response to both increased and retained sales. Of those who responded to all four employment and sales questions (8,419), about 41% responded that they had positive effects in both employment and sales, and only 18% responded “no” to all employment and sales questions. **Table 3** provides a summary of MEP Center results in FY2019.

Although most surveys did not indicate positive effects on all variables, we sum the responses at the state and national levels and treat the aggregate numbers as an overall direct effect (to MEP clients) of MEP activities.

Table 2: Survey Responses for FY2019

Data Element	Number of Responses	Indicated MEP Had a Positive Impact	
		Number	Percent
Number of Jobs Created	8,422	3,244	38.5%
Number of Jobs Retained	8,421	3,876	46.0%
Increase in Sales	8,423	2,900	34.4%
Retained Sales	8,420	3,189	37.9%
Cost Savings	8,422	4,231	50.2%
Investment in Plant and Equipment	8,421	3,649	43.3%
Investment in Products and Processes	8,421	3,417	40.6%
Investment in Information Systems	8,422	2,670	31.7%
Investment in Workforce Training	8,421	4,503	53.5%
Other Investments	8,421	1,670	19.8%
Investment Savings	8,424	2,950	35.0%
At Least One Positive Response	8,424	7,111	84.4%



Table 3: A Summary of MEP Center Results for U.S. Manufacturers in FY2019

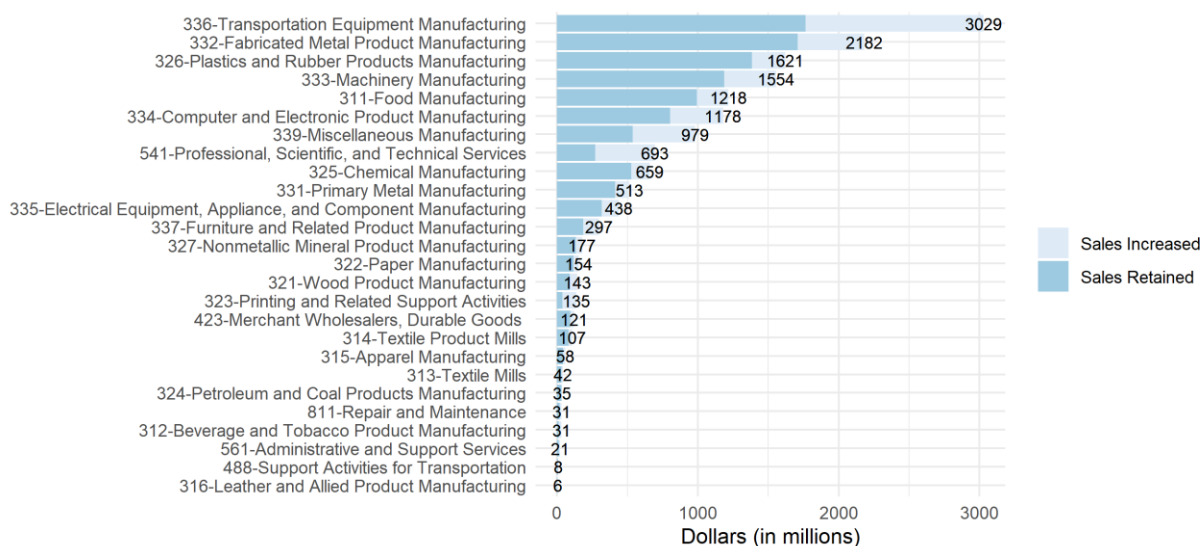
Sales		\$15.7b	Total Investment	\$4.5b
New		\$4.7b	Products and Process	\$1.4b
Retained		\$11.0b	Plant and Equipment	\$2.4b
Jobs		114,650	Information Systems	\$256m
Created		28,132	Workforce	\$228m
Retained		86,518	Other	\$201m
Cost Savings		\$1.1b		
Investment Savings		\$432m		

Overall, the top five industries are consistent across the analyzed outcomes. Transportation Equipment Manufacturing (NAICS 336), Fabricated Metal Product Manufacturing (NAICS 332), Machinery Manufacturing (NAICS 333), Plastics and Rubber Product Manufacturing (NAICS 326), and Food Manufacturing (NAICS 311) account for the bulk of positive impacts delivered via the MEP Centers.

Overview of Sales

In **Figure 2**, most of the industries' positive sales effects were from retained sales rather than increasing sales. Except for Transportation Equipment Manufacturing (NAICS 336) and Professional, Scientific and Technical Services (NAICS 541), retained sales accounted for well over half of the sales effects.

Figure 2: Total Sales by Industries (Top Industries), in Millions



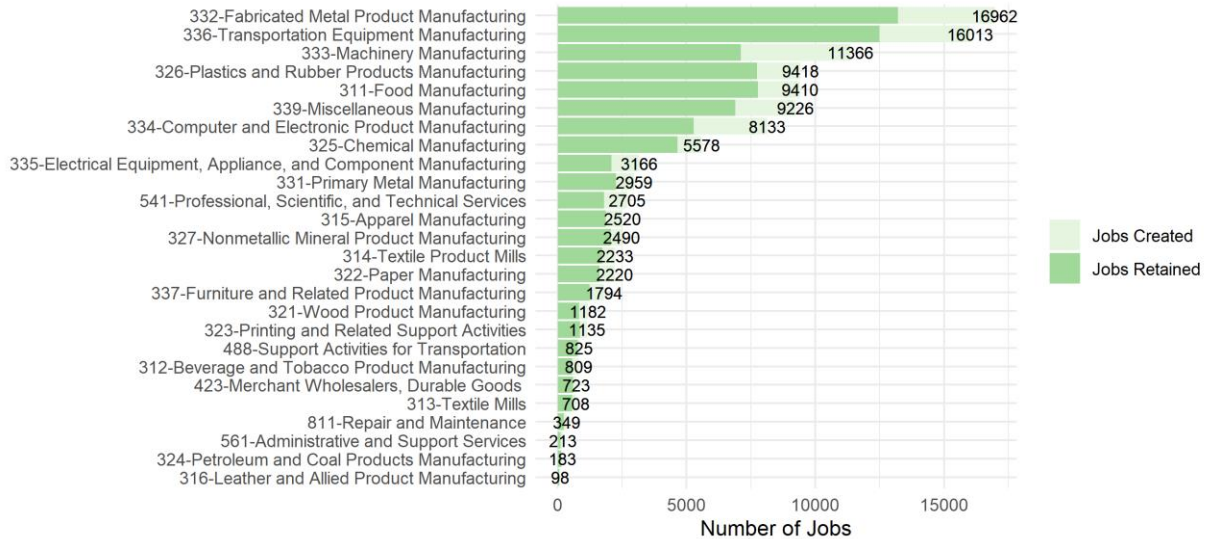
Overview of Jobs

Figure 3 shows the number of created and retained jobs by industry and mirrors the general results reported for sales. There were a few notable differences. Fabricated Metal Product Manufacturing (NAICS 332) and Transportation Equipment Manufacturing (NAICS 336) experienced the largest positive effects in both sales and jobs. Less labor-intensive industries, such as Professional, Scientific, and Technical Services (NAICS 541), experienced a far lower impact on employment per dollar of impacted



sales than more labor-intensive industries, like Apparel Manufacturing (NAICS 315) and Textile Mills (NAICS 313).

Figure 3: Jobs by Industry (Top Industries)



Overview of Investments

Most of the investments were in plants and equipment (\$2.4 billion) and in new products and processes (\$1.4 billion) (see **Figure 4**). Investments in information systems and the workforce were almost the same.

Figure 4: Breakdown of Investments

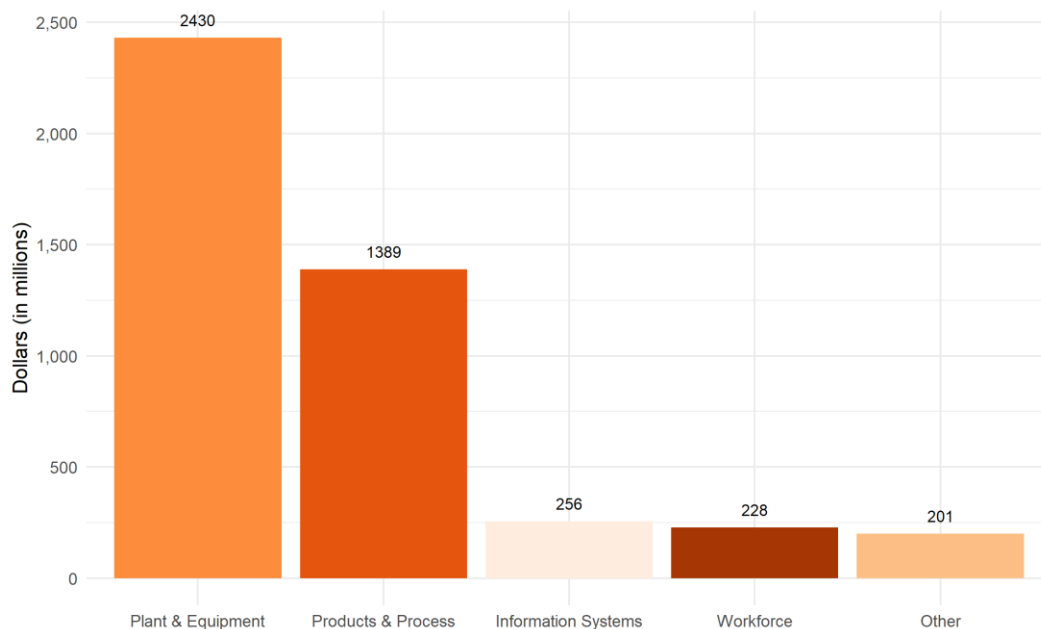
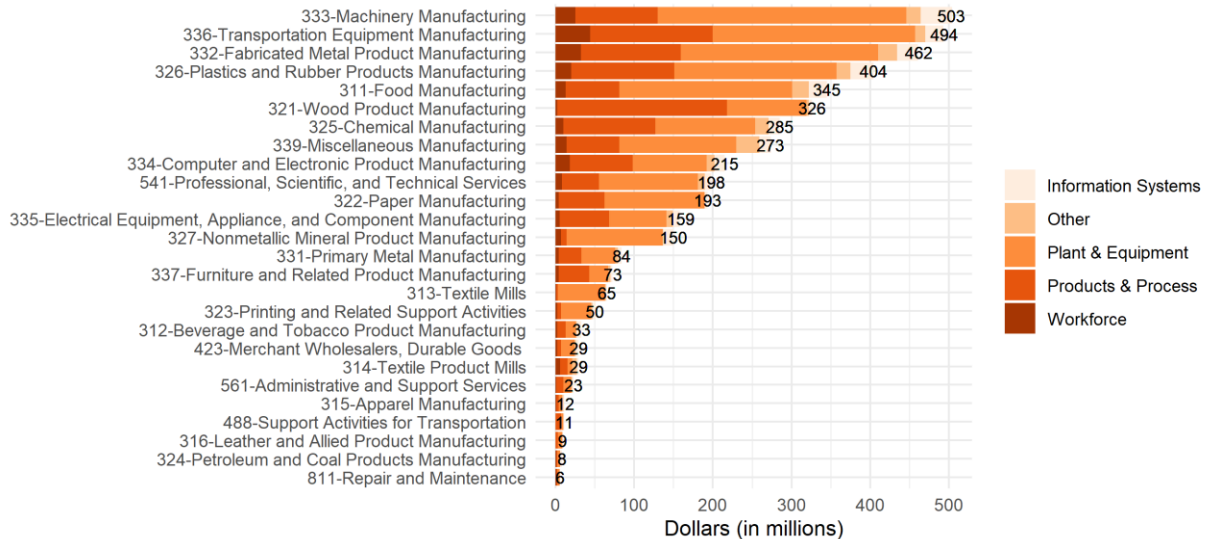


Figure 5 shows the breakdown of total investments by industry, which remains consistent across the NAICS codes.

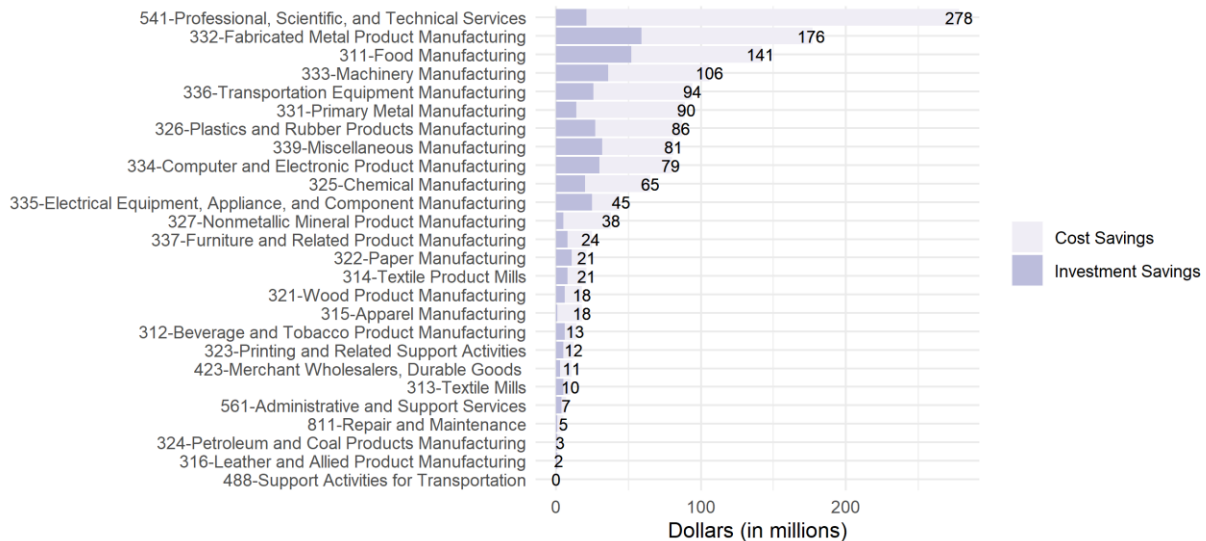
Figure 5: Investments by Industry (Top Industries), in Millions



Cost Savings and Investment Savings

Figure 6 examines the industries with the highest aggregate cost savings. The ranking of industries is somewhat different. Professional, Scientific, and Technical Services (NAICS 541) is a clear outlier with a total of \$278 million in savings, a 58% difference over the next-highest value of \$176 million. Cost savings composed a larger share of savings than investment savings across most industries.

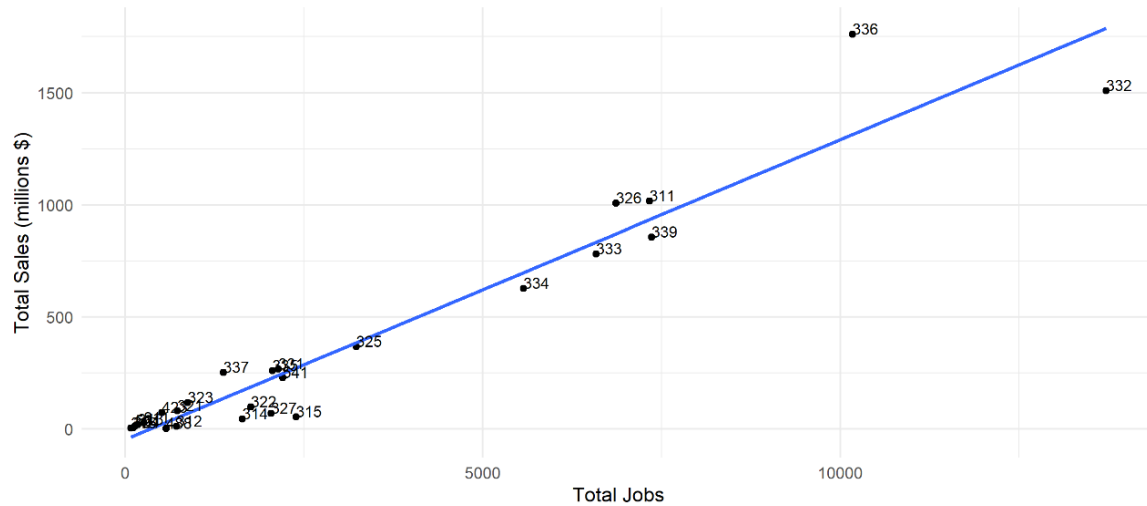
Figure 6: Total Savings by Industry (Top Industries), in Millions



Sales and Jobs

Figure 7 shows a positive linear relationship between total sales and total jobs created or retained. Transportation Equipment Manufacturing (NAICS 336) is well above the line, indicating that it had much higher sales impacts relative to jobs impacts than other industries.

Figure 7: Total Sales and Total Jobs (Millions of \$) by NAICS



Note: Appendix B provides a list of the NAICS code descriptions



IV. ECONOMIC IMPACTS FOR FY2019

This section summarizes the economic impact results for FY2019, shown in Table 1. This study finds that the federal investment of \$140 million into the MEP Centers yields a return to the Treasury of about \$1.87 billion, for a return on investment (ROI) of 13.4:1, based on the more conservative, firm-based estimate.

Using the firm-based scenario, MEP and its Centers contributed to the addition of an estimated 217,646 jobs to what was a strong economy. In addition, the combined efforts added just over \$41 billion in output, an additional \$23 billion in gross domestic product (GDP), and about \$14 billion in personal income to the economy in FY2019.

While the first scenario's unconstrained approach, which uses industry variables and assumes all goods and services produced are exported, is unrealistic, it does provide a set of upper bounds of MEP's effect on the economy. This scenario estimates that MEP contributed to the addition of 674,257 jobs, nearly \$150 billion in additional output, an increase of about \$80 billion in GDP, and nearly \$44 billion more in personal income.

Finally, at the estimated break-even point, investment in NIST MEP contributes to the addition of about 16,173 jobs, just over \$3 billion in output, \$1.7 billion in GDP, and \$1.04 billion in income.



V. CHANGES FROM 2018 TO 2019

Year-to-year variation across the annual client surveys and the REMI model could complicate the comparisons of MEP impacts over time. Differences in MEP impacts across years may be associated with differences in the following factors:

- Survey completion rate
- Completion rate of key questions, such as the client's estimate of number of jobs created due to MEP services
- Employment size of each client establishment
- NAICS-based industry mix, measured by the employment base
- Job creation rate by industry by year (number of jobs the client says were created because of MEP assistance divided by the employment base)

We explored each of these potential discrepancies between FY2018 and FY2019 to determine whether annual comparisons could be made without adjustment. Our findings are summarized in Table 4 and described in this section. We determined that no adjustments need to be made to make reliable comparisons of the FY2018 and FY2019 impact estimates.

Table 4: Summary of FY2018 and FY2019 Comparisons

Metric	2018	2019	Change
Survey Completion Rate	83.9%	82.1%	-1.8pp
Survey Responses	9,588	10,291	+7.3%
Job creation			
Number of Clients Reporting Positive Job Creation Impact	3,401	3,253	-148
Percent of Clients Reporting Positive Job Creation Impact	47.1%	38.5%	-8.6pp
Number of Jobs Created	26,848	28,218	+5.1%
Job Retention			
Number of Clients Reporting Positive Job Retention Impact	3,860	3,887	+0.7%
Percent of Clients Reporting Positive Job Retention Impact	48.0%	46.0%	-2pp
Number of Jobs Retained	96,080	86,744	-9.7%
Employment base			
Employees	1,007,469	1,007,471	<0.1%
Average Number of Employees	105.7	98.4	-7.3

Note: The number of survey responses is different than the number of clients for the FY2018 and FY2019 comparisons. The Dun & Bradstreet (D&B) client ID was the merging variable for the two datasets, which create some duplicate observations in each of the annual survey datasets. These are treated as separate observations for comparison analyses. Employment base only includes clients with non-missing NAICS codes.

We used the FY2018 MEP survey data and the FY2019 MEP survey data for our comparisons and divided these data into three groups (see Figure 8):

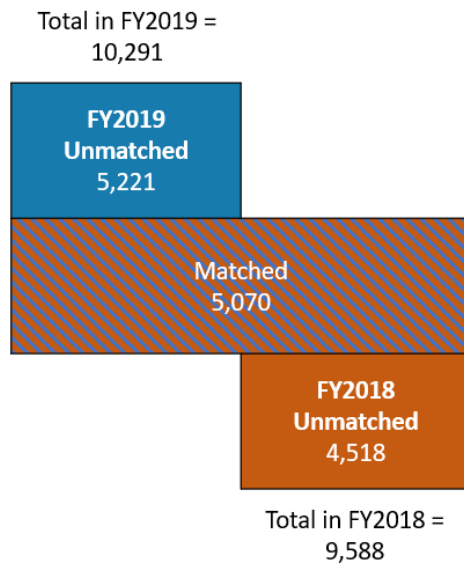
- The first group (matched group) consists of clients who responded to the survey in both years and is matched based on their D&B ID codes.
- The second group (FY2019 unmatched group) includes respondents from 2018-4 through 2019-3 who were not surveyed in FY2018.



- The third group (FY2018 unmatched group) consists of respondents from 2017-4 through 2018-3 who were not surveyed in FY2019.

The matched group provides a control for understanding differences between the same respondents in the two surveys.

Figure 8: Depiction of the Client Groups



Note: The number of observations is different than the number of clients for the FY2018 and FY2019 comparisons. The D&B client ID was the merging variable for the two datasets, which create some duplicate observations in each of the annual survey datasets. These are treated as separate observations for comparison analyses.

As shown in Table 5, most of the survey responses for the matched group were filled out about a year apart.

Table 5: Matched Group Clients and Survey Quarters

Survey Quarter	FY2018 Q1	FY2018 Q2	FY2018 Q3	FY2018 Q4	Total
FY2019 Q1	1,241	8	3	14	1,266
FY2019 Q2	78	1,032	10	12	1,132
FY2019 Q3	78	87	1,183	5	1,353
FY2019 Q4	45	64	87	1,123	1,319
Total	1,442	1,191	1,283	1,154	5,070

Survey Completion Rate

We compared the survey completion rates for FY2018 and FY2019 and determined that the MEP impact results could be reliably compared based on the small discrepancy.

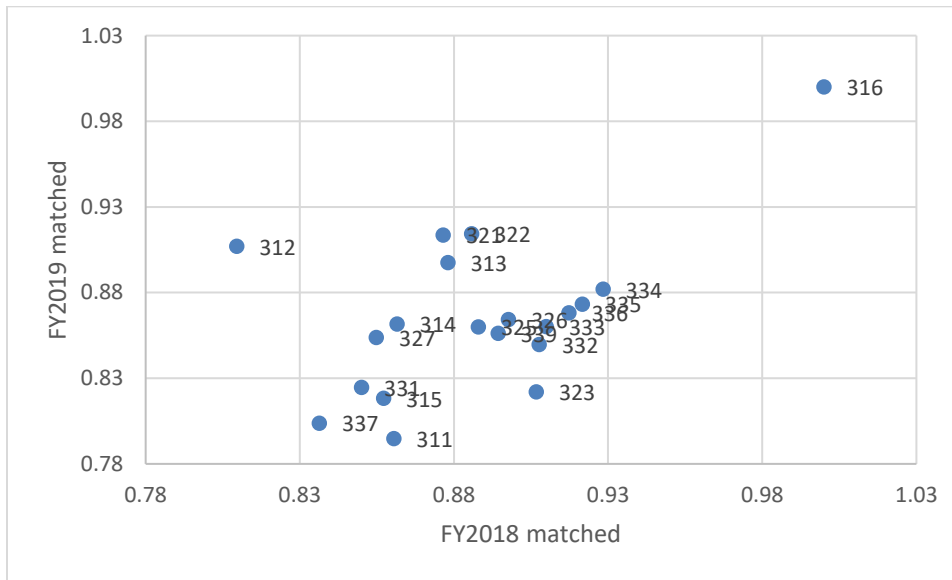
The "Survey Outcome Code" field indicates whether a client completed the survey (code 401) or not (code 049). For the matched group, 89.5% completed the survey in FY2018 and 85.3% completed the



survey in FY2019. The overall completion rate for FY2019 (82.1%) is slightly lower than the completion rate for FY2018 (83.9%). However, because the number of clients in FY2019 was higher, there were more completed surveys in FY2019 than there were in FY2018.

Figure 9 shows that completion rates for the matched group by industry were inconsistent between FY2018 and FY2019, with a correlation coefficient of 0.45.

Figure 9: Completion Rates by Industry, Matched Group Only



Note: NAICS code descriptions can be found in Appendix B.

Job Creation

For each survey outcome (e.g., job creation or increase in sales), the respondents were asked whether MEP services impacted that outcome and were given three options: “yes” (coded with a 1), “no” (coded with a 2), and “I don’t know” (coded with an 8). The sales and employment categories are most important for the analysis because they drive most of MEP’s economic impact estimates.

Table 6 compares the percentage of responses that indicated MEP positively impacted the employment and sales outcomes between FY2018 and FY2019 for the matched group. The percentage of those who said MEP services helped create jobs was about 4 percentage points lower in FY2019. The other outcomes were generally consistent between the two fiscal years.

Table 6: Comparison of Positive Jobs and Sales Outcome Responses, Matched Group Only

Outcome		Percentage of Respondents who Indicated Positive Impact	
		FY2018	FY2019
Jobs	Created	47.6%	43.7%
	Retained	53.1%	51.8%
Sales	Increased	42.2%	40.9%
	Retained	46.5%	45.1%



Table 7 shows that for both years, only about 10% of respondents did not know (coded 8) whether MEP services contributed to job creation. For the matched file, only 96 clients out of 4,040 (or 2.4%) responded that they did not know on both surveys.

Table 7: Comparison of Job Creation Responses, Matched and Unmatched Groups

Job Creation Code	FY2018		FY2019	
	Number	Percentage	Number	Percentage
Yes (1)	3,401	42.3%	3,253	38.5%
No (2)	3,789	47.1%	4,313	51.1%
I don't know (8)	858	10.7%	881	10.4%
Total	8,048		8,447	

Employment Base

We defined the employment base as the total number of employees in a client's firm. Although there were some differences in employment base between FY2018 and FY2019, differences were largely based on a few outlier firms and do not undermine the reliability of comparisons between the MEP impacts across years.

D&B provided the number of employees for all but 33 of more than 10,000 surveys. For the FY2019 sample, the average number of employees was 98 and the median was 38.

Because the employee base was available for most of the clients who did not respond to the survey, we were able to compare the size of the establishments for respondents versus nonrespondents. Nonrespondents tended to be larger (i.e., had more employees) than the survey respondents. Firms who completed the survey had an average of 93 employees, and firms who did not complete the survey had an average of 119 employees.

Similarly, respondents in the FY2018 survey had fewer employees on average than the nonrespondents. FY2019 had a few outlier establishments with hundreds of thousands of employees, and the average difference between respondents and nonrespondents was larger than the average difference in FY2018. These differences mean there is some variation across the two years in the number of employees entered in the REMI model.

Industry Base

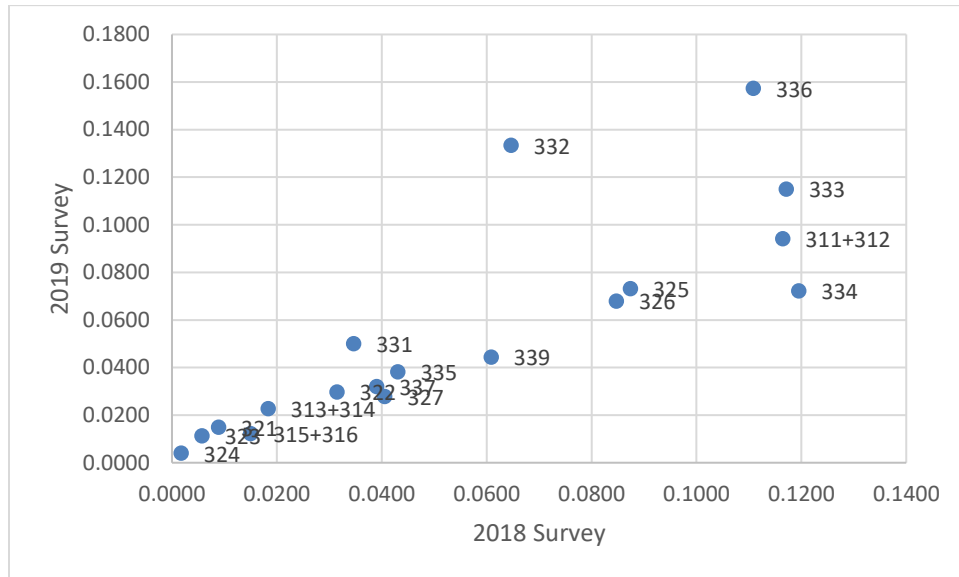
We compared the employment shares of each industry for FY2018 and FY2019 and determined that they were largely consistent and do not require adjustment when comparing MEP impacts across years.

Figure 10 shows the alignment of employment shares between the FY2019 survey and the FY2018 survey. The correlation coefficient is 0.828. Three sectors stand out—Fabricated Metals (332), Computer and Electronics Components (334), and Transportation Equipment (336). Sectors 332 and 336 had larger employment shares in the 2019 survey compared to the 2018 survey, which means that more establishments or larger establishments in these sectors came to MEP for assistance in FY2019 than in FY2018. Sector 334 had a lower employment share in FY2019, meaning fewer and/or smaller firms from this sector came to MEP for assistance in FY2019 than in FY2018. We have no reason to believe these



differences reflect anything other than client needs, and we made no adjustments to account for them when comparing the MEP impacts across FY2018 and FY2019.

Figure 10: Comparison of Manufacturing Employment Shares for FY2018 and FY2019, Matched Group Only

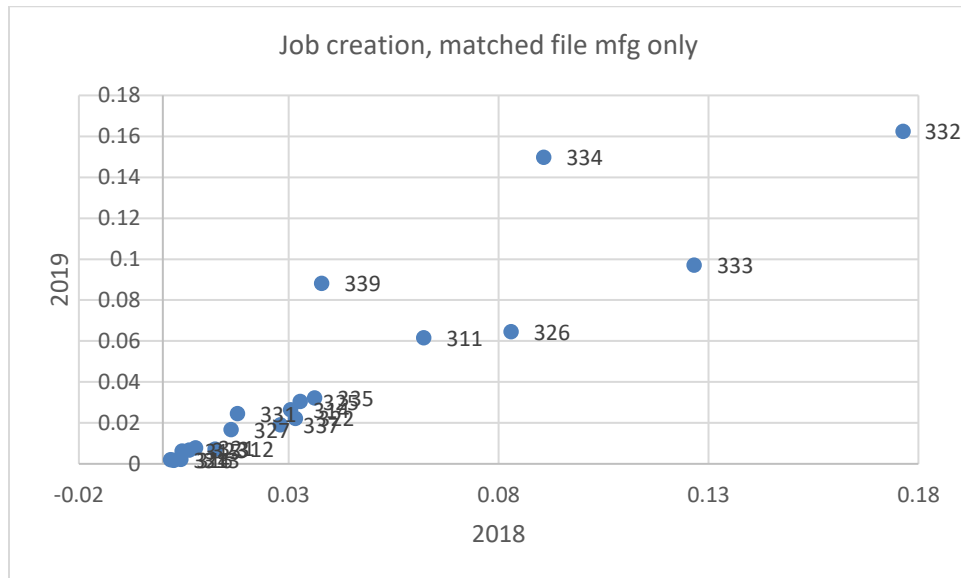


Note: NAICS code descriptions can be found in Appendix B.

Job Creation Rate

The job creation rate is defined as the respondent's estimated number of jobs created as a result of MEP assistance divided by the number of employees in the establishment. **Figure 11** compares the job creation rate between FY2018 and FY2019 by industry. The job creation rate is consistent for the two years. Computers and Electronic Products (334) and Miscellaneous Manufacturing (339) had higher job creating rates in FY2019. Again, we took these differences at face value and did not make any adjustments.

Figure 11: Comparison of Job Creation Rate by Industry, Matched Group Only



Note: NAICS code descriptions can be found in Appendix B.

Total Hours in the Program

We compared the total hours spent by Cooperative Agreement Recipients (CARs) as reported in the surveys. The 2019 survey reports that CARs spent 692,120 total hours serving clients compared with 700,573 total hours in 2018, a decline of 1.2%. Therefore, while the number of clients increased by 7.5% from 2018 to 2019, the number of hours decreased by 1.2%.⁷

However, when restricting the analysis to the matched group, the opposite was true. CARs spent 37,000 more hours with clients, an increase of 8.4% from 443,536 hours in FY2018 to 480,586 hours in FY2019. This amounted to an average of 95 hours per client in 2019 compared with 87.6 hours per client in 2018. Perhaps many projects delivered by MEP Centers build on smaller projects over time, creating larger, more impactful engagements. It can also reflect budget restrictions coupled with increased client demand. Regardless of the reasons, one would expect hours to increase with the number of clients served, which is not the case in looking at the surveys for these two years.

⁷ Results in this section only include clients with non-missing NAICS codes.

APPENDIX A Economic Outcome Definitions

As with most economic impact studies, this study focuses on four main economic outcome variables and a tax revenue variable:

- Jobs created or retained
- Change in GDP
- Change in income
- Change in gross output
- Returns to the U.S. Treasury (tax revenue)

The REMI model generates these outcomes for the national economy, using the survey responses as inputs. Each of the five variables are described in this section.

Jobs Created or Retained

The estimated number of jobs created or retained by MEP activities are simply “jobs” as counted by the U.S. Bureau of Economic Analysis (BEA) and can be either full- or part-time positions. They are likely distributed across multiple industries. In any given industry, a “job” may represent a summation of positions across several industries in which each industry has less than one complete position. For example, the impact study may report one “job,” but the spending patterns in the study may generate positions in three industries. However, each industry may require only one-third of a person. In this case, the three industries that employ one-third of a person each to meet demand would sum to one “job” in the REMI model.

Employment is composed of three elements:

- Direct – The employment created by actual investment, growth, or change
- Indirect – The employment created by the need of the new firm to purchase goods and services, essentially the local supply chain
- Induced – The household that supplies goods and services to the workers in the prior two elements. Examples include education, dry cleaners, accountants, gas stations, lawyers, and grocers.

Gross Domestic Product

GDP is an economic measure of the value of goods and services produced within the U.S. It is the broadest measure of economic activity within a region or country. It consists of compensation of employees; taxes on production and imports, less subsidies; and gross operating surplus. It does not include intermediate inputs, so it is a measure of the value that labor and capital contribute to production.

Income

National income is the goods and services produced by citizens and residents of the U.S. (i.e., gross national product) minus the consumption of fixed capital (i.e., depreciation).

Gross Output

Gross output includes both GDP and expenditures on intermediate inputs. In that way, it is considered double counting, but it is an essential statistical tool to understand the interrelationships between industries. Gross output is principally a measure of an industry's sales or receipts, so it is like the sales reported by individual MEP clients. For the purposes of the model, the sales and receipts are aggregated at the national level.

Returns to the U.S. Treasury

Returns to the U.S. Treasury are estimated using average (mean) personal income for all additional workers (direct, indirect, and induced) who were employed as a result of MEP client activities. Using 2018 Internal Revenue Service (IRS) tax tables, the tax incidence for the mean wage is estimated and then applied to all workers. Although this is an estimate, we acknowledge that some workers will earn more than the average and some will earn less. Similarly, some workers will pay more taxes than the reported value and some will pay less. Note that the average tax based on the average wage is not discounted by any legal form of tax adjustment, including short form or itemized deductions. In tax year 2018, the tables were published for categories single, married filing separately, married filing jointly, and head of household. For purposes of this study, the "head of household" tax rate was applied to estimates of average income.

APPENDIX B NAICS Codes

NAICS Code	Industry
311	Food Manufacturing
312	Beverage and Tobacco Product Manufacturing
313	Textile Mills
314	Textile Product Mills
315	Apparel Manufacturing
316	Leather and Allied Product Manufacturing
321	Wood Product Manufacturing
322	Paper Manufacturing
323	Printing and Related Support Activities
324	Petroleum and Coal Products Manufacturing
325	Chemical Manufacturing
326	Plastics and Rubber Products Manufacturing
327	Nonmetallic Mineral Product Manufacturing
331	Primary Metal Manufacturing
332	Fabricated Metal Product Manufacturing
333	Machinery Manufacturing
334	Computer and Electronic Product Manufacturing
335	Electrical Equipment, Appliance, and Component Manufacturing
336	Transportation Equipment Manufacturing
337	Furniture and Related Product Manufacturing
339	Miscellaneous Manufacturing
423	Merchant Wholesalers, Durable Goods
488	Support Activities for Transportation
541	Professional, Scientific, and Technical Services
561	Administrative and Support Services
811	Repair and Maintenance



APPENDIX C Use of Sales Outcomes When Employment is Missing

When job information was unavailable, the model relied on sales. Table 8 and Table 9 provide cross tabulations between the jobs and sales metrics in FY2019. Generally, most of the respondents who experienced benefits in employment also experienced benefits in sales, and those who responded “No” to jobs were also more likely to respond “No” to sales. There were more “I don’t know” responses for the sales questions than the jobs questions. This may be because jobs are more easily observable and memorable (e.g., meeting new hires) than increased sales, which would require some knowledge of the company’s financial information. Still, these tables indicate that sales information is appropriate to use when employment information is unavailable.

Table 8: FY2019 Comparison of Created Jobs and Increased Sales Responses

		Increased Sales			
		<i>Yes</i>	<i>No</i>	<i>I don't know</i>	<i>Total</i>
Created Jobs	<i>Yes</i>	2,055	611	578	3,244
	<i>No</i>	743	2,629	926	4,298
	<i>I don't know</i>	101	109	670	880
	<i>Total</i>	2,899	3,349	2,174	8,422

Table 9: FY2019 Comparison of Retained Jobs and Retained Sales Responses

		Retained Sales			
		<i>Yes</i>	<i>No</i>	<i>I don't know</i>	<i>Total</i>
Retained Jobs	<i>Yes</i>	2,576	606	693	3,875
	<i>No</i>	450	2,061	624	3,135
	<i>I don't know</i>	162	212	1,035	1,409
	<i>Total</i>	3,188	2,879	2,352	8,419

APPENDIX D Use of Investments and Savings in REMI

The cost savings and investment questions had lower response rates than the employment and sales questions. Still, we were able to examine whether they were appropriate to use in the model by estimating production function models using sales as the output measure and examining their coefficients for reasonableness. Based on the model results, we used the investment and savings survey responses in the model and determined they may be close to the production functions included in the REMI model.

We include two sets of models of the production functions. The first set uses the increase in sales as the dependent variable, and job creation and each investment type as the independent variables. The second set uses sales retention as the dependent variable, and the amount of jobs retained and each cost savings category as the independent variables. The regressions include dummy variables for the three-digit NAICS codes.

The coefficients of capital and labor are all statistically significant in all the models. The two coefficients for each type of capital investment sum to around 1, which suggests that the production functions are somewhat close to Cobb-Douglas production functions, with constant returns to scale or with slightly increasing returns to scale. In the last model (retained sales, cost savings, and job retention), the two coefficients sum to 1.17, which suggests increasing returns to scale higher than any other models.

Table 10: Production Function Model Outputs

<i>Dependent Variable: Increase in Sales</i>				
Type of Capital	Investment Coefficient	Job Creation Coefficient	R-Squared	Number of Observations
Products & Process	0.410 (13.02)	0.587 (10.72)	0.36	928
Plant & Equipment	0.358 (11.92)	0.574 (10.60)	0.349	967
Information Systems	0.356 (8.66)	0.742 (11.18)	0.346	713
Other	0.323 (7.02)	0.741 (10.39)	0.353	506
<i>Dependent Variable: Retained Sales</i>				
Type of Capital	Savings Coefficient	Job Retention Coefficient	R-Squared	Number of Observations
Save Investment	0.263 (6.72)	0.842 (17.74)	0.391	774
Cost of Savings	0.463 (15.16)	0.708 (18.79)	0.438	1,111

