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The Effect of the COVID-19 Pandemic on Ohio Manufacturing

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Prepared by:
Research Team Led by
Iryna V. Lendel, Ph.D.

September 2021

**The Effect of the
COVID-19
Pandemic on Ohio
Manufacturing**

**Center for
Economic
Development**

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TABLE OF CONTENTS

About The Research Team	3
Acknowledgements	3
Introduction	4
Employment.....	4
Output and Productivity.....	5
Industry 4.0 and Manufacturing	11
Looking Forward	15
Conclusion.....	18

LIST OF FIGURES

Figure 1. Employment Trends, 2012-2020.....	4
Figure 2. GDP Trends, 2012-2020	5
Figure 3. Ohio Manufacturing Employment, 1970-2020	6
Figure 4. Ohio Manufacturing GDP, 1978-2020.....	6
Figure 5. Productivity Trends, 2010-2020	10

LIST OF TABLES

Table 1. Top 10 Largest Ohio Manufacturing Industries by GDP and Their Relations To The Ohio Steel Cluster.....	7
Table 2. Top 10 Ohio Manufacturing Industries by Productivity.....	11

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ACKNOWLEDGEMENTS

This research was prepared using Federal funds under award ED20CHI3070034 from the U.S. Economic Development Administration, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are the authors' and do not necessarily reflect the views of the U.S. Economic Development Administration or the U.S. Department of Commerce.

This report was formatted by Aleksandar Milosevic, a graduate research assistant at the Center, who also contributed to the "Looking Forward" section of the report.

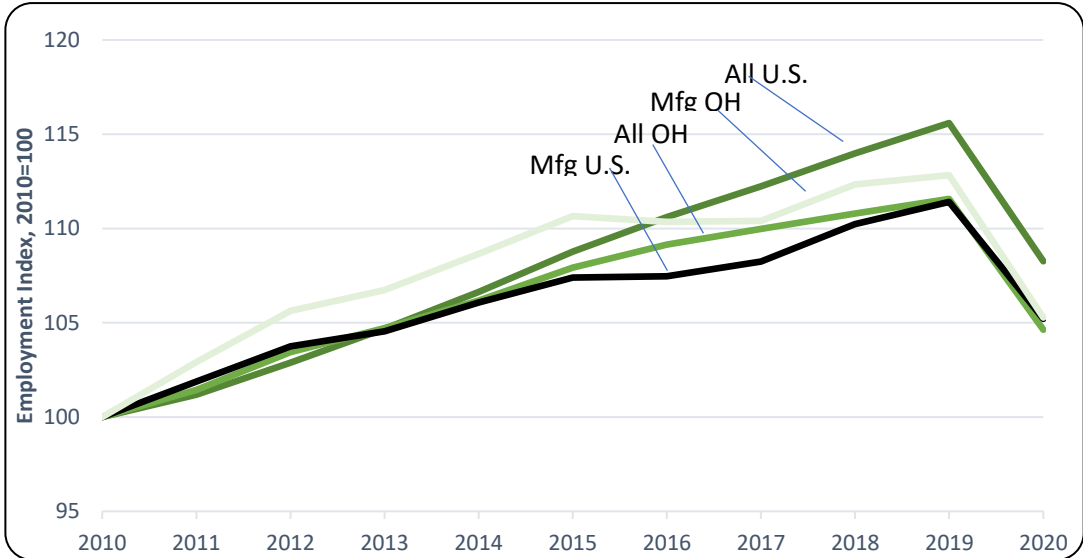
INTRODUCTION

Covid-19 created unprecedented challenges for many industries in Ohio. The closure of businesses in March of 2020 caused many employers to cease operations, including manufacturers. However, some manufacturing businesses were able to continue operations, creating products necessary to fight the pandemic; consequently, those businesses were considered "essential." Although many manufacturing companies continued to work during the lockdown and even increased their production, the Ohio Manufacturing sector overall experienced losses and challenges during the pandemic. Layoffs, supply chain disruptions, and changes in consumer demand all contributed to the uncertainty in the sector’s operations. This research brief analyzes the degree to which producing essential items kept some manufacturing companies from larger losses while also examining other factors impacting the changes in manufacturing productivity and workforce.

EMPLOYMENT

The manufacturing employment in Ohio showed a downward trend from 2010 to 2019. However, manufacturing remained a sizeable industry in Ohio in 2020, employing roughly 650,000 people across the state and accounting for 12.4% of total employment. Due to the pandemic, though, employment went down over 46,000 jobs (a 6.7% loss in employment) from 2019 to 2020, according to Moody’s Economy.com. In comparison, the United States overall saw a 5.8% decline. According to TeamNEO, total employment levels in Northeast Ohio for all industries will not return to pre-pandemic levels until 2025.¹

FIGURE 1. EMPLOYMENT TRENDS, 2012-2020



Prepared by the Center for Economic Development using Moody’s Analytics Data

A major problem with these employment losses is that production occupations, which comprise most manufacturing occupations, have a dim future for well-paying jobs.

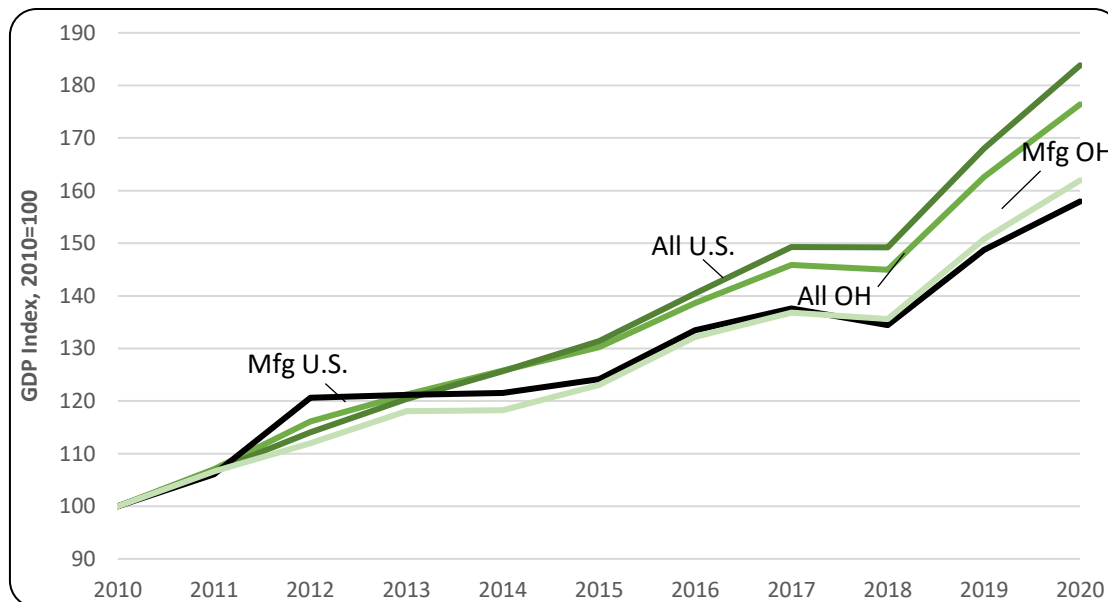
¹ TeamNEO (2021, March). “Post-pandemic economic projections.”

According to the Bureau of Labor Statistics (BLS), the average wage of production occupations in Ohio is \$41,357. Although this wage appears lower than the average wage of all occupations (\$51,510), the average wage of production occupations may not account for overtime and shift work that is prevalent in such occupations. Moreover, thirty-three of all production occupations make more than the average production occupation wage, ranging from \$41,410 (Extruding and Forming Machine Setters; Operators; and Tenders, Synthetic and Glass Fibers) to \$87,400 (Power Distributors and Dispatchers). Unfortunately, the BLS projects that production occupations across the US will decline 4%, with a loss of about 423,200 jobs from 2019 to 2029.² Similar trends are predicted by the Ohio Department of Job and Family Services (a decline of 5.4% by 2028).³

OUTPUT AND PRODUCTIVITY

In contrast, output and productivity are increasing. Overall, output has steadily risen for both manufacturing and all industries in Ohio and the United States. All industries in Ohio grew by 76% over the last ten years and grew by 13% from 2019 to 2020. This growth equates to an increase of \$781 billion. Ohio manufacturing also expanded over the last ten years by 58% and by 9% from 2019 to 2020.

FIGURE 2. GDP TRENDS, 2012-2020



Prepared by the Center for Economic Development using Moody's Analytics Data; data in 2020\$

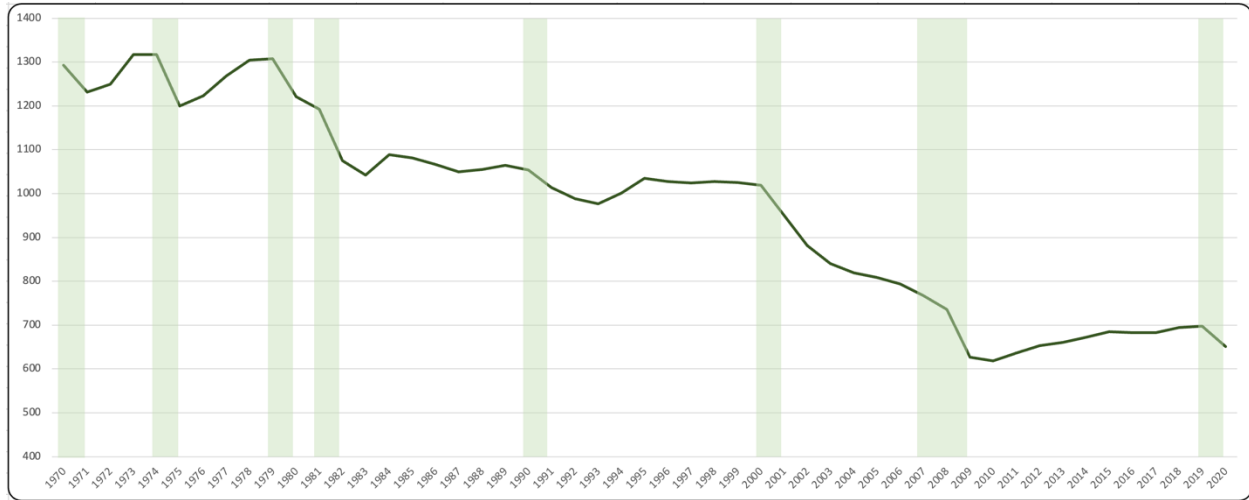
A review of Ohio manufacturing employment and GDP from 1970 to 2020 puts the impact of the recent Covid-19 pandemic into historical context. Figures 3 and 4 display periods of recession, as defined by the National Bureau of Economic Research (NBER), during this time frame. The 2020 pandemic-induced recession is most similar to the 2001 recession for the Ohio manufacturing sector. From 2000 to 2001, Ohio manufacturing lost 141,360 jobs (6.73%), and its GDP decreased by 7.38%. In comparison, from 2019

² Bureau of Labor Statistics (2021, May 14). *Occupational Outlook Handbook*.

³ Ohio Department of Job and Family Services. (2020, June). "Ohio short-term employment forecast."

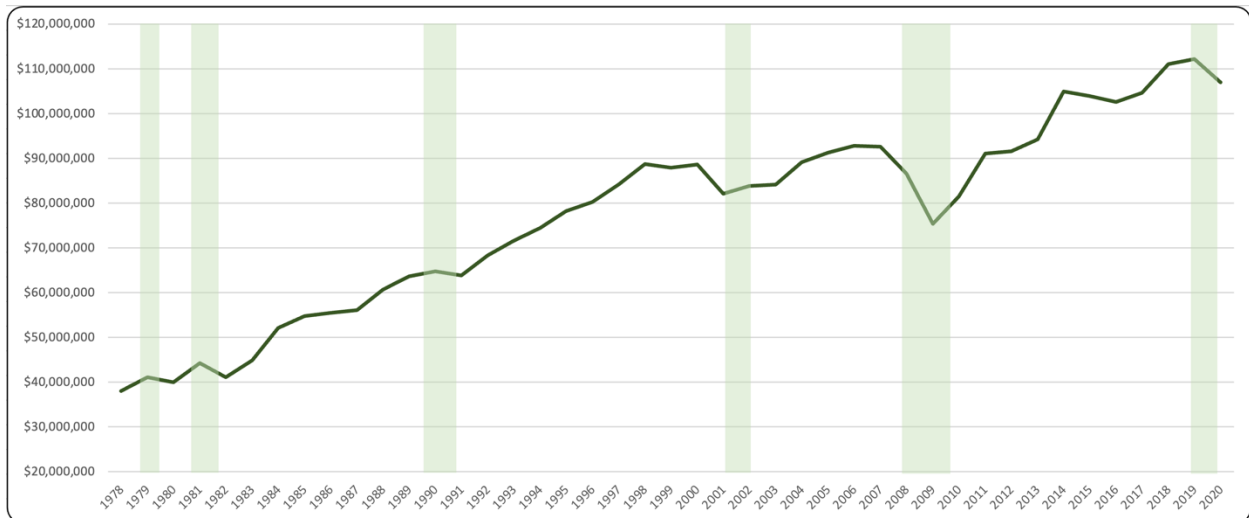
to 2020, Ohio manufacturing lost 46,670 jobs (6.69%), and its GDP decreased by 4.63%. This downturn stemmed from initial mass layoffs caused by economic shutdowns enacted to safeguard public health. More layoffs followed due to physical⁴ distancing requirements and decreases in demand for certain manufactured products. Many worried that the pandemic would wipe out benefits gained during the past ten years as Ohio's manufacturing industry recovered from the Great Recession of 2007 to 2009, but, for both employment and output, this most recent recession has not fallen to the Great Recession's levels.

FIGURE 3. OHIO MANUFACTURING EMPLOYMENT, 1970-2020



Prepared by the Center for Economic Development using Moody's Analytics Data

FIGURE 4. OHIO MANUFACTURING GDP, 1978-2020



Prepared by the Center for Economic Development using Moody's Analytics Data

⁴ Although, many studies are using term “social distancing,” the authors disagree with an adjective “social” in the referencing physical distance as a precautionary measure.

Location Quotients (LQs) measure industry specialization in a region relative to the national economy. A higher concentration in the regional economy (LQ > 1) indicates that industry is part of the regional economic base, producing goods for export outside the region and generating wealth for the region. The top ten location quotients for Ohio’s manufacturing industries are depicted in Table 1.

The highest employment concentrations in Ohio manufacturing industries are in Household Appliance Manufacturing (LQ=5.23); Steel Product Manufacturing from Purchased Steel (LQ=4.46); and Paint, Coating and Adhesive Manufacturing (LQ=4.12). These industries saw significant output growth from 2019 to 2020. Nine of the ten industries with the highest location quotients also experienced GDP growth from 2019 to 2020. The industries with the highest GDP growth were Steel Product Manufacturing from Purchased Steel (GDP growth=10.61%), Household Appliance Manufacturing (8.43%), and Clay Product and Refractory Manufacturing (7.99%). These three industries demonstrate GDP growth that outpaces total Ohio manufacturing GDP growth from 2019 to 2020, which was 4.89%.

TABLE 1. TOP 10 LARGEST OHIO MANUFACTURING INDUSTRIES BY GDP AND THEIR RELATIONS TO THE OHIO STEEL CLUSTER

NAICS Code	Industry Name	Location Quotient	% OH GDP Growth 2019-2020	% OH Employment Growth 2019-2020	Purchasers from Steel Industry	Sellers to Steel Industry
3352	Household Appliance Manufacturing	5.23	8.43%	-2.56%	X	
3312	Steel Product Manufacturing from Purchased Steel	4.46	10.61%	-7.78%	X	X
3255	Paint, Coating, and Adhesive Manufacturing	4.12	6.85%	-2.15%	X	X
3335	Metalworking Machinery Manufacturing	3.47	4.93%	-8.82%	X	
3321	Forging and Stamping	3.37	5.46%	-9.57%	X	X
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	3.27	7.91%	-0.84%	X	
3328	Coating, Engraving, Heat Treating, and Allied Activities	3.18	6.60%	-9.87%	X	X
3271	Clay Product and Refractory Manufacturing	3.17	7.99%	-7.98%		X
3322	Cutlery and Handtool Manufacturing	3.04	4.77%	-10.35%	X	
3315	Foundries	2.94	-2.57%	-7.95%	X	X

Prepared by the Center for Economic Development using Moody’s Analytics Data

According to GDP LQ, the roster of the top ten Ohio manufacturing industries indicates the importance of the steel industry in the state. According to the Ohio Development Services Agency, the Ohio Steel Council, and CED’s own study, Ohio ranked second in the country for raw steel production every year from 2010 to 2020, annually producing 10-

14% of total US output.⁵ These steel producers, defined here as raw steel and fabricated metal product manufacturers, serve as a driving economic force for other Ohio industries because much of Ohio-produced steel remains in-state through sales to other Ohio manufacturing companies. Of the ten most concentrated manufacturing sectors, seven purchase raw or fabricated steel to use in the production of their goods. Products from many of these manufacturers are then bought by Ohio steel producers in return, creating a mutually beneficial production cycle. Of the top ten GDP LQ manufacturing industries, five create materials that steel producers purchase.

An increase in demand due to pandemic circumstances may help explain GDP growth in the top industries. The Steel Product Manufacturing from the Purchased Steel industry comprises establishments primarily engaged in drawing steel wire, manufacturing iron and steel tubes and pipes, and rolling or drawing shapes from purchased steel.⁶ These goods are used in steel-intensive products like home appliances (refrigerators, washers, dryers, grills, etc.) or cars, which have increased in demand since the onset of the pandemic in 2020. The same reasoning can be applied to the production increase in Household Appliance Manufacturing. Ohio company Stanley Steemer, for example, has experienced a boom in demand for cleaning services during the pandemic. The company manufactures its own equipment for such services. Chet White, owner of thirteen Stanley Steemer franchises, reported an increase in sales of \$200,000 from 2019 to 2020.⁷ The Paint, Coating, and Adhesive Manufacturing industry also produces goods that experienced increased demand due to pandemic-driven home-improvement projects. Cleveland-based paint and coating manufacturer Sherwin-Williams reported a 2.6% increase in consolidated net sales from 2019 to 2020.⁸ Company CEO John Morikis explained that residential paint sales to both homeowners and professional remodelers and builders drove the increase.⁹

Nonetheless, as output grew for many Ohio manufacturing industries, employment fell. The total change in employment for all Ohio manufacturing industries from 2019 to 2020 was -6.69%. Of the ten industries with the highest location quotients, employment losses over the same period were the largest in Cutlery and Handtool Manufacturing (employment change = -10.35%); Coating, Engraving, Heat Treating and Allied Activities (-9.87%); and Forging and Stamping (-9.57%). The median measure of employment loss for the most concentrated industries was -7.96%, and the average was -6.79%. Only three of these ten industries experienced decreases in employment smaller than the average or median: Soap, Cleaning Compound and Toilet Preparation Manufacturing (-0.84%); Paint, Coating,

⁵ Ohio Development Services Agency. (2020, March). *Advanced Manufacturing: Ohio Iron and Steel Industry*.

⁶ NAICS Association. (2018). NAICS Code Description.

⁷ Bates, Michael D. (2021, March 10). "Stanley Steemer adapts to COVID-19 world; observes anniversary" *The Citrus County Chronicle*.

⁸ The Sherwin-Williams Company. (2021, January 28). "The Sherwin-Williams company reports 2020 year-end and fourth quarter financial results."

⁹ Vanac, Mary. (2021, January 28). "Sherwin-Williams sets revenue records as DIY paint sales jump during pandemic." *Cleveland Business Journal*.

and Adhesive Manufacturing (-2.15%); and Household Appliance Manufacturing (-2.56%).

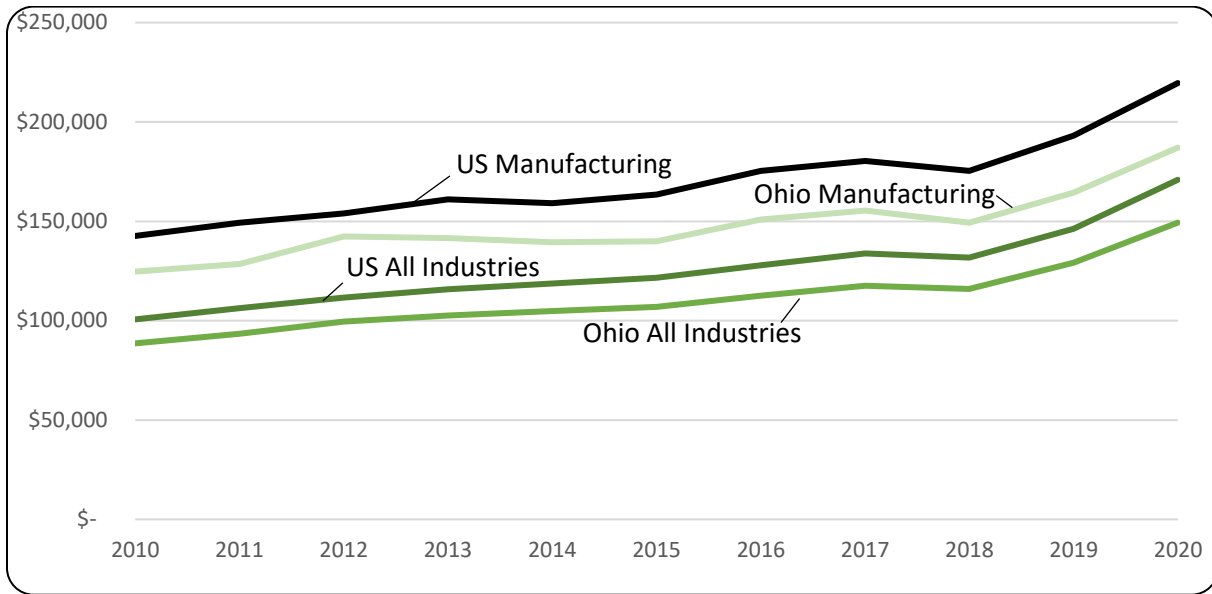
Meanwhile, productivity, as measured by output per employee, has steadily increased for manufacturing due to the increase in output and decline in employment. In fact, manufacturing has higher productivity than all industries in Ohio. In 2020, Ohio manufacturing productivity was \$187,085, increasing \$22,696, or 13.8%, from 2019. Productivity in Ohio manufacturing was 25.3% higher than all Ohio industries in 2020 and 9.5% higher than all U.S. industries in the same year.

Overall, productivity across both the U.S. and Ohio has increased since 2010. From 2010 to 2020, productivity across all Ohio industries increased by 68.6%. However, the trend took a sharp upward turn starting in 2018. From 2010 to 2018, productivity for all Ohio industries increased by 30.8%. From 2018 to 2020, productivity increased from \$115,903 to \$149,348, or 28.9%. That is, almost half of productivity growth in the past decade occurred in the last two years (2018 to 2020). The Ohio manufacturing industry experienced more volatility in productivity changes over time but followed the same general upward trend, increasing 19.7% from 2010 to 2018 and 25.4% from 2018 to 2020.

Ohio manufacturers have succeeded at producing greater output with a smaller workforce, but the secondary data does not show how that productivity growth was achieved. Some anecdotal evidence indicates that such gains in productivity are the result of increasing investments in advanced production equipment and automation. For example, Schaad and Sons, an Ohio custom architectural woodwork and cabinet manufacturer, expressed a desire to continue investing in new technology during the pandemic. According to co-owner Ryan Schaad, the company's goal is "to automate manual production steps while increasing capacity without sacrificing quality."¹⁰ Furniture manufacturing, however, is not one of Ohio's most productive manufacturing industries. A closer look at those sectors that create the most output per employee may provide deeper insight into these productivity gains.

¹⁰ JobsOhio. (2020, November 24). "JobsOhio inclusion grant supports Schaad and Sons' growth goals."

FIGURE 5. PRODUCTIVITY TRENDS, 2010-2020



Prepared by the Center for Economic Development using Moody's Analytics Data; data in 2020\$

Interestingly, the most productive industries in the state of Ohio represent a small share of total employment for the state (8% of total manufacturing employment). The largest Ohio manufacturing employer is the Motor Vehicle Parts Manufacturing industry, which employed 64,590 Ohioans in 2020. Yet this industry's productivity measured at just \$112,890 per employee, well below the measurements of the top ten most productive industries in Ohio. The top ten most productive manufacturing industries all had higher output per employee than the average productivity across manufacturing industries in the state, which was \$187,085.

Seven of the top ten belong to the Petroleum and Chemical Manufacturing sectors. These seven industries, listed in Table 5, account for only 6.91% of total Ohio manufacturing employment in 2020. Across all manufacturing industries, the total employment in 2020 was 651,580, and the average employment per industry was 7,574. The Petroleum and Chemical Manufacturing industries are capital-intensive, requiring more property, plants, and equipment than employees. With less reliance on human resources to produce their goods, these industries were more insulated from the negative effects of the Covid-19 pandemic. They could recover more quickly from the initial lockdown and adjust better to extended pandemic safety requirements such as physical distancing.

Only three industries employed more than the manufacturing average: Basic Chemical Manufacturing (8,530); Soap, Cleaning Compound and Toilet Preparation (10,730); and Paint, Coating, and Adhesive Manufacturing (8,840). Yet these three manufacturers each make up less than 2% of total manufacturing employment. The sizeable increases in productivity from 2019 to 2020 may be explained by increases in demand for certain chemical goods during the pandemic, like soap, cleaning supplies, and basic chemicals like phenol or acetone. A need to decrease in human resource reliance may have spurred these producers to invest more in technologies and equipment that would improve productivity. Colgate-Palmolive, for example, invested \$1.2 million into its Cambridge,

Ohio liquid hand soap production facility as a result of increased demand during the pandemic.¹¹

Pharmaceutical and Medicine manufacturing is another capital-intensive industry that had high productivity in 2020. However, in addition to its reliance on mechanized production, the Pharmaceutical and Medicine Manufacturing industry in Ohio also benefitted from the production of coronavirus vaccines by AstraZeneca, which has a production facility in West Chester, Ohio.

TABLE 2. TOP 10 OHIO MANUFACTURING INDUSTRIES BY PRODUCTIVITY

NAICS Code	Industry Name	Productivity 2020	% Change in Productivity	Employment 2020	% of Total 2020 Mfg Employment	Petroleum/ Chemical Mfg Sector
3122	Tobacco Manufacturing	\$2,885,375	0.9%	160	0.02%	
3241	Petroleum & Coal Products Manufacturing	\$1,093,832	8.9%	4,530	0.70%	X
3254	Pharmaceutical & Medicine Manufacturing	\$877,764	6.0%	5,040	0.77%	
3251	Basic Chemical Manufacturing	\$761,307	10.6%	8,530	1.31%	X
3253	Pesticide, Fertilizer & Other Agricultural Chemical Manufacturing	\$549,476	8.5%	1,450	0.22%	X
3256	Soap, Cleaning Compound & Toilet Preparation Manufacturing	\$446,668	10.2%	10,730	1.65%	X
3252	Resin, Synthetic Rubber & Artificial and Synthetic Fibers and Filaments Manufacturing	\$420,811	10.3%	5,130	0.79%	X
3342	Communications Equipment Manufacturing	\$383,962	20.0%	1,330	0.20%	
3255	Paint, Coating & Adhesive Manufacturing	\$381,172	10.5%	8,840	1.36%	X
3259	Other Chemical Product and Preparation Manufacturing	\$346,955	8.1%	5,820	0.89%	X

Prepared by the Center for Economic Development using Moody's Analytics Data; data in 2020\$

¹¹ JobsOhio. (2020, September 30). "Colgate-Palmolive upgrades its liquid hand soap production at Ohio facility."

INDUSTRY 4.0 AND MANUFACTURING

For the purposes of this study, we approximate productivity as an output created by an employee, but we can also speculate on explanations for a decline in employment that resulted in both output and productivity growth. Multiple factors relate to the productivity gains in manufacturing. The first is the shortage of skilled workers in manufacturing, another is the shift to the digitization of the factory floor (i.e., Industry 4.0), and the third is the pivot to PPE production during the pandemic. It is unclear whether the shortage of workers is causing the digitization, or the digitization is causing the decrease in employment, but they are clearly reinforcing each other.

At the onset of the pandemic, manufacturers had difficulty adjusting to Covid safety demands, including physical distancing, quarantine requirements for exposed employees, and employees' need to be present at home for schooling or childcare. Industry Week estimates that due to physical distancing and concerns for employee safety, "40-50% of the manufacturing workforce [was] unavailable to perform their functions on-site" during the pandemic.¹² This caused employment to decrease. A year into the pandemic, manufacturers were still experiencing employment decreases, with ODJFS reporting 2,600 manufacturing job losses in April 2021. Reported causes for late-pandemic losses included worker retirements, supply chain issues, and higher prices for materials and inputs.¹³ In addition, there has been a workforce shortage in manufacturing industries for decades. According to MAGNET, as of January 2020, almost 60% of manufacturers in Northeast Ohio said they could not find the skilled workers they need.¹⁴

Increasing employment is the highest priority for many Ohio manufacturers, as 57% of companies report that a shortage of skilled workers is the most prominent factor hampering growth.¹⁵ As a result, new training and mentorship programs have been promoted across Ohio to boost employment in advanced manufacturing. In 2019, an Ohio budget allocation funded the Manufacturing Mentorship Program, enabling 16-to-17-year-old students to work part-time in manufacturing to gain valuable workforce experience. The same year, Ohio budgeted \$30 million to increase micro-credentials and short-term training for current and prospective manufacturing workers to decrease the skill gap. Additionally, the Ohio Manufacturing Workforce Partnership was awarded a \$12 million grant from the US Department of Labor to promote more earn-and-learn opportunities for manufacturing trainees.¹⁶

Many studies and anecdotal evidence point to the shift to Manufacturing 4.0 as the reason productivity gains are occurring. Manufacturing 4.0 is used to describe the application of Industry 4.0 technologies to the manufacturing sector, specifically the integration of technology into every step of the production process, allowing manufacturers to increase

¹² Kroupenev, A. (2020, Apr 21). "What will manufacturing's New Normal be after COVID-19?" *Industry Week*.

¹³ Williams, Mark. (2021, June 21). "As employers seek workers, Ohio reports rise in unemployment rate in May." *The Columbus Dispatch*.

¹⁴ Make it Better Ohio. (2020, June).

¹⁵ Magnet & Ohio MEP. (2020, February 14). *2020 Ohio Manufacturing Report*.

¹⁶ Lorain County Community College. (2019, June 25). "Ohio manufacturing workforce partnership awarded \$12 million to scale industry-recognized apprenticeships." *Cision PR Workforce*.

their output and gain operational efficiency. This technology can make a considerable difference for some small- and medium-sized manufacturers with antiquated equipment and computer systems. Meanwhile, Manufacturing 5.0 can be considered a “digitally integrated manufacturing operation.”¹⁷ All of this digital integration means fewer employees needed on the factory floor to man machinery. In fact, many manufacturers want to move to a “lights out” model in which there are no employees on the factory floor, thereby eliminating the extra expense of lights.¹⁸

The Bureau of Labor Statistics acknowledges that “technological advancements are expected to continue to replace many of the manufacturing workers that make up a large share of the production occupations.”¹⁹ The COVID-19 pandemic accelerated this trend, as manufacturers nationwide have reported increased investment in new technologies to drive productivity and potentially reduce the need to bring back lost jobs. A Google report on the impact of COVID-19 on manufacturers worldwide revealed that 76% of manufacturers reported an increase in their use of digital enablers and disruptive technologies such as the Cloud, artificial intelligence, data analytics, robotics, etc.²⁰ United States manufacturing executives echo this statement, as the Deloitte 2021 Manufacturing Industry Outlook post-election poll reported, “76% of manufacturing executives...intend to increase their investments in digital initiatives and plan to pilot and implement more Industry 4.0 technologies.”²¹ Industry 4.0 refers to the fourth industrial revolution, in which innovations in interconnectivity, automation, machine learning, and big data are used to improve business operations across sectors. Two major Industry 4.0 investment areas, cloud computing and automation, will prepare manufacturing companies to navigate disruptions in demand and/or supply, reduce costs, and increase productivity.

Before the pandemic, Ohio manufacturers did not follow these technology adoption trends. According to the 2020 Ohio Manufacturing Report produced by MAGNET and the Ohio Manufacturing Extension Partnership, Northeast Ohio was lagging in Industry 4.0 adoption. For example, the report states that “more than 60% of companies either are not using or just started using automation, and half of the companies say they do not plan to increase capital expenditures on automation” as of 2019.²² In fact, Industry 4.0 did not appear to be a priority for Ohio manufacturers, as “only 21% anticipate using more 3D printing in 2020, only 7% are using robots effectively, and only 10% are creating web-connected products.”²³

However, as manufacturers recovered from the initial effects of the Covid-19 pandemic in 2020, some adopted new technologies to produce more output with a reduced workforce. Difficulty attracting skilled and reliable labor is a common reason for advanced technology

¹⁷ Ohio Manufacturing Institute (n.d.) CED has a forthcoming report on the Future of Manufacturing discussing the differences in Manufacturing 4.0 and 5.0." *Manufacturing 5.0*.

¹⁸ Doherty, C. (2020, Jan 15). "Getting ready for lights-out manufacturing." *Production Machining*.

¹⁹ Bureau of Labor Statistics (2021, May 14). *Occupational Outlook Handbook*.

²⁰ Google. (2020). *Google Cloud Industries: The impact of COVID-19 on manufacturers*.

²¹ Deloitte. (2021). *2021 Manufacturing Industry Outlook*.

²² Magnet & Ohio MEP. (2020, February 14). *2020 Ohio Manufacturing Report*.

²³ Ibid.

development in Ohio manufacturing. Stephen Steinour, Chief Executive of Huntington Bancshares in Columbus, Ohio, reported fielding inquiries from “dozens of business owners about financing for equipment purchases,” citing turnover, hiring difficulties, and wage inflation as reasons many businesses seek to invest in automation.²⁴ RoBEX, an industrial automation company in Perrysburg, Ohio, is responding to manufacturing demand for smart machinery that can promote growth in the industry. RoBEX President Craig Francisco said that their products could address the manufacturing labor shortage through their ability to “help automate repetitive and monotonous tasks that might be difficult for some to do physically and are hard to staff and keep staffed.”²⁵

Economic Development Organizations, like JobsOhio, are incentivizing new technology adoption by manufacturers across the state by providing grants supporting new equipment and machinery costs. Companies like Dorel Home, OCECO, and Winesburg Chair, Ltd. use these grants along with their own financial investments to modernize their manufacturing processes. Dorel Home reports an investment of \$2.57 million for new machinery and equipment to upgrade their Ohio facility.²⁶ OCECO, a safety equipment fabricator, used their \$50,000 grant to help purchase a CNC machine that will assist in automating production.²⁷ Winesburg Chair, Ltd. announced a significant expansion of their manufacturing, warehousing, and office space and will be using their JobsOhio grant to “invest in new equipment and machines that will improve production output to meet growing demand.”²⁸ These investments by industry nonprofits demonstrate the utility of incentivizing outside partners to adopt Industry 4.0 technology.

Productivity increases during the pandemic were also spurred in part by specialized investments in Personal Protective Equipment (PPE) production. Across the country, manufacturers were called to “step up” and help the greater good by producing PPE, hand sanitizer, and other essential items. In Ohio particularly, a coalition formed that included the Ohio Hospital Association, the Ohio Manufacturers Association, the Ohio Manufacturing Extension partnership, and JobsOhio. This coalition became known as the the Ohio Manufacturing Alliance to Fight Covid-19, or “The Repurposing Project.”²⁹ The project guided manufacturers to learn what equipment was most needed and how to adapt current products, operations, and personnel to meet the need. More than 2,000 Ohio companies ramped up PPE production within weeks.³⁰ Additionally, state government-funded grant programs like the Ohio PPE Retooling and Reshoring Grant Program awarded \$20 million to sixty-eight small- and medium-sized manufacturers to help them convert or

²⁴ Lynch, David J. (2021, May 19). "Hiring troubles prompt some employers to eye automation and machines." *The Washington Post*.

²⁵ Kirby, Caylee. (2021, May 20). "Automation robots helping with growth in manufacturing industries, creating more skilled trades jobs." *WTOL*.

²⁶ JobsOhio. (2020, July 27). "Dorel Home invests \$3.27 million to upgrade Ohio facility."

²⁷ Ohio Southeast Economic Development. (2021, June 28). "Winesburg Chair, LTD announces 800,000 sq. ft. expansion, addition of 50 new full-time jobs in three-phase plan."

²⁸ Tiffin-Seneca Economic Partnership. (2020, December 10). "OCECO approved for \$50,000 JobsOhio grant."

²⁹ Repurposing Project (n.d). <https://repurposingproject.com/>

³⁰Garrett, Amanda. (2021, May 16). "Manufacturing 5.0: We're at the beginning of a new Industrial Revolution." *Akron Beacon Journal*.

expand their operations for PPE production.³¹ Such initiatives helped manufacturers retain employees and afford the up-front investment in equipment and/or technology, allowing them to realize more profits by producing at a lower cost. Producing highly in-demand products like PPE and other essential items with government aid to cover costs is a recipe for productivity gains, at least in the short-term. Furthermore, these coalition- and government-based actions focusing on smaller manufacturers kept these producers afloat during the abnormal market conditions of the pandemic, preventing larger losses for the sector. However, as the need for PPE diminishes with the severity of the pandemic, these manufacturers may be in a precarious position once again, demonstrating the need for more long-term strategic planning and Industry 4.0 investments.

To promote technology adoption in the Ohio manufacturing industry more effectively, governments, companies, and industry associations must work together to drive change. Establishing regional sector partnerships through the Ohio Manufacturing Association in 2019 and a state budget allocation of \$5 million for their support provided a foundation for collaboration in manufacturing that has expanded since the pandemic began. Through initiatives like the Ohio Alliance to Fight Covid-19, Ohio manufacturing proved its flexibility and cooperative capacities to help fight a public health crisis while also maintaining company profitability. Industry leaders have developed these partnerships to create a blueprint for Ohio's continuing success in the industry. MAGNET's document, "Make it Better: A Blueprint for Manufacturing in Northeast Ohio," outlines priorities and recommendations for growth in the region's manufacturing industry. The blueprint envisions the region as leading Industry 4.0 adoption, closing the skill gap while achieving full employment in manufacturing, and possessing innovative leadership guided by the power of partnership and community.³²

LOOKING FORWARD

Continued and accelerated investment in Industry 4.0 technologies is a key component for the future of manufacturing post-Covid. Such investments enhance workers' skills and productivity, in addition to creating higher-paying manufacturing jobs by increasing the technical knowledge required to work alongside more advanced machinery. Therefore, will production be more efficient and precise, while manufacturing may once again be a sector young people look to for fruitful careers and lifelong learning opportunities.

Although the Ohio Department of Job and Family Services projects a continual decrease in production occupation employment through 2028, Ohio has invested in improved training programs through a partnership with industry nonprofits like MAGNET and community colleges across the state. MAGNET's 2021 manufacturing blueprint goals include a 100% increase in graduates from advanced manufacturing programs over the next five years.³³ The need for a larger, skilled labor pool will persist and grow as manufacturing transforms into a more automated and technologically-advanced industry.

³¹ Fisher, Jacob. (2020, July 20). "Ohio awards \$20m to manufacturers for sustained PPE production." *Dayton Business Journal*.

³² MAGNET: The Manufacturing Advocacy & Growth Network. (2021, June). *Make It Better: A Blueprint for Manufacturing in Northeast Ohio*.

³³ Ibid.

Despite recognizing the advantages of adopting Industry 4.0 technologies, many manufacturers may not be ready to make large capital investments as they recover from the pandemic. However, some Industry 4.0 technologies are easily and quickly adoptable, including digital performance management and basic retrofit automation for loading or conveyor systems.³⁴ Technologies like these may be the most widely adopted in the wake of the Covid-19 pandemic, as companies continue recovering from pandemic-related losses. Since Ohio has a long history of manufacturing and continues to be a national leader in the industry, adopting advanced technologies is imperative for continuing the tradition of manufacturing success in the state.

Alongside advanced technology adoption, the manufacturing industry may see more reshoring of supply chains due to pandemic-caused disruptions. Most reshoring occurred in the PPE manufacturing space, as manufacturers pivoted to creating masks and other health equipment previously produced overseas, which became expensive or unavailable during the pandemic. For example, the Ohio Development Services Agency awarded Ohio PPE Retooling and Reshoring grants, totaling \$20 million to sixty-eight Ohio manufacturers for the production of PPE in 2020.³⁵ The question now is whether reshoring will restore normal operations for manufacturers who struggled with problems caused by overseas supply chain dependencies during the pandemic. Meanwhile, nonprofit organizations like Heartland Forward and the Reshoring Initiative argue that we should bring more supply chains back to the United States. Heartland Forward's recent report "Reshoring America: Can the Heartland Lead the Way?" claims that "firms may fail to accurately determine the costs of production overseas by as much as 20%."³⁶ Charlie Rowell, the North American Business Development Director of JobsOhio, argues that Ohio is an advantageous site for reshoring initiatives, as the state provides tax breaks and is considered accessible to suppliers and customers since Ohio is only a one-day drive from 60% of U.S. and Canadian populations.³⁷ Such initiatives can support manufacturing business growth in Ohio and add to the state's strength as an industry leader in the nation.

Nevertheless, these advancements and initiatives also have detriments. The main barriers to automation, historically, have been cost and function (namely, the lack of flexibility in the tasks robots are able to perform).³⁸ Depending on the size of the firm and its production process, the height of those barriers varies, but one thing remains consistent: As barriers come down, automated processes become more adaptable and cheaper to implement, while the value of labor decreases as its cost increases.³⁹

Inevitably, this leads to the creation of "lights out" facilities,⁴⁰ resulting in the shrinking and elimination of what is currently 12.56% of Ohio's workforce.⁴¹ For now, Ohio's

³⁴ McKinsey & Company. (2021). "Industry 4.0: Reimagining operations after COVID-19."

³⁵ Bowerman, Dan. (2020, August 2). "Ohio awards \$20 million in PPE retooling and reshoring grants." *OEDA*.

³⁶ Rowell, Charlie. (2021, March 10). "Made In America: Why reshoring in Ohio can restore America's supply chains." *JobsOhio*.

³⁷ *Ibid*.

³⁸ Burman, J. (2021, Apr 21). "The four barriers to automation and robotics." *SHD Logistics*.

³⁹ Tilley, J. (2020, October 20). *Automation, Robotics, and the Factory of the Future*. McKinsey & Company.

⁴⁰ Doherty, C. (2020, Jan 15). "Getting ready for lights-out manufacturing." *Production Machining*.

⁴¹ "2019 Ohio manufacturing facts." (n.d.). *NAM*.

manufacturing sector is relatively safe from a widespread transition to automation. Employers are facing a labor shortage, have no choice but to pay higher wages, and are working hard to attract new workers to the sector as the current labor pool ages out.⁴² Nonetheless, the COVID-induced employment decline suggests a similar future decline as automation becomes more prevalent.

When presented with the opportunity, labor was quickly and successfully replaced with automated systems.⁴³ Productivity is at an all-time high, while employment levels in Ohio's manufacturing industry decline. Current unskilled and semiskilled jobs will be replaced with highly-skilled positions in technology, engineering, and management, but those jobs will go to those privileged enough to complete higher education.⁴⁴ Meanwhile, the lower and lower-middle classes that worked on the production floor will be left with worsening job prospects and forced to compete with technological advancements in robotics and 3D printing.

This phenomenon will only exacerbate the socio-economic dynamics we have seen play out since the 1970s.⁴⁵ U.S. manufacturing, particularly in the state of Ohio, is an illuminating representation of this changing societal landscape. Manufacturing is important to the state of Ohio and to the United States, but its importance stems from the economic benefits it delivers to a large group of people. Any sector-wide visions for Industry 5.0 and beyond should consider the reeducation and retooling of the workforce in addition to the ramifications of occupational obsolescence and what that means for manufacturing in Ohio and beyond.

⁴² Dowell, E. (2021, Jan 6). "Manufacturing faces a labor shortage as workforce ages." *The United States Census Bureau*.

⁴³ Lee, D. (2021, May 4). "As COVID-19 wanes, employers are accelerating the use of robots. Where does that leave workers?" *Los Angeles Times*.

⁴⁴ Hufford, A. (2019, Dec 9). "American factories demand white-collar education for blue-collar work." *The Wall Street Journal*.

⁴⁵ Prentice, B. (2020, March). "WTF happened in 1971?"

CONCLUSION

Ohio's manufacturing industry has experienced great change because of the COVID-19 pandemic. Employment sharply decreased since its onset, further exacerbating the industry's labor shortage. At the same time, GDP and productivity grew for the industry as a whole and for most individual manufacturing sectors in Ohio. The rise in unemployment is largely due to pandemic circumstances, such as the initial economic shutdown and a need to keep employees safe from the health risks of the virus. Parallel increases in GDP and productivity in the industry were influenced by a wider variety of factors, from factories pivoting to creating Personal Protective Equipment and other healthcare supplies, to investments in new technology streamlining the production processes. Fortunately, partnerships among companies, nonprofits, and government entities have been strengthened and forged by the challenges and successes of manufacturing production during the pandemic. Such partnerships may support the industry's growth in the future.