

# 2022 Montana Manufacturing Report

Prepared by the  
Bureau of Business and Economic Research  
University of Montana



# 2022 Montana Manufacturing Report

Bureau of Business and Economic Research

University of Montana  
Missoula, MT

September 8, 2022

# Contents

<b>Acknowledgments</b>	<b>v</b>
<b>Executive Summary</b>	<b>vi</b>
<b>Introduction</b>	<b>1</b>
<b>1 The State of the Overall Economy</b>	<b>2</b>
1.1 The United States . . . . .	3
1.2 Headwinds . . . . .	5
<i>Box: Industry 4.0</i> . . . . .	8
1.3 Montana Economy . . . . .	10
1.4 Global Regional Overview . . . . .	12
1.5 National Manufacturing Overview . . . . .	13
<b>2 Manufacturing in Montana</b>	<b>14</b>
2.1 Manufacturing Establishments . . . . .	18
2.2 Manufacturing Annual Earnings by Industry . . . . .	20
2.3 Manufacturing Employment by Industry . . . . .	22
2.4 Montana's Manufacturing Exports . . . . .	23
2.5 Montana Manufacturing Forecast . . . . .	25
<b>3 Montana Manufacturers Survey</b>	<b>28</b>
3.1 Year in Review . . . . .	28
3.2 Employment . . . . .	29
3.3 Supply chain: The COVID-19 Pandemic and Russia-Ukraine War . . . . .	30
3.4 Manufacturer's Expectations for 2022 . . . . .	32
<b>4 The Montana Manufacturing Extension Center</b>	<b>33</b>
4.1 Overall Satisfaction . . . . .	34
4.2 Why Choose MMEC . . . . .	37
4.3 Future Challenges . . . . .	37
4.4 Quantitative Estimates of MMEC Visit Outcomes . . . . .	38
4.5 Economic Impacts of MMEC Visits and Services . . . . .	38
4.6 Return on Investment and Fees . . . . .	39
<b>Appendix A Estimated interest rate elasticities</b>	<b>41</b>
<b>Appendix B Forecast methodology</b>	<b>42</b>

## List of Tables

1.1	OECD June 2022 real GDP growth projections . . . . .	3
2.1	Number of Private Firms in 2021 . . . . .	20
2.2	Firms by the number of employees in 2020 . . . . .	21
2.3	Annual Earning in 2021 (millions of \$s) . . . . .	22
2.4	Employment in 2021 . . . . .	23
2.5	Top 20 export markets, 2021 (millions of \$s) . . . . .	25
2.6	Manufacturing exports by sector ranked, 2021 (millions of \$s) . . . . .	26
3.1	Survey questions: Sales, production and profit. . . . .	29
3.2	Survey questions: Investment and Capacity . . . . .	29
3.3	Survey questions: Employment . . . . .	30
3.4	Survey questions: Supply chain . . . . .	31
3.5	Major issues that affected individual manufacturing plants: % responding yes .	31
3.6	In 2022 do you anticipate ... . . . .	32
4.1	Have you used any external providers for business performance services? . .	34
4.2	Would You Recommend To Other Companies (Scale 0 – 10) . . . . .	35
4.3	Important factors for your firm choosing MMEC . . . . .	37
4.4	Important future challenges facing your business . . . . .	38
4.5	Total sales, costs, investments and jobs earned or saved in 2022 . . . . .	39
4.6	Economic impacts of MMEC services, 2021 . . . . .	39
A.1	Estimated interest rate elasticity . . . . .	41

## List of Figures

1.1	CBOE Volatility Index (VIX) . . . . .	2
1.2	Global Supply Chain Pressure, the Manufacturing PPI and Core inflation . . . .	6
1.3	Montana output (Real GDP) and unemployment rate . . . . .	11
1.4	Montana employment and housing . . . . .	11
1.5	ISM Manufacturing Production Index . . . . .	13
2.1	US and Montana manufacturing output (RGDP) . . . . .	15
2.2	Composition of manufacturing in 2020 (percent of total manufacturing) . . . .	16
2.3	Manufacturing Employment and GDP since 2020 . . . . .	17
2.4	Montana Durable vs Nondurable Employment . . . . .	17
2.5	Share of basic earnings in Montana, 2021 . . . . .	18
2.6	Montana real manufacturing exports and GSP. . . . .	24
2.7	Manufacturing Forecasts . . . . .	27
2.8	Durable vs nondurable manufacturing forecast . . . . .	27

## Acknowledgments

This report was prepared by the Montana State University Montana Manufacturing Extension Center and the Bureau of Business and Economic Research (BBER) at the University of Montana under award 70NANB21H145 from the National Institute of Standards and Technology Manufacturing Extension Partnership, U.S. Department of Commerce. The statements, conclusions and recommendations are those of the author and do not necessarily reflect the views of the National Institute of Standards & Technology Manufacturing Extension Partnership or the U.S. Department of Commerce. BBER's project manager John Baldrige directed the survey. BBER economist Derek Sheehan provided able data assistance. BBER would like to acknowledge the assistance of Jenni West, Carla Little, and Paddy Fleming from MMEC. All errors or omissions are our own.

### About the Bureau of Business and Economic Research

The Bureau of Business and Economic Research (BBER) was founded in 1948 as the research arm of the University of Montana's School of Business Administration. The Bureau's mission statement states,

*"The purpose of the Bureau is to serve the general public, as well as people in business, labor, and government, by providing an understanding of the environment in which Montanans live and work."*

BBER has since developed to become one of the most sought-after sources of information and analysis on the Montana economy. The Bureau has published the *Montana Business Quarterly*, an award-winning business periodical, since 1962, and has conducted the Montana Economic Outlook Seminars, a half-day program on the economic outlook presented in 10 cities statewide, on an annual basis since 1976.

## Executive Summary

This report is on the state of Montana manufacturing conducted for the Montana Manufacturing Extension Center (MMEC). The report and analysis were done by the Bureau of Business and Economic Research (BBER) at the University of Montana. This is the 26<sup>th</sup> year that BBER and MMEC have collaborated to produce reports on Montana's manufacturing climate. The three primary topics are: the state of manufacturing at the state and national level in a general economic context; a survey of Montana manufacturers about the state of Montana manufacturing; and an impact survey of firms which used MMEC's consulting services. The report covers the year 2021 for the economic analysis and survey. The MMEC impact survey was conducted during the first quarter of 2022.

## State of Montana Manufacturing

Montana's manufacturers face different challenges than the nation as a whole because the composition of manufacturing production is different and is primarily concentrated in non-durable production – the Bureau of Economic Analysis defines nondurable goods as goods that have an average life of less than three years. The two largest manufacturing sectors in Montana, petroleum and coal, and wood product manufacturing, are not among the seven largest sectors nationally, demonstrating how the Montana manufacturing sector differs substantially from the experience of the country.

Some summary facts about Montana manufacturing in 2021 are:

- Over 4,100 manufacturing firms are in operation in Montana, including sole proprietors;
- Manufacturing accounts for over 20% of Montana's economic base;
- Manufacturing jobs paid about \$57,000 in earnings, compared to the state average of just under \$51,000;
- Accounts for 6.4% of total private state income equaling \$1.6 billion;
- Employs 4.3% of Montana's nonfarm workforce, with about 21,400 employees;
- Produced 7.8% of Montana's output with a value of \$3.8 billion; and
- Montana manufacturing employment and output growth was more than double the national average in 2021.

In the aftermath of the 2020 COVID-19 recession, Montana manufacturing bounced back relatively quickly from the deep economic drop in the second quarter of 2020. Last year, we predicted that nondurable manufacturing would return to pre-COVID levels with a year or so. Employment in this sector returned to pre-pandemic levels in early 2021. Durable manufacturing is forecast to return to the long-run trend a year or so later, in line with our predictions from a year ago.

Montana manufacturers are active in global markets as well. The three largest export sectors for Montana in 2021 were: chemicals, machinery and transportation equipment. Food,

beverages and tobacco fell out of second place during the pandemic. By far the largest export market is Canada, accounting for almost 30% of Montana's manufactured exports. In 2021, the remaining large export markets were: China (2), South Korea (3), Mexico (4), and Belgium (5).

## Montana Manufacturers Survey

This section of the report presents the findings of the 2021 Montana Manufacturers Survey. The purpose of the survey is to learn the manufacturers' assessment of their plant's economic performance in 2021 and their outlook for 2022. Manufacturing in Montana is predominantly performed by small businesses. The U.S. Census Bureau reports 1,700 manufacturing firms with employees in Montana, and 51% of Montana manufacturers have five or less employees. There are no manufacturers with 300 or more workers in the state.

Highlights from the 2021 manufacturing survey:

- Over one-half of manufacturing firms saw an increase in total sales and profits from 2020;
- Ninety-five percent of firms did not reduce production capacity;
- A minority of firms (21%) reduced employment;
- Almost one-half of Montana's manufacturing firms experienced a significant worker shortage;
- Roughly 61% of all firms had supply chain issues in 2021, similarly 61% experienced issues with the cost of intermediate goods; and
- 70% of durable good manufactures experienced issues with finding employees, compared to 30% of nondurable producers facing the same problem.

## Evaluation of Montana Manufacturing Extension Center

The Montana Manufacturing Extension Center works with manufacturers to create and retain jobs, innovate, reduce costs, increase profits, and save time and money. MMEC employees typically make on-site visits to manufacturing clients to assess problems, suggest appropriate solutions and assist with implementation. MMEC closely monitors its performance by welcoming feedback and carefully following an evaluation procedure developed by the National Institute of Standards and Technology (NIST) and administered by an independent third party. The primary NIST survey findings from 2021 are as follows:

- Montana manufacturing clients were very satisfied, with 66% of respondents saying they relied exclusively on MMEC as a business service provider;
- Approximately 90% of respondents said they were highly likely to give a positive recommendation of MMEC to other potential clients;
- Staff expertise was again the most important factor for firms to use MMEC services;

- The most important challenges facing surveyed MMEC clients were ongoing continuous improvement/cost reduction strategies, employee recruitment and retention, and product innovation/development;
- The Montana return on investment for MMEC during 2021 was 7.4 to 1; and
- The ROI for MMEC clients was about 42.8 to 1.



## Introduction

This report is on the state of Montana manufacturing conducted for the Montana Manufacturing Extension Center (MMEC). The report and analysis were done by the Bureau of Business and Economic Research (BBER) at the University of Montana. This is the 25th year that BBER and MMEC have collaborated to produce reports on Montana's manufacturing climate. The three primary topics are: the state of manufacturing at the state and national level in a general economic context; a survey of Montana manufacturers about the state of Montana manufacturing; and an impact survey of firms which used MMEC's consulting services. The report is divided into four primary sections:

### **Section 1: The State of the Overall Economy**

This section provides a brief summary of the global, regional, national, and state economies. This section also contains a brief discussion of factors and the potential headwinds that could be problematic for the foreseeable future and highlight how technology is being adopted in current and future manufacturing practices. Lastly, we highlight the national state of manufacturing.

### **Section 2: Manufacturing in Montana**

Here we use the most recent state level data to give an overview of the current state of Montana manufacturing. The section focuses on number of firms, earnings, employees, and exports by the various manufacturing sectors. A forecast of manufacturing output and employment finishes the section.

### **Section 3: Montana Manufacturers Survey**

Results of the Montana Manufacturers Survey conducted by the BBER are the subject of this section. The survey was completed in first quarter of 2022 and so captures the effects of the ongoing supply chain pinch points and Russo-Ukrainian war.

### **Section 4: The Montana Manufacturing Extension Center**

The final section contains the results of the client impact survey conducted by an independent third party following a project completed by MMEC. The survey is used to evaluate the effectiveness of MMEC and for calculations of the centers return on investment (ROI) and economic impact.

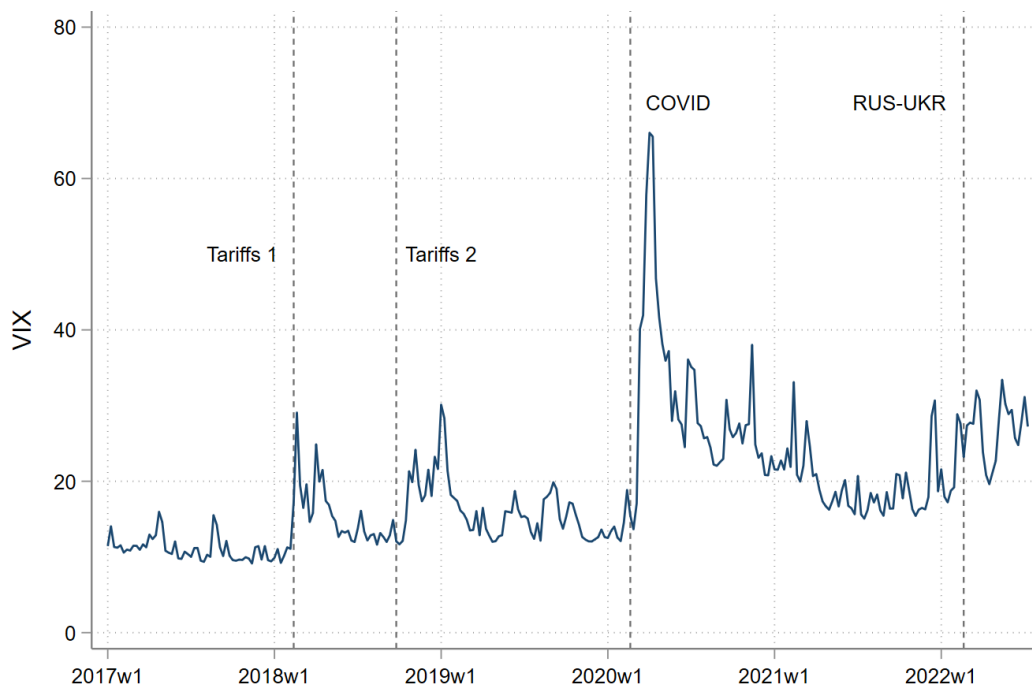
# 1 The State of the Overall Economy

To get a view of the overall economy from 30 thousand feet, a good place to start is volatility in the financial markets. This is a useful tool as markets tend to react quickly, though not always accurately, to changes in the global situation and provide insight into the perceived riskiness and trajectory of the global economic environment.

Our view from 30 thousand feet uses the Chicago Board of Options Exchange (CBOE) volatility index, or VIX. Figure 1.1 shows the VIX index from 2017 to 2022 annotated with events that had an impact on the national and global economy. Peaks, and their magnitude, reflect perceived increases in economic risk. Since 2017 the US economy has absorbed a number of economic shocks. The first two came as a result of tariffs introduced by the Trump administration, Tariff 1, and their later expansion to include billions of dollars of Chinese imports, Tariff 2.

The next big economic shock was the Covid pandemic, the top of the peak in 2020 corresponds to the World Health Organization (WHO) declaring a global pandemic. On March 16, 2020 the index hit its highest level ever, 82.7, roughly two points higher than during the financial crisis in 2008. The last great economic shock captured in this figure is Russia's invasion of Ukraine in February of 2022. This hardly registers mention when compared to Covid, but it does reflect a change in economic risk. The peaks between the initial Covid one and the Russian invasion are the various outbreaks of the Covid variants.

**Figure 1.1: CBOE Volatility Index (VIX)**



(Source: Chicago Board Options Exchange)

**Table 1.1:** OECD June 2022 real GDP growth projections

Country	2021		2022		2023
Australia	4.8%	—	4.2%	↓	2.5%
Canada	4.5%	—	3.8%	—	2.6%
China	8.1%	↓	4.4%	—	4.9%
Euro area	5.3%	↓	2.6%	↓	1.6%
Japan	1.7%	↓	1.7%	↑	1.8%
Korea	4.0%	↓	2.7%	—	2.5%
Mexico	4.8%	↓	1.9%	↓	2.1%
United Kingdom	7.4%	↓	3.6%	↓	0.0%
United States	5.7%	↓	2.5%	↓	1.2%
World	5.8%	↓	3.0%	↓	2.8%

Note: Down/up arrows indicate a down-/up-ward revision of at least 0.3%.

(Source: OECD *Economic Outlook*)

The reason the war does not register as strongly as might be expected is because global markets have been focused on rising inflation due in part to clogged supply chain channels – this event only serves to worsen, from Western market’s point-of-view, a pre-existing condition. The final economic shock is the date the Federal Reserve increased its policy interest rate by 2.5% points at the end of July, though this does a change in the VIX as it was an anticipated. Nevertheless, this, and predicted future monetary tightening, could have far reaching implications to the US economy over the next 2-3 years.

The net effect of these obstacles, and the war in particular, has caused many international economic institutions to re-consider previous forecasts of national, regional, and global economies. Table 1.1 shows real GDP growth projections for the largest economies in the world from the Organization of Economic Cooperation and Development (OECD). The projections for 2022 and 2023 are June revisions from those done in January, up and down arrows reflect whether or not the forecasts were updated because of the ongoing Russo-Ukrainian War. Estimates with a “—” mean there was no significant changes to the forecast. The majority of the countries are expected to experience slower economic growth than previously anticipated – notably, the 2023 forecast for Japan was revised upward. For the US economic growth is forecast to fall to 1.2% in 2023. The International Monetary Fund (IMF) has a rosier revised forecast. In the US they anticipate growth in 2022 and 2023 to be 3.7% and 2.3% respectively, though it should be noted their estimates were done 2-3 months before those done by the OECD.<sup>1</sup>

## 1.1 The United States

At the time of this writing, the discussion of whether or not the US will experience a recession in the next 18 months or so has taken on new relevance. Since January the Dow Jones

<sup>1</sup>IMF, *World Economic Outlook: War Sets Back the Global Recovery*, April 2022.

Industrial Average has fallen about 13%, inflation – driven by supply side effects but exacerbated by past demand side fiscal stimulus – has reached levels not seen in 40 years, and bond yields are rising as a hedge against risk. All this has prompted the Federal Reserve (Fed) to tighten monetary policy. This has prompted the “will we, or won’t we?” recession discussion. And while a recession is not a forgone conclusion, there are nevertheless several headwinds, discussed in more detail below, that will adversely affect the US economy over the short and medium term. And/or there could be some unforeseen negative shock which is enough to upset the apple cart.

What are the likely drivers for the economy over the next year or so? Briefly, they are:

**Household behavior** During the pandemic, households shifted expenditures away from services towards manufactured durable and nondurable goods. Pre-pandemic services accounted for roughly 65% of household expenditures, but by mid-2021 this share had fallen to about 58%, putting additional pressure on final manufactured goods already facing supply shortages. As personal consumption re-balances expenditures, we will see demand for merchandise return to pre-pandemic levels.

**Housing and financial markets** As housing markets and financial markets cool down personal consumption expenditures will similarly slow as household wealth cools. This could be exacerbated as personal savings fall and individual consumption slows with continuing high inflation rates.

Alternatively, though housing price growth is beginning to slow, parts of the country, such as in parts of Montana, continue to struggle with supply shortages keeping housing prices relatively high.

**Investment** Investment is a function of interest rates and as these rates rise, investment in new physical capital tends to decline. As discussed below, Montana firms are more interest rate sensitive than the national average, so the effects could be more pronounced in the state.

**Economic policy** National budget politics have returned to pre-pandemic norms causing increased policy and regulatory uncertainty. This year alone, there have been five months of continuing resolutions which makes decisions for government agencies challenging and leaves them little time to decide what to do with the appropriations once they are made.

Meanwhile, other elements of Federal fiscal policy have an uncertain future. Many tax benefits of the Tax Cuts and Jobs Act of 2017 set up to help individuals and families will expire in 2025. The end of pandemic-era support is reducing aggregate demand and generating a drag on growth. The impact of these factors, coupled with tightening monetary policy designed to ameliorate inflation, does not bode well for robust economic growth over the next couple years.

**Labor markets** Labor markets are in a state of flux. While the unemployment rate has dropped to pre-pandemic levels an alternative labor market indicator, the employment-population ratio, has not. The difference between these two data points is explained by the still considerable number of potential workers who have yet to re-enter the labor force. The reasons include: the impacts of the Covid unemployment insurance,

fear of rejoining the labor force because of the pandemic, and difficulties obtaining child care – which is particularly acute for women in the workforce. Longer term, an aging population is contributing to a shrinking labor force participation rate.

**Technology** As with all sectors of the economy manufacturing is also adopting new computer hard and software technologies, so-called Industry 4.0. A laundry list of technologies currently being used by manufacturers includes: the industrial internet of things, robotics, blockchain, artificial intelligence, 3D printing, local 5G networks, and more. Applying more technology reduces costs for worker safety and productivity while improving efficiency. Introducing technology is not without its repercussions: for many manufacturing practices traditional methods and skills will slowly phase out, subsequently requiring workers with different training, such as data analytics and computer programming. Cybersecurity and the protection of intellectual property rights is also a concern. More detail on technology in manufacturing can be found in the **Industry 4.0** box on pages 8 – 9.

## 1.2 Headwinds

This section summarizes the headwinds introduced above and provide some context as to how they may, or continue to, impact the state and national economies.

**Tariffs** Throughout 2018 the Trump administration imposed a number tariffs targeting appliances, solar panels, steel and aluminum across a broad range of countries, including some of America's closest trading partners. Also part of the package were tariffs imposed on Chinese imports. Altogether the US imposed about \$285 billion of tariffs on imports, with rates ranging from 10-25%. While the Biden administration has removed some of these tariffs, roughly \$350 billion worth of restrictions on Chinese imports remain in place. There is no consensus for how much the tariffs are contributing to higher import costs, but it is sector specific. For manufacturers requiring substantial amounts of tariffed intermediate goods, this continues to be an issue. However, the impacts of these tariffs are overshadowed by larger health and geo-political risks.

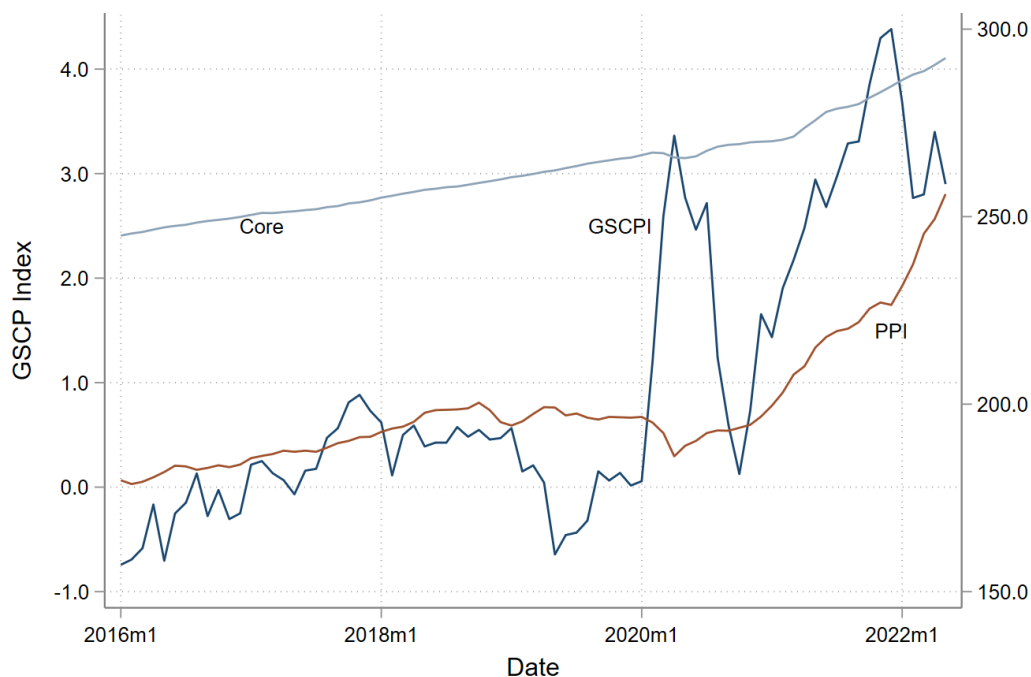
**Covid** The recession associated with the Covid pandemic officially ended in the US in April of 2020. Nevertheless, it this does not mean that Covid is done with us. In July 2022 the new Omicron variants, BA.4 and BA.5, though less virulent than previous variants are more contagious infecting over 3.8 million Americans. A new variant, such as BA.4.6, could continue to impact economies and would, therefore, require updating current economic projections.

**Russo-Ukrainian War** The invasion of Ukraine by Russia in February caused re-evaluations of all economic forecasts. Commodity prices, in particular grains and oil, have had negative impacts on both households and firms. A recent agreement between Russia and Ukraine has resulted in the resumption of Ukrainian grain exports leading to lower global agricultural commodity prices. The war has had a dramatic effect on European natural gas prices which may encourage policy makers to raise interest rates more sharply to control inflation by slowing demand growth.

Manufacturing in Asia, which is a net importer of oil, has driven up production costs for manufactured final intermediate good exports, further exacerbating supplies and prices of inputs. As the world's biggest manufacturing region, the impacts of the war on Asian producers undermine pre-existing pandemic-induced supply bottlenecks. The Ukrainian war also threatens to curtail global supplies of steel. The subsequent rise in oil prices is increasing transport and production costs. War tactics, such as cutting off transportation routes have led to logistics firms suspending services and air freight pushing up sea and air shipping rates. Shipping container prices remain \$5,500 higher than pre-pandemic levels.

**Fiscal Policy** While not a headwind, per se, relatively loose fiscal policy over the past three years has added considerable, though somewhat short-lived, demand for final durable and nondurable goods. Concurrently, because of the pandemic, there was a dramatic shift in household consumption behavior away from services towards durable and non-durable goods.

**Figure 1.2:** Global Supply Chain Pressure, the Manufacturing PPI and Core inflation



(Source: Bureau of Labor Statistics & Federal Reserve Bank of New York)

**Supply Chain and Inflation** The confluence of the above events are driving the highest rate of consumer inflation in over 40 years. The Federal Reserve Bank of New York constructs a supply chain index called the “Global Supply Chain Pressure Index” (GSCPI) which tracks stress in global supply chains. This is then translated into higher production costs, proxied by the manufacturers producer price index (PPI), and then consumer inflation. Figure 1.2 shows the relationship between these three economic indicators. We use the “core” rate of inflation, which removes more volatile food and energy prices, rather than the headline rate of inflation. Increases in the GSCPI are pushing up pro-

ducer costs which in turn are passed on to consumers. As the figure shows, consumer inflation was able to resist some of cost push inflationary pressures for a year or so, but in 2021 inflation began to accelerate.

Montana manufacturing output is twice as interest rate sensitive as the national average.

**Monetary Policy** To combat the rise of US and global inflation the Federal Reserve (Fed) and most other central banks have aggressively raised policy interest rates. The federal funds rate target currently stands at 2.25% but the median member of the Federal Open Market Committee anticipates this rate to be about 3.25% by the end of 2022 and 3.5% in 2023.

This results in an increase in all borrowing rates. This could undermine future investment by Montana manufacturers. In Montana about half of manufacturing firms have less than 10 employees. Because small firms rely more heavily on borrowing from commercial banks, they are more responsive to changes in interest rates. Nationally, a one percent rise in borrowing rates are associated with a 5% decline in manufacturing output, but in Montana this decline more than doubles.<sup>2</sup> Firms which rely on traditional bank financing are likely to face higher borrowing costs as the Fed applies the brakes to slow core inflation to its long run target level of 2%.

In addition, the rise in US interest rates is accompanied by a stronger US dollar as financial markets shift assets into dollar accounts. Since the Fed's announcement of higher interest rates, the US dollar has appreciated about 7% since August of 2021 – and 2% to the Canadian dollar. This is good for firms importing intermediate goods such as steel, but more problematic for those companies which export final products.

**Wildcards** One or more “wildcard” events could further impact the economy. A non-exhaustive list worth mentioning includes:

- Natural disasters and climate change: flooding, wildfire, drought, etc. For example, the recent flooding in north Yellowstone and Gallatin and Park counties;
- More virulent variants of Covid or some other disease, such as monkeypox;
- A more contentious and polemic US Congress could potentially have an impact on interest rates by raising the risk premium; and
- China-US relations and global political and social uncertainty.

---

<sup>2</sup>Additional details and estimates can be found in Appendix A.

## Industry 4.0: Technology in manufacturing

Manufacturing has evolved considerably from the nail factory made famous in Adam Smith's *Wealth of Nations*. It has grown from small artisanal workshops to hand crafted skill specialization to Ford's production line to robotics and now to increasing levels of technological computerization. There are a number of trends pertaining to the adoption of new technologies in manufacturing. This latest transformation is referred to as "Industry 4.0". The primary trends in Industry 4.0 are:

**Industrial Internet of Things (IIoT)** This generally tops the list of most important innovations in manufacturing. In the IIoT, interconnected devices are used in manufacturing plants to collect data that can be used to enhance and improve efficiency in the manufacturing process. This data can then be used by producers to evaluate machine performance; optimize maintenance schedules; reduce downtime; and predict future problems.

**Predictive maintenance** This refers to the use of artificial intelligence using sensor data to detect failures in manufacturing. This technology allows producers to make repairs before the equipment breaks down thus reducing costs and downtime. This technology can be used with older machines as well as those which are state-of-the-art.

**Robotics** Factories are becoming more and more automated, there is less demand for low-skill labor as machines take on a larger percentage of manufacturing duties. This lowers overall production costs and improves manufacturing productivity and accuracy. Workforce skill requirements will change as the production floor becomes more digitized and people work alongside collaborative robots (co-bots), which interact with human labor to do repetitive tasks or lift heavy objects

**Immersive Technology & 'Digital Twins'** Immersive technology, such as virtual reality and the metaverse, can be used to help design the entire manufacturing process, from floor layout to simulating and testing the supply chain. This can allow producers to consider the impacts of various types of "what-ifs" – particularly events that are outside the control of producers, such as a factory shut down in Romania, rising container costs, and a strike by longshoremen in Long Beach, CA.

**Additive Manufacturing** 3D printing reduces waste and uses less material than traditional methods. Moreover, it allows a more custom approach to production rather than a one-size-fits all approach which in the past allowed factories to gain economies of scale to reduce production costs.

**Sustainable Manufacturing** Climate change and commodity price volatility is leading manufacturers to adopt production techniques which are increasingly sustainable and require less energy. Moreover, the rapid growth of the internet of things (e.g. "smart" refrigerators), not to be confused with the IIoT, is changing what types of products are being manufactured. Producers will therefore have to explore ways to manufacture what customers want as consumer preferences move more reusable and recyclable products. Patience with planned obsolescence is also waning as customers would prefer to be able to fix a product rather than buy a new one. As younger generations enter their prime consumption years demand for longer lived products will only grow.



## Industry 4.0: Technology in manufacturing, continued

**Technology Infrastructure** These new technologies require a substantial amount of high-tech infrastructure. Fortunately advancements in infrastructure are becoming less costly to implement.

- **Big Data & Analytics:** New technologies require the ability to store and analyze increasingly large sets of data using different platforms, and programs. Combined with machine learning big data finds patterns in data to provide real time assessment of manufacturing worker productivity and safety while also improving efficiency and reducing costs.
- **5G Networks:** IIoT, Big Data, predictive maintenance, etc. require machines to be able to “talk” to each other quickly, continuously, and securely. More devices require more bandwidth and 5G networks allow even small firms to set up a reliable network to augment communication across multiple platforms.
- **Cloud Computing:** All this data needs storage space, and cloud computing helps bypass costly computer hardware and servers, “greasing the wheels” of data sharing across platforms. Additionally, it enables factory and remote workers to collaborate in real-time.

The above has obvious implications for structural changes in manufacturing’s labor demand. Among the relevant Industry 4.0 skills forecast to shift the most over the next decade or so are: operations research analyst, information security analysts, and computer numerically controlled tool programmers. Moreover, the global pandemic has shown that remote working is viable across all sectors – manufacturing included. The increased use of automation reduces the demand for on-site labor which can be replaced by, say, remote computer programmers or CAD designers. *The future of manufacturing is one where workers are free of routine tasks and able to focus on more innovative work.* In this version of manufacturing, employers will need qualified people in the workforce prepared for a technological world – a far cry from Smith’s nail factory.

Lastly, using technology does raise concerns about cybersecurity. A 2019 study by Deloitte and MAPI found that 48% of survey respondents identified operational risks, include security, as a threat to adopting technology in businesses. The greater interconnectedness of high-tech factories exposes businesses to greater security risk which could impact workers, technology, and the intellectual property of companies which embrace technology.

“Industry 4.0 technologies offer valuable opportunities for Montana to advance our manufacturing capabilities, and strengthen our national and global competitiveness,” said Paddy Fleming, MMEC Director. “Initial investment costs are decreasing, and the efficiency and quality gains provide strong ROI. Moreover, employees with advanced technology skill sets achieve higher wages and more advancement opportunities; Industry 4.0 is increasingly mitigating some of our critical talent and workforce challenges.”



Small, flexible collaborative robots (“cobots”) are well-suited to many repetitive tasks and other applications in manufacturing

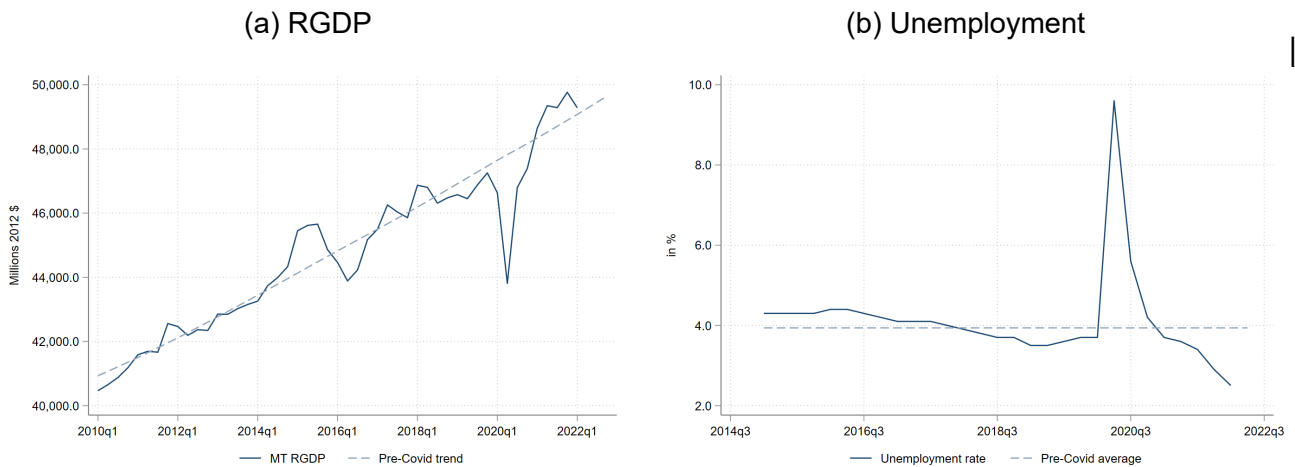
The future of manufacturing is one where workers are freed from routine tasks and are able to focus on innovation.

### 1.3 Montana Economy

Montana’s recovery from the Covid recession was robust. Real gross domestic product (GDP) returned to the pre-Covid trend in the first quarter of 2021, Figure 1.3(a) as did Montana’s unemployment rate, Figure 1.3(b). And the recovery has yet to lose much steam. Real GDP remains above the pre-Covid trend and the unemployment rate is the lowest it has ever been since state level unemployment rate was first published in 1976.

Montana has also been enjoying a rapid increase in its population. While the natural population growth rate of the state is zero, there have been substantial net inflows of people from other states. In 2021, Montana attracted about 20 thousand new residents and workers. We can see from Figure 1.4(a) that over 2021 the state consistently added nonfarm workers on par with the number of new residents, particularly in Flathead, Gallatin, Missoula, Ravalli, and Yellowstone counties. This migration has not come without repercussions as there has been

**Figure 1.3: Montana output (Real GDP) and unemployment rate**

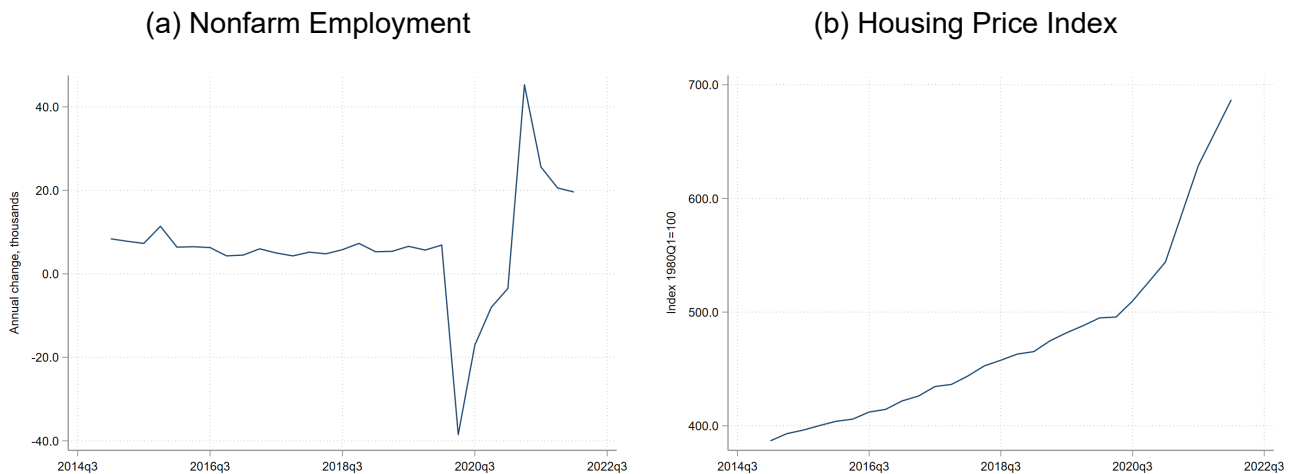


(Source: Bureaus of Economic Analysis and Labor Statistics)

considerable pressure on housing markets. Figure 1.4(b) shows a sharp inflection point in statewide housing prices in the second quarter of 2021 because home supply is been unable to keep up with demand.

Continuing net inflows of residents are likely to present the Montana economy with challenges and opportunities. The challenges will mostly arise in the short run and are familiar to issues the state faces today: high housing prices, insufficient infrastructure, inadequate health and childcare, etc. – though these are not issues idiosyncratic to Montana.

**Figure 1.4: Montana employment and housing**



(Source: Bureaus of Economic Analysis and Labor Statistics)

The benefits arise from a more skilled workforce which increase productivity and incomes for residents of the state. The number of IT workers increased by 1,700 between 2020 and 2021. This sector uses both specialized inputs and, itself, is an input to other downstream sectors. For example, manufactured goods are used in the technology sector, but also use computer

software for production. While this rapid inflow of highly skilled workers does create short term bottlenecks, over time the benefits accrued will diffuse throughout the economy.

## 1.4 Global Regional Overview

Many of the global regions are experiencing similar economic impacts of the ongoing pandemic and the Russo-Ukrainian war. Differences are primarily in the degree of impact. Countries which are more integrated in the global goods, energy, and financial markets are the hardest hit by disruptions to trade and supply side shocks.

### Europe and the European Union

The Russian invasion of Ukraine will have economic consequences for Europe. The resulting increases in commodity prices and supply disruptions lend themselves to further fueling inflation undercutting household incomes and firm profits. This is reflected in the OECD's downgrading of European economic growth shown in Table 1.1. Russia and Ukraine are anticipated to face even larger contractions. The escalation of inflation and policy required to fight rising prices are further compounded by disruptions to energy flows to the European Union member countries. Over the longer term, the war and its aftermath will likely result in structural challenges in a post-pandemic Europe.

### Asia and Pacific

Economic growth in Asia and the Pacific are dominated by the fortunes of China. The Russo-Ukrainian war looks likely to contribute to Asia's headwinds as the former soviet republics are significant sources of oil, gas, and other commodities. Moreover, rising energy prices will lead to a corresponding increase in transportation costs which could lead to a slowing of growth and rising inflation. The liberalization of China's economy has resulted in a sharp increase in household, firm and government debt, which could potentially have a negative impact on the Chinese economy within the next 5-10 years. China's Covid policy of lockdowns to prevent infections will also contribute to slower growth in the region. As seen in Table 1.1 both Australia and China had their forecasts downgraded by the OECD.

### Latin America and Canada

Latin America and Canada are not immune to the macroeconomic impacts of the war in Ukraine. Latin America's recovery from the pandemic was losing momentum even before the war in Ukraine and economic growth has been further hampered by unrest in the former soviet states. The war has worsened inflation and policymakers across the region reacted aggressively by tightening money while simultaneously implementing measures to reduce the effects of higher food and energy prices on low income households to ameliorate the risk of social unrest. Tighter monetary policy does come with an additional cost, and higher interest rates complicate debt management which could worsen as the war drags on.

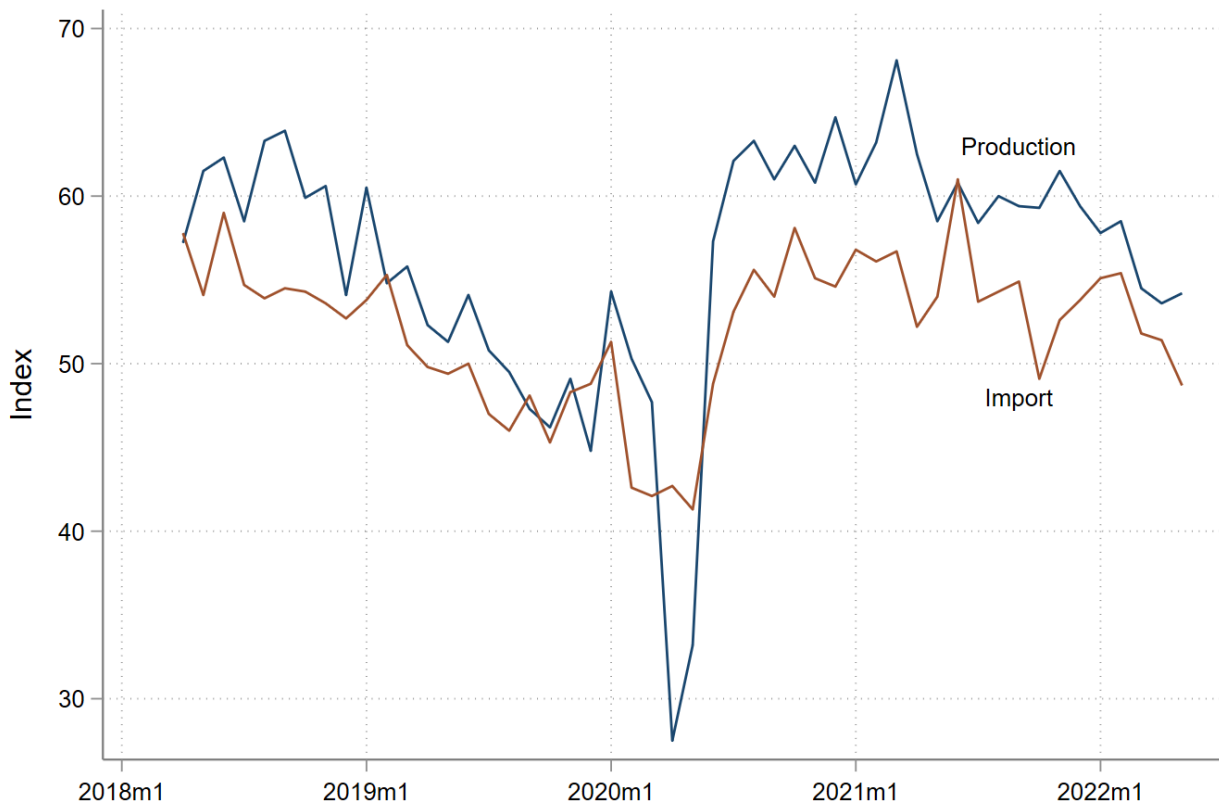
Canada continues to transition away from pandemic recovery to a more normal growth plan, however the war is also a spanner in the works for the upcoming year. Canada is less subject

to global economic volatility and is not seeing the same level of inflation that the US and some developed countries are. OECD forecasts of Canadian growth are unchanged for June compared to January and while the road to normality will not be smooth, it is forecast to grow about 3.8% in 2022 before returning to normal growth rates of about 2.2%.

### 1.5 National Manufacturing Overview

Despite ongoing pandemic related issues and the war in Ukraine, at the national level, manufacturers remain relatively upbeat. The National Association of Manufacturers 2022Q2 Manufacturers’ Outlook Survey finds that 83% of respondents are optimistic about their own firm’s outlook and expect sales to grow at almost 4.6% over the next 12 months. These numbers are lower than the first quarter results, but include the effect of the Russo-Ukrainian war.

**Figure 1.5: ISM Manufacturing Production Index**



(Source: Federal Reserve Bank of Philadelphia)

There are a number of caveats. First, 60% of manufacturers report that ongoing inflationary pressures raise the likelihood of a recession in the next year and noted that inflation was making it increasingly difficult to remain competitive. The reasons cited for these pressures are: increasing raw material prices (97.2%), transportation costs (83.9%), wages and salaries (79.5%), and energy costs (55.9%) – 49.4% also cite worker shortages. These apprehen-

sions are higher than those found in the Montana Manufacturing Survey which was conducted at roughly the same time.

Unease is reflected in two US ISM Manufacturing Indices illustrated in Figure 1.5, a score above 50 reflects an expansion: (i) the production index gauges the level of production activity in manufacturing as compared to the previous month and (ii) the import index measures the ease of getting imported intermediate production. Both have fallen off since January, but the production index remains more optimistic whereas the import index suggests that supply chain issues remain a challenge.

## 2 Manufacturing in Montana

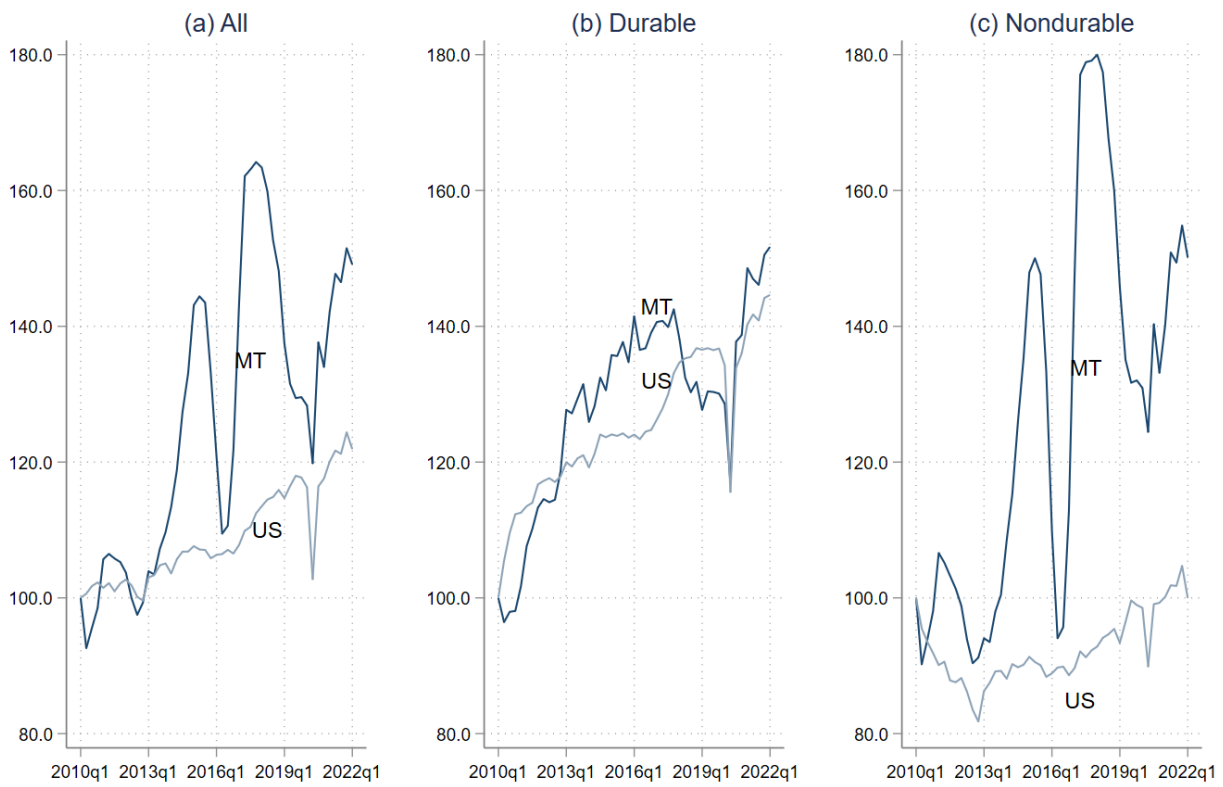
Manufacturers in Montana remain relatively optimistic compared to the national averages. And for good reason, Montana's manufacturing sector has generally out performed the nations manufacturers in the aftermath of the pandemic induced recession. As such, manufacturing continues to be a stable economic sector. In 2021 manufacturing employment as a share of total nonfarm employment was 4.3% growing 4.4% to 21,400 workers. Similarly, manufacturing's labor earnings as a share of Montana private industry grew 11.9% to \$1.6 billion which is about 6.4% of total state earnings. This translates to an average annual pay of \$57,000 in 2021. In 2021, manufacturing's share of total state output, gross state product (GSP), climbed 13.1% to \$3.8 billion, or about 7.8% of Montana GSP.

In 2021 manufacturing in Montana:

- Accounts for 6.4% of total private state earnings equaling \$1.6 billion
- Employs 4.3% of Montana's workforce, with about 21,400 employees with an average annual pay of over \$57,000
- Produced 7.8% of Montana's output with a value of \$3.8 billion

Montana manufacturing has been growing relative to the US as a whole. Comparisons between Montana and nationwide manufacturing output since 2010 can be found in Figure 2.1, which shows an index of all manufacturing production (2010Q1=100). Between 2010 and 2013 Montana's manufacturing kept pace with the national economy. However, after 2013 Montana's manufacturing output accelerated relative to the US. Manufacturing in Montana is about 50% larger today than it was in 2010 compared to 22% in the US, shown in Figure 2.1(a).

Montana durable goods manufacturing has mirrored patterns in the national average Figure 2.1(b), and has also outpaced the national economy. Nondurable manufacturing is presented in Figure 2.1(c). US nondurable manufacturing growth shrank between 2010 and the end of 2019, but has grown significantly in Montana, fueled by growth in the petroleum and coal and food and beverage sectors, discussed below. The sharp decline in nondurable manufacturing in 2016 is from declines in the value of manufactured goods in the petroleum and coal sector because of a sharp fall in oil prices.

**Figure 2.1: US and Montana manufacturing output (RGDP)**

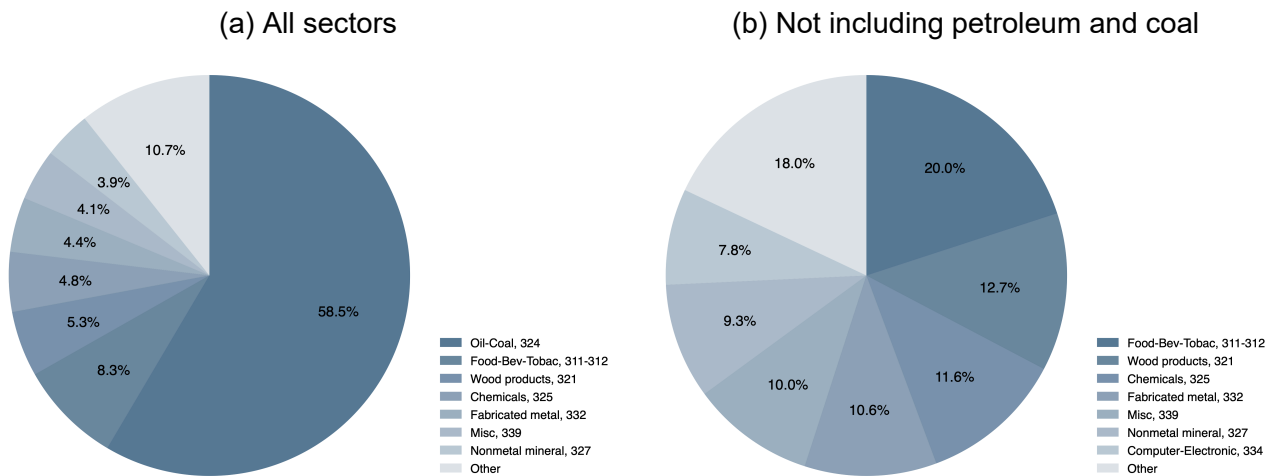
(Source: Bureau of Economic Analysis)

Figure 2.2(a) shows the share of total manufacturing earnings of the six largest sectors in Montana; only sectors with a 4% or larger share are presented. The largest Montana manufacturing industries in 2020, the most recent available data, were associated with the processing of crude oil and coal and the hospitality sector. Petroleum and coal products (primarily oil refining) was the largest manufacturing industry accounting for 58.5% of total manufacturing earnings in 2021, roughly the same as in 2020. The next largest industry was food, beverages and tobacco, rising from 2019 to 10.7% of earnings. Wood product manufacturing, fabricated metals, nonmetallic product and chemical manufacturing round out the remaining four sectors.

All other sectors accounted for about 15% of total manufacturing production. What is notable is the size of the oil and coal manufacturing sector relative to the other manufacturing industries. Removing this sector from the data provides insight into how the remaining sectors are distributed, presented in Figure 2.2(b). Only sectors with a 7% or better share of manufacturing output are included.

Manufacturing in Montana has recovered from Covid much more quickly than in the nation as a whole. Figures 2.3(a)-(b) show the net change in employment since February 2020, the beginning of the pandemic, and Figure 2.3(c)-(d) do the same for manufacturing output as measured by real GDP (RGDP). As the figures show, employment in Montana manufacturing

**Figure 2.2:** Composition of manufacturing in 2020 (percent of total manufacturing)



(Source: Bureau of Economic Analysis)

returned, and then surpassed, pre-pandemic levels by January 2021. US manufacturing employment has still not fully recovered by mid-2022. Output in both the state and the nation recovered by 2021Q3, but it was more pronounced in Montana.

What is driving this growth is the rapid recovery of nondurable manufactured goods. As shown in Figure 2.4, durable manufacturing employment returned to levels seen in early 2020 by the Fall of the same year, but nondurable employment did not return to pre-pandemic levels until one year later.

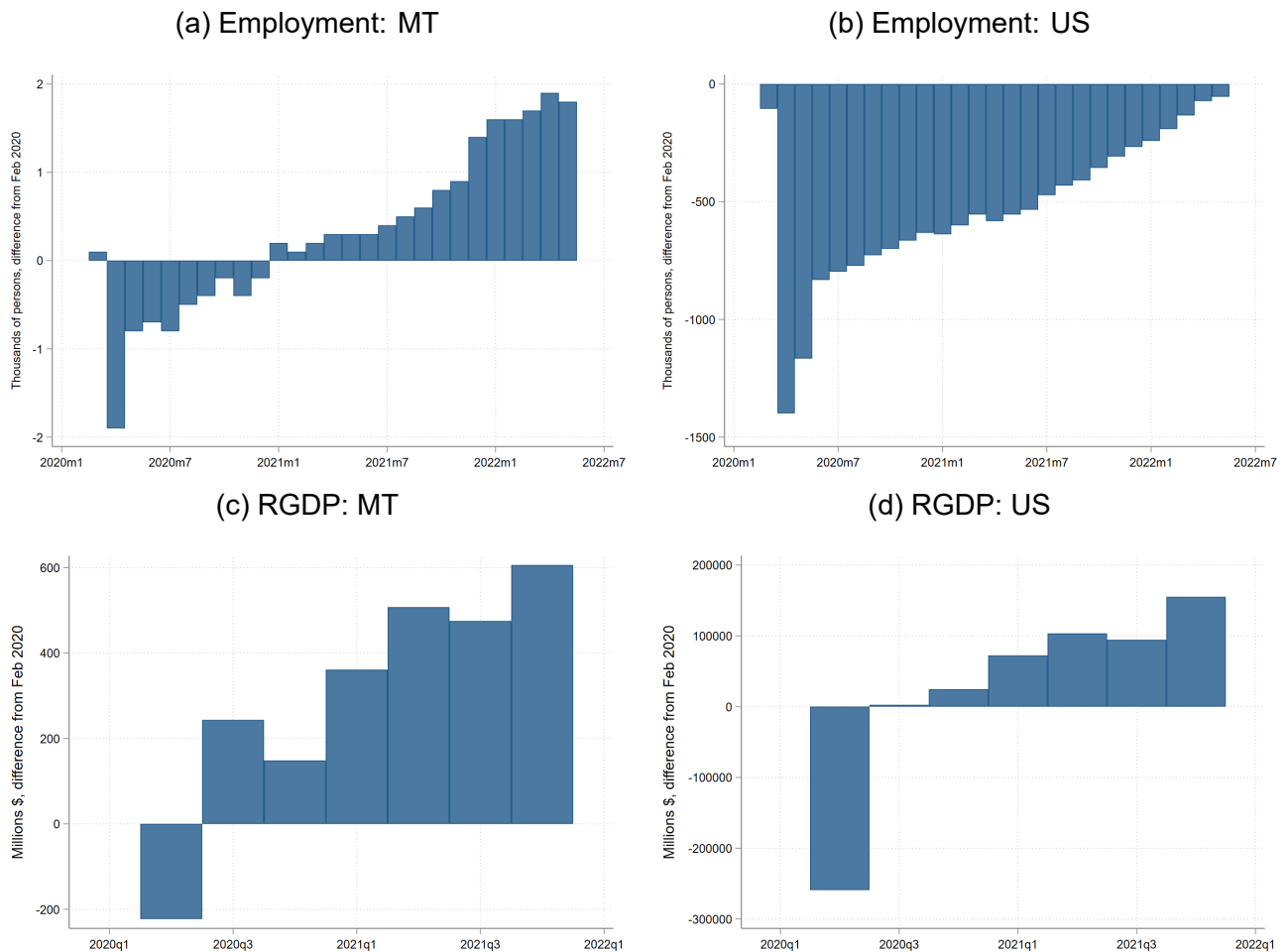
### Base Industries

Trends in the Montana economy are primarily determined by its base industries. Base industries are those which sell most of their products out of state or are otherwise influenced by factors beyond the state’s borders. Base industries inject new funds into the state economy and are responsible for creating income and jobs. To quantify the role base industries play in the Montana economy we consider labor earnings for each base sector.

Labor earnings data is more appropriate for analyzing trends from one year to the next and for periods of a decade or more. The share of basic earnings over the period 2009-21 in each of Montana’s base industries are shown in Figure 2.5. Collectively, the federal government, which includes the military, accounts for about 20.5% of base industry earnings. Manufacturing as a share of base industries is up to 20.1% from 16% last year. Tourism, proxied by the hospitality sector is now at 19.5%. Farming and military earnings fell and rose respectively when 2020 and 2021 are included. Transportation is more or less unchanged. Note, these shares include COVID and it is likely that tourism’s share of base industry earnings fell in 2020 which explains some of the drop in hospitality’s share.

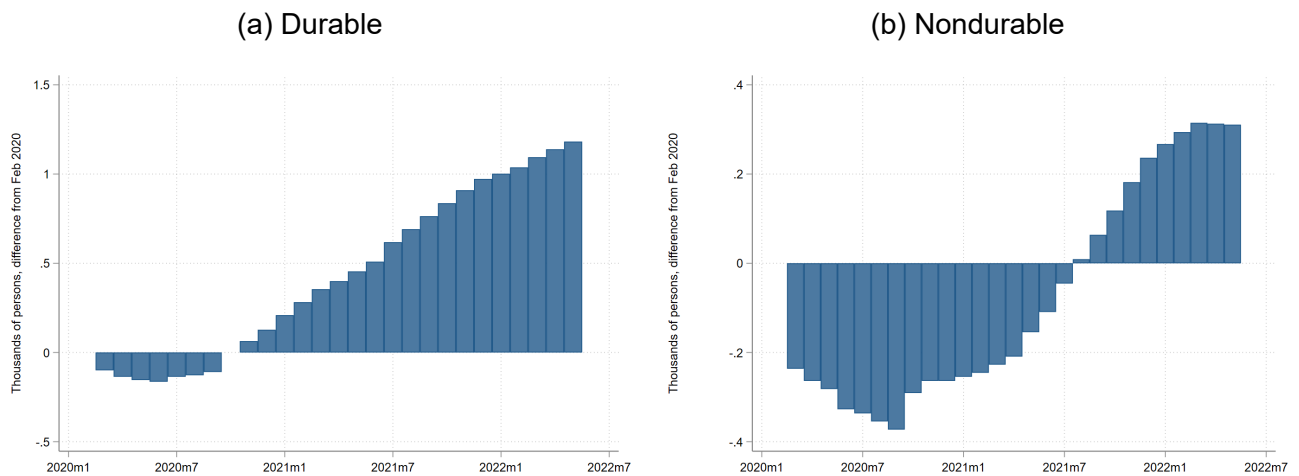


**Figure 2.3: Manufacturing Employment and GDP since 2020**

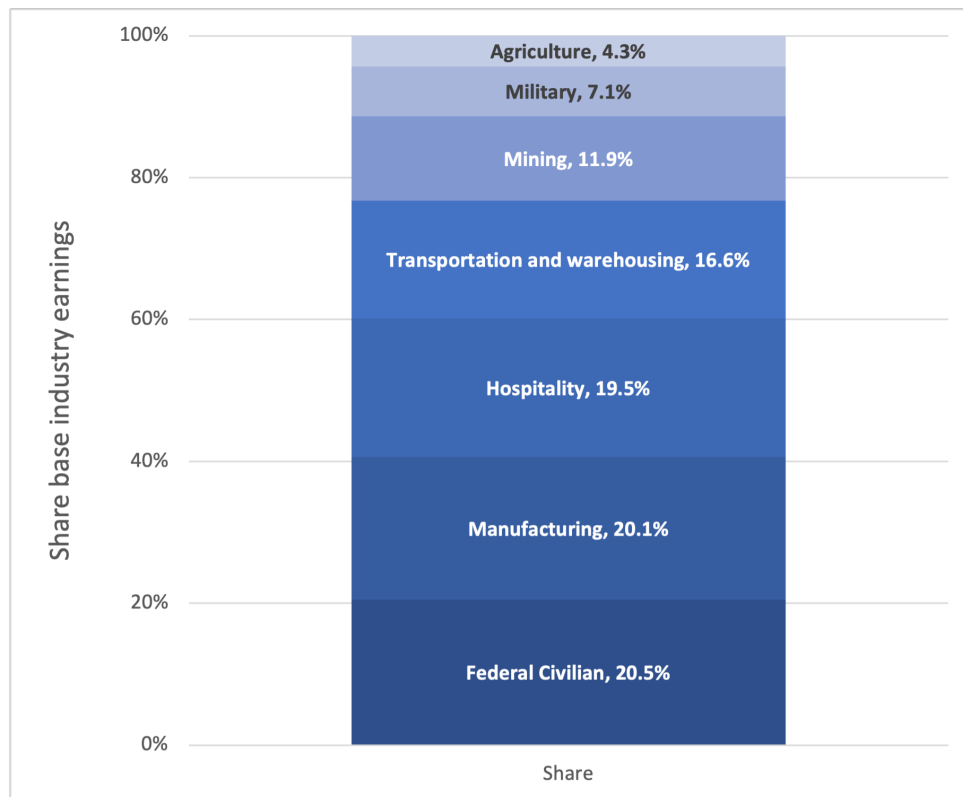


(Source: Bureaus of Business Analysis and Labor Statistics.)

**Figure 2.4: Montana Durable vs Nondurable Employment**



(Source: Bureau of Labor Statistics.)

**Figure 2.5:** Share of basic earnings in Montana, 2021

(Source: Bureau of Economic Analysis)

Manufacturing share of base industry earnings rose to about 20% – an increase of about 4% from last year’s report.

This is the first time since we started using hospitality as a measure of tourism that manufacturing represents a larger percentage of economic base than tourism – though it should be mentioned that 2020-2021 were COVID years when the tourism industry was down across the board.

## 2.1 Manufacturing Establishments

According to the Bureau of Labor Statistics (BLS), 1,773 Montana manufacturing establishments in 2021 have employees. The US Census Bureau has records for 2,482 manufacturing firms and Dunn and Bradstreet lists over 4,100 manufacturers in Montana.<sup>3</sup> For the remain-

<sup>3</sup>The explanation for the discrepancies in the number of firms is due to how companies are defined. The BLS numbers only include NAICS sector codes 31-33 which are defined as manufacturing whereas the Census Bureau’s and Dunn and Bradstreet’s definitions of manufacturing are broader. Secondly, the BLS only counts firms which have employees. Many manufacturing firms in the state are proprietor only businesses and therefore are uncouned in the BLS data, but are quantified by Dunn and Broadstreet.



There has been substantial growth in non-durable manufacturing in Montana, including the number of breweries, wineries, and distilleries.

der of this report we use the BLS's definition of manufacturing by restricting the discussion to NAICS sectors 31-33, "†"s indicate nondurable manufactured goods.

To better understand structural changes in Montana manufacturing, we first look at the one-year average and ten-year average growth rate for manufacturing firms from 2011 to 2021 from the BLS data (see Table 2.1). The ten-year average growth rate is a better way of gauging each sector as global market conditions change considerably year to year, particularly in the food and energy markets. Sectors such as petroleum and oil require significant capital investments making changes to the number of firms less likely.

The fastest-growing industries in terms of firm creation are beverages and tobacco (NAICS 312) and apparel (315) with an average 10-year growth rate of 10.8% and 10.3%, respectively. These sectors are twice that of the third fast-growing sector, transportation (336). Much of the growth in beverages and tobacco occurred from the formation of breweries, wineries and distilleries. One of Montana's traditional industries, wood products (321), gained slightly over this period with 0.8% more firms – this could be due to the growth of the housing market over 2020-22 because prior to 2021 this sector had been in decline over 10 years. Rounding out the bottom are petroleum and coal (324), textile mills (313), and paper (322), each losing an

**Table 2.1:** Number of Private Firms in 2021

NAICS	Commodity	2021	Share 2021	2020-21 growth	Mean 2011-21 growth
332	Fabricated Metal	285	16.4%	2.9%	4.6%
339	Miscellaneous	190	11.0%	2.7%	2.2%
311†	Food	184	10.6%	3.4%	0.7%
321	Wood Products	155	8.9%	4.7%	0.8%
312†	Beverage & Tobacco	148	8.5%	-1.3%	10.8%
337	Furniture & Related	136	7.8%	1.5%	1.3%
323†	Printing & Related Support Activities	107	6.2%	4.9%	2.4%
327	Nonmetallic Mineral	106	6.1%	1.9%	2.4%
334	Computer & Electronic	76	4.4%	15.2%	6.9%
325	Chemical	66	3.8%	1.5%	3.5%
333	Machinery	62	3.6%	-1.6%	4.0%
336	Transportation Equipment	59	3.4%	20.4%	5.4%
314†	Textile Mills	31	1.8%	-11.4%	-2.0%
326†	Plastics & Rubber	30	1.7%	25.0%	2.7%
316†	Leather & Allied	29	1.7%	-3.3%	4.9%
335	Electric Equip., Appliances & Components	23	1.3%	9.5%	1.4%
315†	Apparel	16	0.9%	0.0%	10.3%
331	Primary Metal	15	0.9%	15.4%	-1.8%
324†	Petroleum & Coal	9	0.5%	0.0%	-2.8%
313†	Textile Mills	3	0.2%	-25.0%	-2.8%
322†	Paper	3	0.2%	50.0%	-2.8%
	Total	1,733		5.5%	2.5%

(Source: Bureau of Labor Statistics, †denotes nondurable manufactured goods.)

average of 2.8% of firms every year over 10 years. It should be noted that there are very few firms in these sectors collectively accounting for less than 1% of manufacturing firms in the state.

Montana's manufacturing firms tend to be small businesses following a similar trajectory to the US as a whole. Table 2.2 breaks down manufacturing by sector and the number of employees using data from the US Census Bureau in 2020. Seventy-two percent, have less than 10 employees and only 1.4% have more than 100 employees. The largest number of firms are in fabricated metals (332), 452, and three-quarters are small-scale operations. The firms with over one hundred employees concentrate in four sectors fabricated metal, food, miscellaneous manufacturing (339), and wood products.

## 2.2 Manufacturing Annual Earnings by Industry

Table 2.3 provides insights into sector earnings and growth using the growth as in Table 2.1, sorted top-down by total earnings. Price volatility in some sectors distorts the value of output measures, such as gross state product, for specific industries, such as petroleum refining.

**Table 2.2:** Firms by the number of employees in 2020

NAICS	Commodity	<10	10 – 49	50 – 99	≥ 100	Total
332	Fabricated Metal	332	112	8	0	452
311†	Food	198	86	9	4	297
339	Miscellaneous	236	26	10	3	275
321	Wood Products	148	74	18	15	255
312†	Beverage & Tobacco	143	75	3	0	221
337	Furniture & Related	151	34	0	0	185
327	Nonmetallic Mineral	100	63	3	0	166
323†	Printing & Related Support Activities	129	36	0	0	165
333	Machinery	62	27	6	0	95
336	Transportation Equipment	57	19	0	3	79
325†	Chemical	44	23	7	0	74
314†	Textile Mills	48	10	0	0	58
316†	Leather & Allied	43	0	0	0	43
334	Computer & Electronic	21	11	0	0	32
326†	Plastics & Rubber	20	3	3	0	26
315†	Apparel	21	0	0	0	21
331	Primary Metal	14	0	0	7	21
335	Electrical Equip., Appliance, & Component	8	0	0	0	8
313†	Textile Mills	3	3	0	0	6
324†	Petroleum & Coal	0	0	0	3	3
	Total	1,778	602	67	35	2,482

(Source: Bureau of Labor Statistics, †denotes nondurable manufactured goods.)

Consequently, worker earnings are the best measure of the composition of manufacturing because it is the amount earned by manufacturing workers in the state.

The largest sectors in terms of earnings were the “traditional” petroleum and wood manufacturing industries.

While the apparel and beverage and tobacco industries are the fastest growing in terms of the number of firms, due to relatively low entry costs, computer and electronics (334) have experienced the most rapid earnings growth. However, it should be noted that computer and electronics make up a small share of total earnings accounting for \$58 million, or 5.3%, in earnings in 2021. The largest sectors in terms of earnings were petroleum and wood products, with 2021 earnings of \$170 million and \$133 million, respectively. However, average annual earnings growth over 10 years was 5% and 3%.

**Table 2.3:** Annual Earning in 2021 (millions of \$s)

NAICS	Commodity	2021	Share 2021	2020-21 growth	Mean 2011-21 growth
324†	Petroleum & Coal	\$176.5	16.2%	3.6%	5%
321	Wood Products	\$147.2	13.5%	10.2%	4%
332	Fabricated Metal	\$130.6	12.0%	9.7%	7%
311†	Food	\$117.0	10.7%	6.9%	4%
339	Miscellaneous	\$95.9	8.8%	16.6%	5%
333	Machinery	\$94.4	8.7%	17.0%	5%
325†	Chemical	\$85.5	7.8%	21.4%	4%
327	Nonmetallic Mineral	\$80.7	7.4%	8.9%	10%
334	Computer & Electronic	\$58.2	5.3%	-2.2%	9%
336	Transportation Equipment	\$53.7	4.9%	19.5%	9%
323	Printing & Related Support Activities	\$45.7	4.2%	6.5%	4%
312†	Beverage & Tobacco	\$44.5	4.1%	11.2%	7%
337	Furniture & Related	\$29.4	2.7%	10.4%	4%
326†	Plastics & Rubber	\$26.4	2.4%	20.1%	9%
335	Electric Equip., Appliances & Components	\$11.6	1.1%	10.1%	4%
331	Primary Metal	\$9.9	0.9%	0.5%	8%
314†	Textile Mills	\$5.7	0.5%	11.0%	2%
316†	Leather & Allied	\$2.7	0.2%	40.9%	8%
315†	Apparel	\$0.7	0.1%	-17.4%	
	Total	\$1,091	100.0%	10.8%	6.1%

(Source: Bureau of Labor Statistics, †denotes nondurable manufactured goods.)

### 2.3 Manufacturing Employment by Industry

Finally, we turn our attention to manufacturing employment in Table 2.4. The largest employer in manufacturing is in wood products, followed by food and fabricated metal. The sector with the fastest long run annual employment growth is beverages and tobacco, averaging 7.4% per year over ten years. This sector also grew a sizable 8.5% from 2020 to 2021. Transportation equipment also has average high annual growth, 6.6%, over the past ten years and over the last year transportation grew over 15% from 2020, though much of this is likely “catching up” after declines in demand and production stemming from the pandemic. Overall, manufacturing has averaged annual growth of about 3.0% over the past 10 years and in 2021 was 4.1% higher than the previous year.

**Table 2.4:** Employment in 2021

NAICS	Commodity	2021	Share 2021	2020-21 growth	Mean 2011-21 growth
321	Wood Products	2,713	12.8%	3.5%	0.3%
311†	Food	2,647	12.4%	1.9%	0.6%
332	Fabricated Metal	2,623	12.3%	6.3%	4.2%
339	Miscellaneous	1,978	9.3%	8.5%	2.1%
312†	Beverage & Tobacco	1,585	7.4%	3.0%	7.4%
324†	Petroleum & Coal	1,302	6.1%	-2.3%	1.7%
325†	Chemical	1,269	6.0%	10.6%	2.1%
333	Machinery	1,266	6.0%	6.3%	2.1%
327	Nonmetallic Mineral	1,239	5.8%	0.9%	4.4%
323†	Printing & Related Support Activities	945	4.4%	-2.0%	0.5%
336	Transportation Equipment	941	4.4%	15.3%	6.6%
334	Computer & Electronic	806	3.8%	2.0%	4.2%
337	Furniture & Related	695	3.3%	8.4%	1.4%
326†	Plastics & Rubber	553	2.6%	4.9%	4.8%
314†	Textile Mills	204	1.0%	10.3%	0.6%
331	Primary Metal	203	1.0%	-5.6%	3.1%
335	Electric Equip., Appliances & Components	183	0.9%	2.2%	0.9%
316†	Leather & Allied	87	0.4%	19.2%	3.0%
315†	Apparel	37	0.2%	-15.9%	
	Total	21,276		4.1%	2.8%

(Source: Bureau of Labor Statistics, †denotes nondurable manufactured goods.)

Manufacturing employment has averaged annual growth of about 3.0% over the past 10 years and in 2021 was 4.1% higher than the previous year

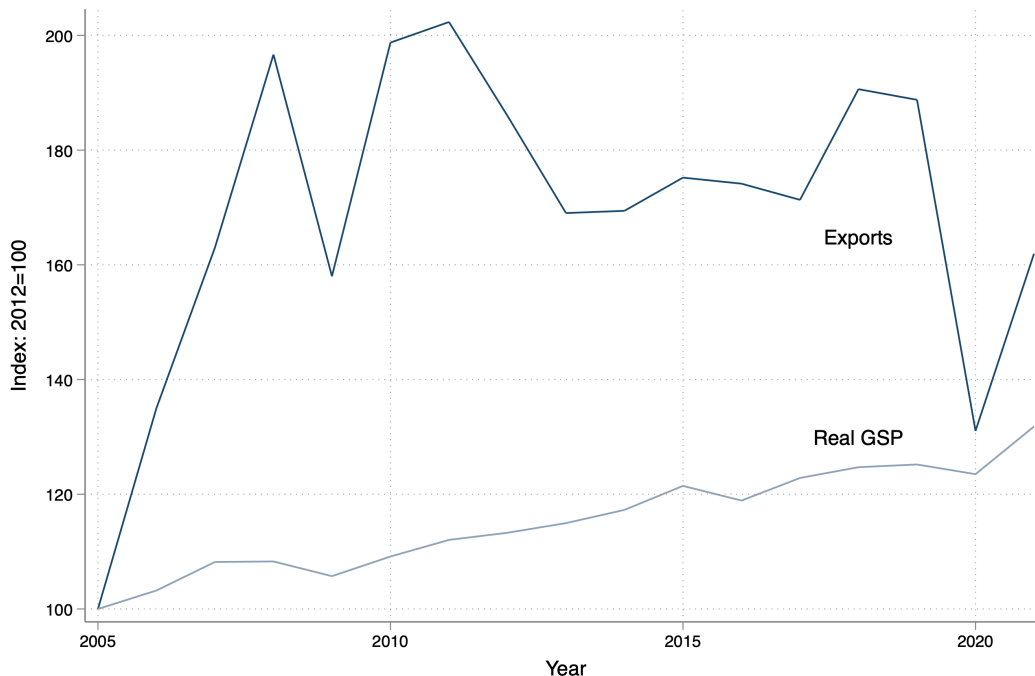
Beverages and tobacco manufacturing averaged 7.4% growth per year over ten years. This sector also grew a sizable 8.5% from 2020 to 2021, more than any other sector.

## 2.4 Montana's Manufacturing Exports

After a burst of growth in the mid-2000s, the value of Montana exports have remained relatively stable since 2012. Nevertheless, recent volatility in worldwide economic trends and policies have had an impact on Montana exports. The trend in Montana manufacturing exports adjusted for inflation from 2005 to 2021 is presented in Figure 2.6 and are compared to real Montana gross state product, all in 2012 dollars. The data is indexed to 2012 to make comparisons over time easier to see. In 2021, Montana exports were about 60% above their 2005 level while real GSP is about 30% higher over the same period. The decline in global

economic activity is evident in the decline in exports after 2019 and then the strong rebound from 2020 to 2021.

**Figure 2.6:** Montana real manufacturing exports and GSP.



(Source: US Census Bureau and Bureau of Economic Analysis)

In 2021, Montana manufacturers exported \$1.1 billion worth of goods, a 28% increase over 2020, but still about 10% below exports in 2019, reflecting the rebounding health of the global economy in 2021. Montana's primary export markets can be found in Table 2.5. The table also includes the share of total exports by sector, and the annual growth of exports for the years 2019 to 2020 and 2020 to 2021. Collectively, these 20 countries accounted for over 77% of total manufacturing exports. Canada, China, and South Korea alone represent almost half of total manufacturing exports. Notable is that half of Montana's top ten markets are in Asia. The fastest growing export market in 2021 was Singapore, in 2016 Singapore was Montana's 14<sup>th</sup> largest export market, jumping considerably in 2021.<sup>4</sup>

Montana manufacturing exports by industry are reported in Table 2.6, ranked by export value. As before, the table also includes the share of total exports by sector, and the annual growth of exports for the years 2019 to 2020 and 2020 to 2021. The largest export sector continues to be chemicals (NAICS 325), accounting for one-third of Montana exports, followed by machinery (333) and transportation equipment (336) accounting for 8% of total exports. These three sectors combined for over 60% of all manufactured exports. Two nondurable sectors, food and refined commodities (324) accounted for about 10% of manufactured exports. Beverages and tobacco exports fell dramatically between 2019 and 2021 and despite strong growth over the last year have yet to recover to pre-pandemic levels.

<sup>4</sup>Over the past decade Montana's manufacturing trade with Singapore has been trending down this increase is due to a one-time large export in the semi-conductor industry.



**Table 2.5:** Top 20 export markets, 2021 (millions of \$s)

Rank	Country	2021	Share 2021	% Change 2019-21	% Change 2020-21
1	Canada	\$332.1	30.1%	30.0%	-41.3%
2	China	\$104.8	9.5%	24.9%	11.3%
3	Korea, South	\$82.1	7.4%	54.1%	35.5%
4	Mexico	\$67.9	6.2%	47.6%	46.6%
5	Belgium	\$63.2	5.7%	30.1%	18.7%
6	Japan	\$54.9	5.0%	15.9%	-11.7%
7	Taiwan	\$52.6	4.8%	31.3%	-6.2%
8	Singapore	\$34.8	3.2%	109.8%	190.8%
9	United Kingdom	\$33.0	3.0%	13.5%	-13.2%
10	Netherlands	\$26.3	2.4%	56.2%	74.2%
11	France	\$21.9	2.0%	35.4%	22.8%
12	Germany	\$21.8	2.0%	-4.2%	-31.9%
13	Sweden	\$20.0	1.8%	157.0%	88.6%
14	Australia	\$17.1	1.5%	35.2%	106.1%
15	Malaysia	\$13.8	1.3%	19.9%	68.4%
16	Israel	\$10.9	1.0%	53.2%	244.5%
17	Norway	\$10.5	1.0%	103.0%	260.3%
18	Indonesia	\$9.7	0.9%	80.3%	-24.5%
19	Italy	\$8.9	0.8%	99.6%	58.3%
20	Denmark	\$8.9	0.8%	83.4%	144.3%
Total		\$1,103.2	77.2%	-9.8%	28.3%

(Source: USATrade, US Census. Total includes *all* countries.)

Half of Montana's top 10 manufactured export markets are in Asia. The top 3 export markets account for almost 80% of Montana's exports. The largest manufactured export was chemicals.

It is important to note that several of Montana's manufacturing sectors were relatively pandemic "resistant", for example, Chemicals, machinery, and primary metals all grew throughout the past two years. As with beverages and tobacco, transportation manufacturing exports took a hit during the pandemic.

## 2.5 Montana Manufacturing Forecast

What does the future for manufacturing hold? We provide some forecasts for four primary manufacturing indicators to shed light on what to expect over the next couple of years. As with any forecast, unforeseen events occur which can have global, national, and state level effects. To provide the structure of our forecasts we use IHS Markit's January and June

**Table 2.6:** Manufacturing exports by sector ranked, 2021 (millions of \$s)

NAICS	Export	2021	Share 2021	% Change 2019-21	% Change 2020-21
325†	Chemicals	\$367.1	33.3%	24.3%	31.7%
333	Machinery, Except Electrical	\$215.8	19.6%	25.4%	55.9%
336	Transportation Equipment	\$88.0	8.0%	-39.1%	1.8%
327	Nonmetallic Mineral	\$64.2	5.8%	-6.1%	22.7%
311†	Food & Kindred	\$54.4	4.9%	7.4%	-1.5%
324†	Petroleum & Coal	\$46.7	4.2%	8.4%	40.0%
331	Primary Metal Mfg	\$43.5	3.9%	44.9%	31.1%
334	Computer & Electronic	\$43.3	3.9%	-2.9%	12.4%
312†	Beverages & Tobacco	\$40.9	3.7%	-82.8%	35.2%
321	Wood Products	\$38.2	3.5%	22.1%	22.5%
339	Misc. Manufactured Goods	\$37.4	3.4%	33.3%	47.6%
335	Electric Equip., Appliances & Components	\$31.4	2.8%	-9.3%	9.7%
332	Fabricated Metal	\$10.3	0.9%	-46.0%	25.7%
326†	Plastics & Rubber	\$8.1	0.7%	18.7%	26.2%
316†	Leather & Allied	\$7.7	0.7%	-1.9%	-6.4%
315†	Apparel & Accessories	\$1.9	0.2%	-24.9%	17.4%
337	Furniture & Fixtures	\$1.5	0.1%	-0.4%	13.5%
314†	Textile Mill	\$0.9	0.1%	-6.7%	24.0%
323†	Printed Matter And Related	\$0.8	0.1%	35.7%	81.5%
313	Textiles & Fabrics	\$0.6	0.1%	-52.2%	21.0%
322	Paper	\$0.4	0.0%	-83.5%	25.4%
	<b>Total</b>	<b>\$1,103.1</b>	<b>100.0%</b>	<b>-9.8%</b>	<b>28.3%</b>

(Source: USATrade, US Census. †denotes nondurable manufactured goods.)

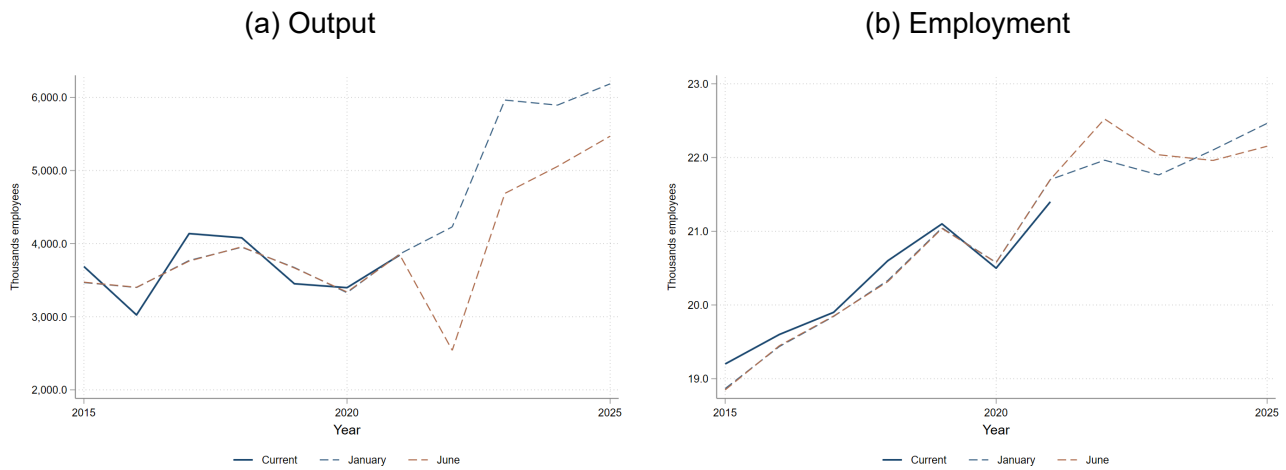
macroeconomic forecasts as control variables.<sup>5</sup> We compare predictions for output (real gross state product), earnings and employment using the January data which is pre-Russo-Ukraine War to the June version of IHS Markit's data which help to better understand the impacts of the war on Montana manufacturing. Forecasts are estimated using an ARIMA-X model, more details can be found in Appendix B.

In the absence of any new macroeconomic shocks, Montana manufacturing earnings are forecast to grow at a relatively constant rate through 2025. Output and employment will continue to grow but their growth will likely be bumpier.

Figure 2.7 shows the current data and two forecasts, one using the January data, the blue dashed line, and one using the June version, red dashed. Both output and employment follow an upward trajectory, but display considerable differences across the two forecasts, with the negative effects of the war plainly visible.

<sup>5</sup>IHS Markit, U.S. Economic Outlook, January and June 2022.

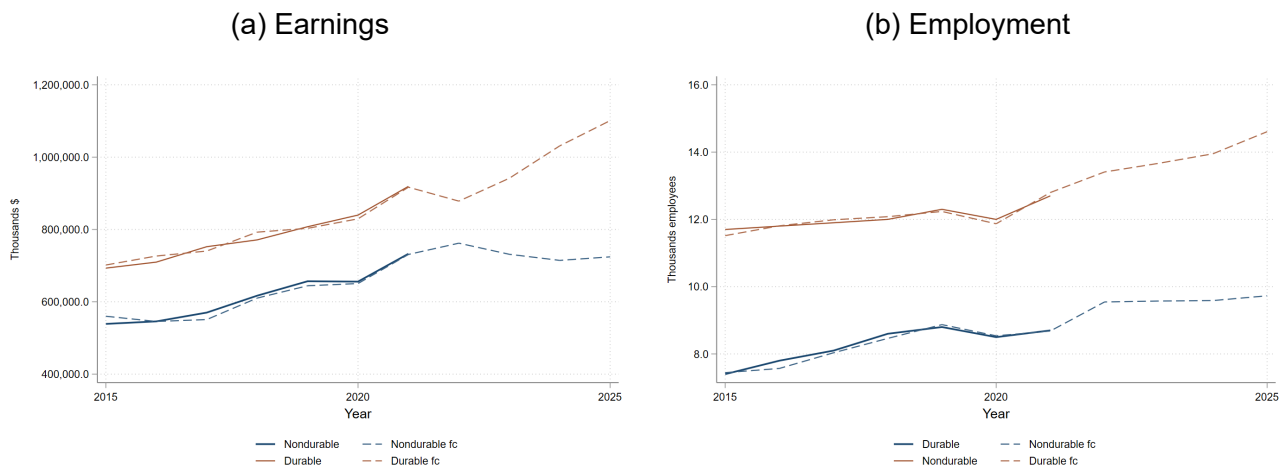
**Figure 2.7: Manufacturing Forecasts**



(Source: BBER, IHS Markit, Bureaus of Economic Analysis and Labor Statistics)

Lastly, we split the earning and employment into Durable and Nondurable manufacturing, Figure 2.8: durable is red and nondurable is blue, forecasts are the dashed lines. Here we only use the June scenario which includes the effects of the war and is more timely. The trajectory of these estimates are similar to those found in the Figure 2.7. Differences across these estimates reflect differences in inputs and demand. Nondurable goods include oil and food manufacturing and are more sensitive to commodity price fluctuations. Secondly, as we saw above, American households dramatically changed their consumption patterns during the pandemic which exacerbated some of the supply chains. Thus, as these patterns return to pre-Covid levels there will be some reshuffling of production which must be accounted for.

**Figure 2.8: Durable vs nondurable manufacturing forecast**



(Source: BBER, IHS Markit, Bureaus of Economic Analysis and Labor Statistics)

### 3 Montana Manufacturers Survey

Montana manufacturers are a diverse group of small- to medium-sized firms producing everything from beer to high-tech products. The Bureau of Business and Economic Research surveys manufacturers each year to gain insight into the previous year and inquire about their expectations for the upcoming year. Responses to the survey rose to about 175, an increase of about 25%, in 2021, with two-thirds of respondents being in the durable manufacturing sector. Montana manufacturers were queried about a number of indicators and whether they thought the indicator would increase, decrease or stay the same during 2022. This year the results of the survey have been divided into durable and nondurable manufacturers to gauge what challenges and the environment in each of the manufacturing sub-sectors. Surveys were completed by April 30, 2022 and therefore the responses reflect the economic climate during the ongoing Russo-Ukrainian War.

#### 3.1 Year in Review

Montana manufacturers were asked to report on their plant's performance in 2021. Montana manufacturers reported that 2021 was a moderately positive year with about one-half of firms reporting a better year. Twenty-five percent saw a decline, an improvement from 2020, but illustrating the continuing hang-over from the Covid induced recession which includes supply shortages and overall uncertainty.

Questions 1–3 asked how Montana manufacturers fared in 2021 vis-à-vis 2020 (Table 3.1). Overall, we can see that in 2021 roughly 20% of firms saw no change or an increase in their sales, production, and profit compared to 2020. As the table shows there are also some differences across durable and nondurable good manufacturers.

In 2021 over 55% of durable goods manufacturers experienced an increase in sales compared to 2020. Nondurable manufacturers sales rose 53% over last year.

Largely, as we have seen, the state, national, and global economies continue to return to pre-pandemic norms. As seen above, national manufacturing production is above the pre-pandemic trend but state is still about 8% below the 2020 trend. Nevertheless, responses in 2021 are more optimistic than in last year's survey.

In 2021, about 48% of firms made new major capital investment (Table 3.2), with 55% of nondurable manufacturers making significant changes to their capital. Fewer durable manufacturing firms reported making a sizable investment, with 44% responding yes. About 45% of firms reported investment in plant or equipment and 27% invested in information systems or software. Production capacity remained at 2020 levels for most of the state's manufacturers. Fully 94% of respondents reported that no production capacity was eliminated during the year.

**Table 3.1:** Survey questions: Sales, production and profit.

*For calendar year 2021, did your plant's **GROSS SALES** increase, stay about the same, or decrease from 2020?*

	Durable	Nondurable	Overall
Increase	55.3%	53.0%	54.6%
Stay about the same	26.3%	23.3%	25.3%
Decrease	18.4%	23.3%	20.1%
Count	114	60	174

*For calendar year 2021, did your plant's **PRODUCTION** increase, stay about the same, or decrease from 2020?*

	Durable	Nondurable	Overall
Increase	50.9%	55.0%	52.3%
Stay about the same	30.7%	23.3%	28.2%
Decrease	18.4%	21.7%	19.5%
Count	114	60	174

*For calendar year 2021, did your plant's **PROFITS** increase, stay about the same, or decrease from 2020?*

	Durable	Nondurable	Overall
Increase	43.4%	40.0%	42.2%
Stay about the same	26.5%	21.7%	24.9%
Decrease	30.1%	38.3%	32.9%
Count	113	60	173

**Table 3.2:** Survey questions: Investment and Capacity

*In calendar year 2021, did your plant make any major capital expenditure in facilities or equipment during the year?*

	Durable	Nondurable	Overall
Yes	43.9%	55.0%	47.7%
No	56.1%	45.0%	52.3%
Count	114	60	174

*Over calendar year 2021, did your plant permanently eliminate production capacity during the year?*

	Durable	Nondurable	Overall
Yes	4.4%	8.3%	5.7%
No	95.6%	91.7%	94.3%
Count	114	60	174

## 3.2 Employment

Employment for Montana's manufacturers was positive given the state of the economy (Table 3.3). The number of firms hiring more workers was higher than those that were downsizing,

22% as compared to 21%. Roughly half of the firms stayed the same. Unlike last year when about two-thirds of manufacturing firms did not experience any significant shortage of workers, in 2021 almost half recorded a worker shortage, and 48% of nondurable employers had difficulty finding employees.

**Table 3.3:** Survey questions: Employment

*Over calendar year 2021, did your plant's number of employees ...?*

	Durable	Nondurable	Overall
Increase	20.2%	26.7%	22.4%
Stay about the same	57.9%	55.0%	56.9%
Decrease	21.9%	18.3%	20.7%
Total	114	60	174

*Did your plant have a significant shortage of workers at any time during 2021?*

	Durable	Nondurable	Overall
Yes	45.6%	48.3%	46.6%
No	54.4%	51.7%	53.4%
Total	114	60	174

About 45% of firms reported investing in plant or equipment and 27% invested in information systems and/or software.

### 3.3 Supply chain: The COVID-19 Pandemic and Russia-Ukraine War

As discussed above, there have been continuing global economic shocks which have made navigating the production space relatively difficult. Ongoing pandemic shutdowns in China have slowed the supply of intermediate durable goods, the war in Ukraine has undermined global supplies of agricultural goods and cause oil and associated energy and transportation costs to rise. Couple these with the continued tariffs on imported intermediate goods prices for manufacturing inputs and production costs remain elevated. As reported in Table 3.4, Montana manufacturers have not escaped this economic environment. 7.6% of manufacturers anticipate their supply chain to improve in 2022, with only 5% of nondurable producers expecting an improvement. Unfortunately, as of now, the light at the end of the tunnel remains faint. The war in Ukraine appears to be ongoing for some period of time and new variants of the omicron Covid variant continue to force temporary closures in China.

Given the state of the economy in face of a global pandemic and war between Russia and Ukraine, the 2021 BBER manufacturing survey asked questions about how these shocks impact Montana's manufacturers. Generally, the partial shutdown of the economy did not have the medium to long term effects on the economy initially forecasted. Manufacturers in the state do report some understandable interruptions in the industry, but they did not turn out to be as problematic as they might have been.

**Table 3.4:** Survey questions: Supply chain

*What do you anticipate will happen with your plant's supply chain in 2022?*

	Durable	Nondurable	Overall
Get worse	44.1%	53.3%	47.4%
Stay about the same	46.8%	41.7%	45.0%
Will improve	9.0%	5.0%	7.6%
Total	111	60	171

Roughly 39% of nondurable manufacturers reported having supply chain issues compared to 62% of durable firms.

Table 3.5 quantifies survey responses to the open-ended question “What were the major issues that affected your plant in 2021?” There are interesting differences between the durable and nondurable producers. For example, roughly 39% of nondurable manufacturers reported having supply chain issues, compared to about 62% of durable firms. Also notable is that 100% of durable manufacturers reported “increased demand” as major issue, while no nondurable producers did. As discussed above, during the pandemic households shifted spending patterns away from services – restaurants, bars, movies, etc – towards merchandise. As spending patterns return to pre-pandemic norms we should see this issue become more balanced.

Alternatively, over two-thirds of durable employers had troubles finding suitable employees but less than one-third of nondurable firms did. The subsectors were equally concerned about government regulations and Covid related issues, with 50% replying yes to these issues.

**Table 3.5:** Major issues that affected individual manufacturing plants: % responding yes

Issue	Durable	Nondurable
Availability or cost of raw materials	61.5%	38.5%
Transport, shipping, supply chain problems	60.9%	39.1%
Increased demand	100.0%	0.0%
Decreased demand	54.5%	45.5%
Internal issues or issues unrelated to business such as health	100.0%	0.0%
Inability to find employees	69.4%	30.6%
Government restrictions, general government	50.0%	50.0%
COVID-19 related such as absentees, closures	50.0%	50.0%
Fuel cost	33.3%	66.7%
Inflation	60.0%	40.0%
None	50.0%	50.0%

### 3.4 Manufacturer's Expectations for 2022

The final part of the survey asked producers to make predictions about the upcoming year. Results are tabulated in Table 3.6. The predominant response is that the foreseeable future will progress along the same lines as the past year or so. The notable difference is employment. Durable manufacturers anticipate more employees, about 33%, but also suspect it will be a challenge, 41%. About one-third of durable and nondurable manufacturing firms expect both recruitment and retention to be a challenge

**Table 3.6:** In 2022 do you anticipate ...

<i>...the number of employees in your plant to?</i>			
	Durable	Nondurable	Overall
Increase	33.0%	21.7%	29.1%
Stay about the same	54.5%	61.7%	57.0%
Decrease	12.5%	16.7%	14.0%
Total	112	60	172

<i>...major capital investment expenditures?</i>			
	Durable	Nondurable	Overall
Yes	38.9%	36.7%	38.2%
No	61.1%	63.3%	61.8%
Total	113	60	173

<i>...the cost of your plant's major inputs to?</i>			
	Durable	Nondurable	Overall
Increase	73.0%	78.3%	74.9%
Stay about the same	22.5%	18.3%	21.1%
Decrease	4.5%	3.3%	4.1%
Total	111	60	171

<i>...the human resources/employment challenges you will face?</i>			
	Durable	Nondurable	Overall
Recruitment	41.1%	35.0%	39.0%
Retention	4.5%	13.3%	7.6%
Recruitment and retention	35.7%	35.0%	35.5%
Neither will be a challenge	18.8%	16.7%	18.0%
Total	112	60	172



## 4 The Montana Manufacturing Extension Center

The Montana Manufacturing Extension Center (MMEC) is a statewide manufacturing outreach and assistance center staffed by full-time professionals with extensive experience in manufacturing and business in a variety of industries. MMEC's mission is to grow Montana's economy by helping manufacturers succeed.

MMEC serves the manufacturers of Montana by helping them assess and improve their manufacturing operations, providing trainings and workforce development, and leveraging research and technological developments to keep manufacturing competitive in the state.



MMEC Business Advisors work closely with Montana manufacturers to help improve their operations

Established in 1996, MMEC is housed in the Norm Asbjornson College of Engineering at Montana State University in Bozeman, with remote offices in Billings, Missoula, Kalispell, Great Falls and Butte. The Center's staff has a combined experience of hundreds of years in manufacturing and offers expertise on a broad range of topics.

MMEC is also part of the National Institute of Standards and Technology's Manufacturing Extension Partnership (MEP) National Network. NIST is a non-regulatory agency of the U.S. Department of Commerce that promotes U.S. innovation and industrial competitiveness. The

MEP National Network is a unique public-private partnership with centers in all 50 states and Puerto Rico dedicated to serving only small and medium-sized manufacturers, who pay fees for services provided.

Since 2000, MMEC's clients have reported project impacts to their businesses through an independent third-party survey. Results of these surveys show that MMEC has strengthened Montana's manufacturing economy between 2000 and 2021 by generating:

<b>\$358.5 million</b>	<i>new investment</i>
<b>\$1.46 billion</b>	<i>new and retained sales</i>
<b>6,878</b>	<i>new and retained jobs</i>
<b>\$177.9 million</b>	<i>cost savings</i>

The MMEC evaluation process follows guidelines developed by the National Institute of Standards and Technology (NIST) as part of its management information reporting procedures. NIST specifies the timing of the evaluation and provides a standardized questionnaire distributed to manufacturing firms served by MMEC. The analysis of the surveys and a written report are provided by an independent analyst.

Manufacturing clients are asked to evaluate the effectiveness of MMEC and to quantify the economic impact of MMEC's activities on their business and its effects on the Montana economy. Clients are surveyed six months after a project is complete and asked about their satisfaction with the services they received. These respondents are also asked to quantify certain economic impacts and outcomes associated with the MMEC project. MMEC sent the independent analyst preparing this report the questionnaires for the 2021 evaluation period. There were 90 responses in the 2021 evaluation. These responses provided the largest sample size since the evaluations began, eclipsing the 68 responses in 2020.

## 4.1 Overall Satisfaction

Manufacturing clients said they relied on MMEC and were very satisfied with the services received. In 2021, about 34% percent of the respondents said they relied on external services (Table 4.1), roughly the same as in from 2020 when 37% of respondents relied on external services.

**Table 4.1:** Have you used any external providers for business performance services?

	Frequency	Percent
No	59	65.6%
Yes	31	34.4%

Montana manufacturers were asked if they would recommend MMEC to other potential clients. They were asked to rate the likelihood of a positive recommendation with one being the least likely and 10 being the most likely. As shown in Table 4.2, about 90% of 2021 respondents chose a score between 8-10. Six did not respond to this question. The net promoter score, which is the percent of respondents choosing nine or 10 minus the percent of respondents with scores of six or below is 82.2.

**Table 4.2:** Would You Recommend To Other Companies (Scale 0 – 10)

Score	Frequency	Percent	Cumulative
NA	6	6.7%	6.7%
3	2	2.2%	8.9%
6	1	1.1%	10.0%
8	4	4.4%	14.4%
9	4	4.4%	18.9%
10	73	81.1%	100.0%
	90	100.0%	

### Client Comments

The NIST questionnaire provides a number of opportunities for Montana manufacturers to provide suggestions and comments to MMEC. These responses were edited slightly to preserve anonymity and grouped by topic. These comments provide insight into the many ways manufacturers are benefitted by MMEC services. The vast majority of the comments are highly positive and detailed. As in the past, respondents made several specific suggestions concerning ways in which MMEC may further tailor its services in the future.

### Professionalism and Relevance

Paddy Fleming was excellent to work with. He made himself available multiple times for consultation as well as provided expertise within the market segment. He was also able to provide excellent qualified leads for our Company to follow up with resulting in reduced cost to generate leads and sales.

They have been very helpful and have put us in touch with several potential suppliers and partners

This was done during Covid-19 restrictions and complications. Its hard to compare what it would be like in and NON-World Pandemic! The MMEC team was incredible and was on site and involved in the process. Very engaged and very informed.

TDMI was extremely valuable in quantifying my "gut instinct." That research also led to adding services to our portfolio and driving future investment in R&D.

Working with Doug is great. He has helped me take a deeper look at our true costs which has helped in our decision making. Doug has greatly improved our efficiency as an overall unit. This has led to greater profitability and job satisfaction for the team.

We're very fortunate to have MMEC in Bozeman. The service and support they provide is a great asset to our tech community.

Thanks. I thoroughly enjoy working with MMEC. I have learned how to focus on what is important for the business to grow and give our employees more responsibility. Our growth plan most likely would not have happened if not for everyone I have worked with at MMEC.

### Suggestions for MMEC

I under-estimated the time we would still need on our side to implement a lot of these changes. As a result it did take us more time and resources to implement outside of the money we paid to MMEC. This could be something the Center can evaluate when starting a project.

Continue to provide small food businesses with expert assistance with food safety regulations Continue to offer assistance to small business owners who are planning to sell their businesses Consider offering advice and/or information for helping businesses add individual packaging to their product offerings

Very difficult year to assess value gained (Covid impact). MMEC coordinated several efforts with Montana Manufacturers to support the PPE needs Regular business greatly impacted recovery is slow but we are still here MMEC has been instrumental in helping our Executive Team identify strengths and weaknesses within our organization and ourselves. Alistair has helped increased the transition readiness of [the company] as we move from an entrepreneurial style to a professionally managed manufacturing business focused on profit velocity.

I think MMEC should work with Gallatin College and Montana State University to teach Lean Manufacturing to students in the CNC and engineering programs.

## 4.2 Why Choose MMEC

The NIST questionnaire provided eight factors for choosing MMEC and the respondents were asked to identify the two most important. The responses are reported in Table 4.3, with responses from 2019 and 2020 for comparison. Staff expertise remains the primary reason respondents choose to use MMEC, down about 4 percentage points to 63.3% from last year.

The second most important factor for firms choosing MMEC was the MMEC's costs with about 29% of the respondents mentioning this factor, down from 2020. Fair and unbiased advice, with 26%, remains third and slightly higher from the previous two years. Reputation for results claims the fourth position, with 22% responding positively. Also slightly up is knowledge of the respondent's industry. Down in 2021 are the responses to specific knowledge, down to 13.3%, which may be the result of general uncertainty due to the Covid pandemic. Only 4% responded that they used MMEC because no other nearby providers were available.

**Table 4.3:** Important factors for your firm choosing MMEC

Factor	2019	2020	2021
Center staff expertise	69.8%	67.6%	63.3%
Cost price of services	36.5%	33.8%	28.9%
Fair and unbiased advice services	25.4%	25.0%	25.6%
Reputation for results	17.5%	22.1%	22.2%
Knowledge of your industry	11.1%	19.1%	20.0%
Specific services not available from other providers	7.9%	20.6%	13.3%
Other	11.1%	4.4%	6.7%
Lack of other providers nearby	9.5%	5.9%	4.0%

## 4.3 Future Challenges

The NIST questionnaire provided two opportunities for the respondents to identify future challenges they may face. The first opportunity instructed the respondents to pick three of nine categories of potential future challenges and the second was an open-ended question. Given the unique circumstances surrounding the COVID pandemic throughout this section, as before the report includes responses in 2019 and 2020 as well.

As shown in Table 4.4 in descending order of 2021 responses, the most often mentioned future challenges were ongoing continuous improvement/cost reduction strategies (61%). Personnel issues (employee recruitment and retention) has consistently climbed since 2009 and ranked second in 2021 with 60% of respondents stating this is likely to continue to be a challenge, providing further evidence of an ongoing labor market tightening. Identifying growth opportunities is the third most frequently mentioned challenge, largely unchanged from last year. Falling considerably in 2021 was Product Innovation/Development, which lost about 27 percentage points, but remained the fourth most often mentioned challenge. The least mentioned were exporting/global engagement falling to 5.6% and technology needs (8%). Financing as a challenge fell back 11% in 2021, the same as in 2019. Though the

**Table 4.4:** Important future challenges facing your business

Factor	2019	2020	2021
Ongoing Continuous Improvement/Cost Reduction Strategies	71.4%	70.6%	61.1%
Employee Recruitment and Retention	46.0%	54.4%	60.0%
Identifying Growth Opportunities	36.5%	45.6%	44.4%
Product Innovation/Development	42.9%	45.6%	27.8%
Managing partners and suppliers	20.6%	16.2%	24.4%
Sustainability in products and processes	20.6%	14.7%	21.1%
Financing	11.1%	17.6%	11.1%
Technology Needs	12.7%	10.3%	7.8%
Exporting/Global Engagement	12.7%	7.4%	5.6%

Paycheck Protection Program (PPP) provided necessary funding in 2020 commercial loans fell back to trend until mid-2021 as the recovery gained traction and lending risk fell.

#### 4.4 Quantitative Estimates of MMEC Visit Outcomes

The NIST survey asked Montana manufacturers to quantify outcomes of their MMEC services. They were asked the number of new and retained jobs, the amounts of cost savings, new and retained sales, capital and workforce investments and avoided unnecessary investments during the previous 12 months. Starting in 2009, the respondents were queried further about four detailed investment categories.

Table 4.5 shows the results for the 2021 responses to the quantitative outcomes. There was a considerable jump in outcomes in the 2021 survey over several categories – though is due to the 33% increase in the number of survey participants. The 2021 respondents said that there were 479 new or retained jobs as a result of working with MMEC. New and retained sales were about \$74.5 million. Cost savings totaled approximately \$8.5 million. Capital and workforce investments were roughly \$4.9 million down. Avoided unnecessary investment totaled about \$3.3 million. The final column totals all the survey responses from 2013 to 2021.

#### 4.5 Economic Impacts of MMEC Visits and Services

MMEC clients were queried about the number of new jobs created and the number of jobs retained as a result of working with MMEC. The 2021 respondents reported 210 new jobs created and 269 jobs retained for a total of 479 jobs.

The preliminary data suggest that average wages for Montana manufacturing jobs were about \$57,156 in 2021 – compared to the state average income of \$50,756 – up from \$54,178 in 2020. Total wages associated with the new and retained jobs were approximately \$27.4 million. Using an average tax rate of 4.95%, the new and retained workers paid approximately \$1.4 million in Montana individual income taxes.

**Table 4.5:** Total sales, costs, investments and jobs earned or saved in 2022

	2020	2021	Total: 2013-2021
Total jobs created/retained	310	479	3,830
Retained	234	269	-
Created	76	210	-
Total sales increased/retained	\$55,245,202	\$74,502,332	\$649,748,595
Increases	\$20,783,401	\$39,056,836	-
Retained	\$34,461,801	\$35,445,496	-
Total Investment	\$14,060,502	\$21,534,252	\$194,540,483
New product	\$4,226,000	\$2,734,879	\$14,385,874
Workforce	\$842,484	\$1,380,794	\$7,075,933
Plant or equipment	\$4,008,760	\$9,823,817	\$65,696,297
Information systems/software	\$637,971	\$725,420	\$5,665,482
Other	\$4,345,287	\$6,869,342	\$101,716,897
Avoid unnecessary investments	\$2,355,038	\$3,290,337	\$13,921,382
Cost savings amount	\$10,297,945	\$8,496,615	\$68,787,386

The Montana Department of Labor and Industry estimates that the employment multiplier of manufacturing is 3.58. This suggests that about 2.58 new jobs will be created in other sectors as a result of one new manufacturing job. This agency also reports that the wage multiplier is 2.72, implying that an additional \$1.72 in wages is created elsewhere in the Montana economy for each \$1 in new manufacturing wages.

**Table 4.6:** Economic impacts of MMEC services, 2021

Sector	Jobs	Wages	Montana individual income taxes
Manufacturing	479	\$27,377,724	\$1,355,197
Other industries	1,236	\$47,089,685	\$2,330,939
Total	1,715	\$74,467,409	\$3,686,137

Calculations based on employment and wage multipliers are reported in Table 4.6. The 479 new and retained jobs associated with MMEC services reported in 2021 led to a total of 1,715 new jobs in Montana and approximately \$74.4 million in statewide wages. The additional wages generated roughly \$3.7 million in Montana individual income tax revenue.

## 4.6 Return on Investment and Fees

MMEC is a public-private partnership that was awarded \$727,975 in 2021 from the National Institute of Standards and Technology with a match requirement. In 2021, MMEC matched the federal funds with \$500,000 from the state of Montana and \$477,414 in project fees that were charged to Montana manufacturers who requested MMEC services. The benefits of these investments may be estimated by calculating a return on investment (ROI) for each.

The ROI for the state of Montana is calculated by comparing the estimated increase in Montana individual income tax payments associated with the reported jobs created or saved due to working with MMEC. The ROI for MMEC clients is estimated by comparing the cost savings, plus avoided unnecessary investment, plus a portion of the increased sales to the amount paid by clients.

In 2021

- MMEC’s ROI to the Montana taxpayer was **7.4 to 1**.
- ROI for private firms was **42.8 to 1**

As shown in Table 4.6, MMEC projects generated approximately \$3.7 million in Montana individual income taxes from both direct and indirect jobs. Based on \$500,000 calendar year funding for MMEC, Montana’s return on investment during 2021 was approximately 7.4 to 1.0, a considerable rate of return for Montana taxpayers.

As presented in Table 4.5, MMEC clients reported \$8,496,615 in costs savings, \$3,290,337 in avoided unnecessary investments and \$74,502,332 in new or retained sales. Assuming a modest 10% gross margin, the net gain to clients of the new or retained sales was \$8,628,928.40.

Cost savings + avoided investments + gross margin associated with new and retained sales equals \$20,415,880. Based on the \$477,414 in fees paid by MMEC clients, their return on investment in 2021 was approximately 42.8 to 1.0. Similarly, fees paid by MMEC clients similarly provide them an excellent return. This is a considerable ROI, however it comes with the caveat that 2021 continues to be a unique year. It should be noted in previous years the adjusted cost savings was used in the ROI calculations, whereas this year the actual data is being used.



## Appendix A Estimated interest rate elasticities

To measure the responsiveness of output and earnings to interest rate we used the following statistical model:

$$\ln Y_t = \alpha + \beta R_t + X_t' \gamma + \epsilon_t$$

where  $Y$  is alternatively defined as output, in the case of manufacturing output and earnings for Montana total, durable and nondurable manufacturing subsectors.  $R$  is alternatively defined as the AAA and BAA corporate yields and represents borrowing rates.  $X$  is a control vector which includes the Federal Reserve Banks of Cleveland's inflation risk premium and the current and forward output gap. The estimate of  $\beta$  is the parameter of most interest and is given as

$$\hat{\beta} = \frac{\partial \ln Earnings_t}{\partial R_t}$$

and represents the elasticity of earning with respect to changes in the interest rate. The smaller, in absolute value terms, the elasticity is, the less responsive output and earnings are to interest rate changes.

To account for likely autocorrelation and heteroskedasticity in the errors, we use Newey-West standard errors including 2 lags. Results from the above model can be found in Table A.1. Estimates of the controls,  $\hat{\gamma}$ , are repressed. “\*”s denote statistical significance, with \*\*\*, \*\*, and \* denoting significance at the 0.01, 0.05, and 0.10 levels respectively.

**Table A.1:** Estimated interest rate elasticity

			MT manufacturing earnings		
	National	Montana	Durable	Nondurable	Total
AAA yield	-0.049*** (0.00)	-0.116*** (0.00)	-0.150*** (0.00)	-0.151*** (0.00)	-0.149*** (0.00)
BAA yield	-0.038*** (0.00)	-0.090*** (0.00)	-0.112*** (0.00)	-0.113*** (0.00)	-0.112*** (0.00)

(Note:  $p$ -values from Newey-West errors with two lags in parenthesis. Control variables include the inflation risk premium and the current and two quarters forward of the output gap.)

First, all the estimates are highly statistically significant. As can be seen, overall state level manufacturing is more responsive to changes in both the AAA and BAA yields than it is at the national level. This is the hallmark of smaller firms which have less access to capital markets and rely more heavily on borrowing than do larger corporations. When we look at the impact on MT manufacturing earnings, there appears to be little to no difference in how durable and nondurable earnings respond to changes in interest rates.

## Appendix B Forecast methodology

To conduct the forecast we use an *ARIMA* –  $X(2, 1, 0)$  model. The control variables used are: Real GDP, Brent oil prices, housing starts, the trade weighted exchange rate, the core rate of inflation, and consumer sentiment. When manufacturing is split into durable and non-durable subsamples, we also include personal consumption of durable and nondurable goods respectively. The control variables are two 2022 vintages from IHS Markit, one in January and one in June. The June version updates the January version and includes the impacts of the Russian-Ukrainian War.



**BUREAU OF BUSINESS AND  
ECONOMIC RESEARCH**  
UNIVERSITY OF MONTANA

Bureau of Business and Economics Research  
Gallagher Business Building, Suite 231  
32 Campus Dr.  
University of Montana  
Missoula, MT 59812  
Phone: (406) 234-5113  
Email: [bbermail@business.umt.edu](mailto:bbermail@business.umt.edu)