Analysis of Trends in the Workforce of the Construction Industry

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Abstract

Construction is a labor-intensive business that contributes to a country's employment rate. The status of the country's economy and construction industry are strongly intertwined. An increase in the construction industry's unemployment rate might have a negative influence on the country's economy. Local markets are no longer local. Because of globalization, there is international competition even in local markets. As a result, variations and new trends in the construction sector must be carefully examined due to their possible impacts on the employment rate and labor profile [1]. This project discusses the construction industry's contribution to the US employment rate; employment patterns in the construction industry during the years 2011 - 2021; and factors that influence these trends in the construction industry.

1. Introduction

Data analysis is a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making

Data analytics is key to gaining valuable insights from the data that can help business or governments in taking decisions in order to improve the business processes or helps the government to form better policies.

Data analytics of the construction sector will also give us an idea of the increase and decrease in the trends of employment rate in the sectors in different states and regions.

There is construction all around us. We used to build with blocks as kids and were attracted by bulldozers. We witness the strength and sweat of construction workers in the roads we drive on, the buildings we work in, and the houses we call our own as adults [22].

The construction sector is a major component of the U.S. economy. During the past decade, construction was a prime beneficiary of low interest rates and the housing-led economic boom, but was also one of the largest casualties of the subsequent financial crisis. Construction spending comprised about 7%-8% of U.S. annual economic output from 1995 to mid-2000, reaching nearly 9% of gross domestic product at the peak of the housing run-up in 2006, before declining to about 5% in 2010. Likewise, construction employment ranged from a low of about 4.6 million during the early 1990s to a high of 7.7 million during the 2006 housing boom, and was about 5.5 million in early 2011.

In our project, We are working on deriving key insights and trends from the employment data for the last decade in the Construction Sector.

1.1 Why is studying employment information important?

Analyzing the employment rates will give us a better idea on hiring rates of the sector that can aid in better policy making by the government to maximize the employment rate. By analyzing the data we can uncover key insights from the data. We can observe and analyze different perspectives from the employment data. Those include seasonal variations, long term or overall

trend present in the data, any sudden changes or trends in the data and how did covid impact the employment in construction sector.

By analyzing the data we can also highlight the regions and states that have an increase in construction employment rate. This helps in finding out key regions and states that have performed better in the last decade compared to the other states or regions. It also helps in diversifying jobs so that in case of the resurgence of another pandemic it will not have huge impacts on employment. Many lost their jobs during the covid-19 pandemic as the jobs required them to come in person and be present in their workplace to carry out their duties. Diversivation or minimizing the impacts of covid-19 is important to reduce the drops in hiring rates of an organization incase of resurgence of pandemic or to be better prepared for future airborne pandemics like covid-19.

2. Survey

2.1 Has the problem been addressed by previous studies?

Construction employment as a percentage of total employment has also been used to assess the economy's contribution to construction (Strassmann, 1970; Turin, 1978; Wells, 1985). Turin (1978) proposed that because construction employment is positively associated with economic growth, construction could be used to provide long-term employment.

Looking at counties in the U.S., Black etal.(2005a, 2005b) found that a10 percent increase in the earnings of low-skilled workers could decrease high school enrollment rates by as much as five seven percent.

Deaton and Niman (2012) find that the massive short-term increase in wages in resource extraction areas during boom periods reduces poverty rates almost immediately. However, after the resource boom ends,with individuals that have lower human capital accumulation, they find that poverty rates again increase. This hints that lowered human capital accumulation retards the

movement of these low-skilled, low-educated workers to move to other industries when the mining sector suffers, and that the higher wage sare transitory.

Carl Benedikt Frey and Michael A. Osborne (2013) conducted analysis across many different sectors of employment and found that in the US 47% of jobs were at risk of being lost to automation. They also found evidence that wages and level of education attainment strongly predicted the lack of a computerization risk.

Jill Manzo, Frank Manzo IV and Robert Bruno (2018), This report is a theoretical assessment of the potential economic impacts of a highly automated construction industry. They produced the results which predicted that approximately 49 percent of all construction tasks can be automated, with higher risks in specific construction occupations resulting in nearly 2.7 million construction workers being displaced or replaced by 2057, resulting in a $127.5 billion drop in construction labor income.

Shahid Hussain, Wang Xuetong, and Talib Hussain (2020), this paper explains that through the survey they conducted it is revealed that unskilled labor has a significant negative impact on project performance during the construction phase, whereas skilled labors have a significant positive impact on project performance in enhancing the success rate of the project in the public construction industry. Even if there are many open positions, it is difficult to find skilled workers and hence leading to many positions left unfilled leading to unemployment.

3. Data

3.1 Where does the dataset come from?

The economic dataset “all_metro_employment.csv” has been extracted from the U.S. Bureau of Labor Statistics website (https://www.bls.gov/regions/economic-summaries.htm#TX). We consider data between the period Jan 01,2019 and Apr 01,2021 from the time series data given for a decade (2011-2021).

3.2 What does the data specify?

The dataset constitutes 57784 observations and 13 features. The features of employment data are mentioned below.

1. STATE: The historical employment data of all 52 states
2. AREA: The regions of respective states
3. TIME: The time series data for a decade period
4. TOTAL NONFARM: The number of employees (in thousands) in nonfarm sector
5. MINING, LOGGING, and CONSTRUCTION: The number of employees (in thousands) that contribute to nonfarm sector
6. MANUFACTURING: The number of employees (in thousands) that contribute to nonfarm sector
7. TRADE, TRANSPORTATION and UTILITIES: The number of employees (in thousands) that contribute to nonfarm sector
8. INFORMATION: The number of employees (in thousands) that contribute to nonfarm sector
9. FINANCIAL ACTIVITIES: The number of employees (in thousands) that contribute to nonfarm sector
10. PROFESSIONAL and BUSINESS SERVICES: The number of employees (in thousands) that contribute to nonfarm sector

11. EDUCATION and HEALTH SERVICES: The number of employees (in thousands) that contribute to nonfarm sector
12. LEISURE and HOSPITALITY: The number of employees (in thousands) that contribute to nonfarm sector
13. GOVERNMENT: The number of employees (in thousands) that contribute to nonfarm sector

4. What problem do we solve with this dataset?

We are expected to analyze the employment data from the following four perspectives:

1. Seasonal variations
2. Long term/overall trend
3. Sudden changes in the employment numbers
4. Covid effect

Let's discuss each of these trends in detail:

4.1 Impact of Seasonal Variations on Employment rate in the Construction Sector

General Overview:

As it relies on labor and outdoor activities, the construction industry is one of the most susceptible to bad weather conditions [20]. Weather disturbances provide significant uncertainty factors that reduce the productivity and length of construction projects [2]. Weather delays 45% of construction projects worldwide resulting in costing project owners and contractors billions of dollars in extra costs and lost revenue each year. Furthermore, climate change is predicted to increase the frequency and intensity of weather conditions that cause construction delays. Weather's impact on several parts of construction has been studied by researchers. Extreme temperatures, precipitation, and high winds were identified as the most significant weather conditions for construction in a systematic state-of-the-art analysis of 3207 publications published between 1972 and October 2020.

Despite the predominance of climate-focused delay studies, current studies fail to account for future climate in delay modeling and strategy selection. As a result, planners and project managers can utilize these observations to identify weather-vulnerable activities, factors for changing climate in projects, and establish administrative or organizational capability to help mitigate construction weather delays [23]. Seasonal/weather events have a direct impact on the ability to accomplish construction jobs, which is often referred to as task feasibility. The effects on task feasibility range from full work stoppage to decreased worker productivity and, eventually, project delays. Lightning and high winds pose substantial risks to workers, slowing production or necessitating work stoppages [23].

Construction also has challenges with location, as the project is sometimes located far from home. Workers may choose to wait on the sidelines or locate more stable work – even though it pays less – closer to home [21].

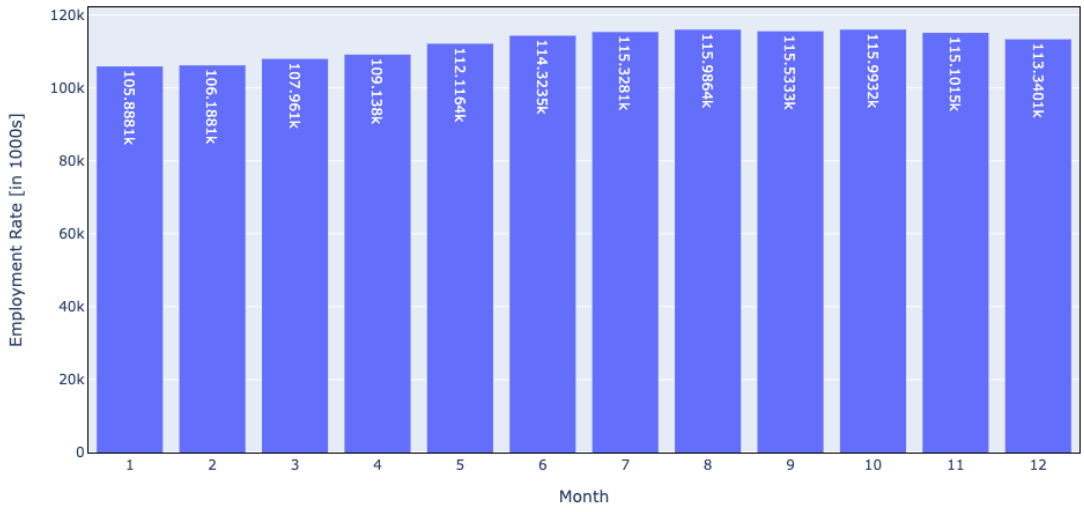


Figure 1: Seasonal Employment Rate for the Last Decade

Graph: The above graph represents the number of employees hired during every month for the last decade. We observe an increasing trend of the number of opportunities in the construction sector until July and there is a stable rate of employment for next three months and there is a slight drop during December.

Analysis: There is a drop in construction jobs in winter months(dec to feb), followed by an increasing trend in the number of construction jobs each month after the winter months. This trend can be attributed to the adverse impacts the weather can have on construction sector where operations and site preparations can be heavily impacted by precipitation and low temperatures rate[20]. These weather factors affect labor, materials, and equipment, each in unique ways. Temperature changes generally affect the length that laborers can work outside, in addition to putting limitations on equipment if conditions prove unsafe for operations.

In the last decade the Construction sector in many metros like The Houston-The Woodlands-Sugar Land. Phoenix-Mesa-Scottsdale, Ariz. Dallas-Plano-Irving, and Orlando-Kissimmee-Sanford, Florida improved a lot. This can be attributed to the growing needs of the huge metro areas that lead to increasing spending of construction in both residential and non residential areas.

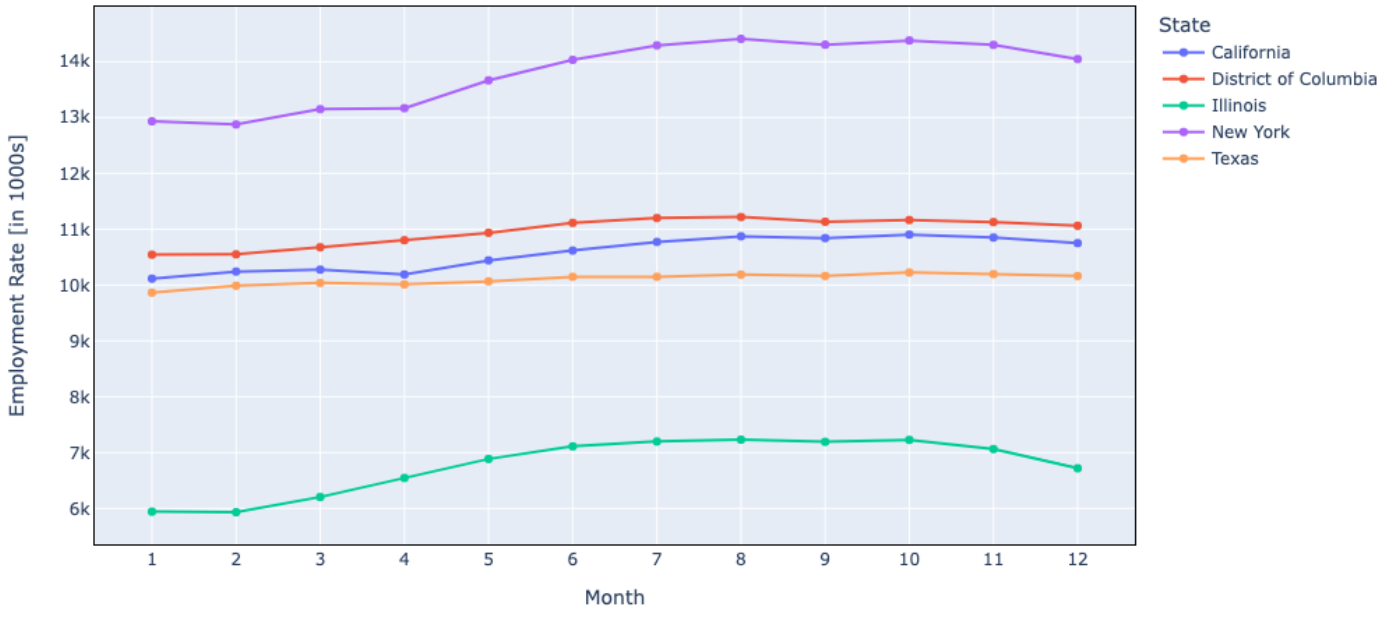


Figure 2: States with the highest employment level in Construction Laborers **for the Last decade**

Graph: The above graph represents the top 5 states with their employment rate in the construction sector for the last decade.

Analysis: We can observe that New York has the highest rate of employment as compared with states followed by the District of Columbia, California, Texas and Illinois.
We see the overall trend being continued into the Top 5 states where there is a drop in construction jobs in winter months as there is an increase in the number of jobs each month after winter months.

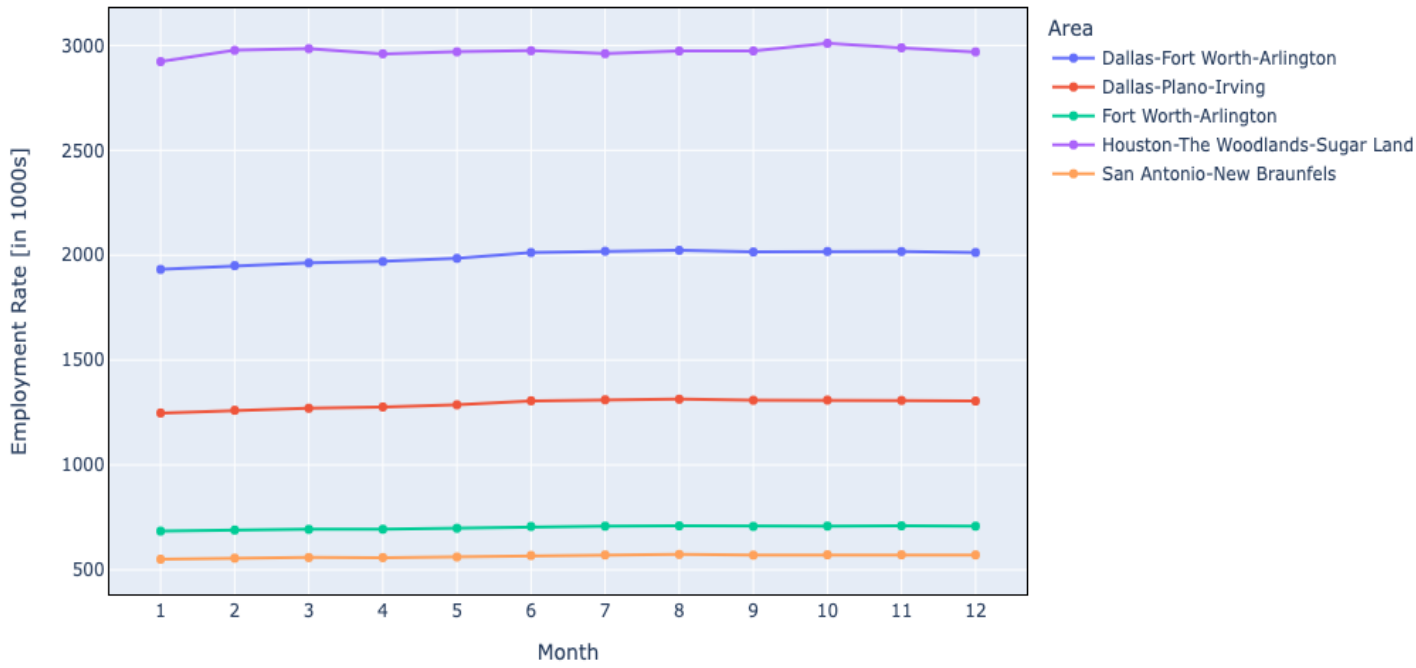


Figure 3: Top 5 Metro areas with Construction employees in Texas

Graph: The above graph represents the top 5 metro areas in Tex

Analysis: We observe Houston- The Woodlands- Sugar Land metro area employs the highest rate of construction employees, followed by Dallas-Fort Worth, Dallas-Plano, Fort Worth-Arlington and San Antonio-New Braunfels.

We see the overall trend being continued into the Top 5 metro areas in texas as well, where there is an increase in the number of jobs each month after winter months.

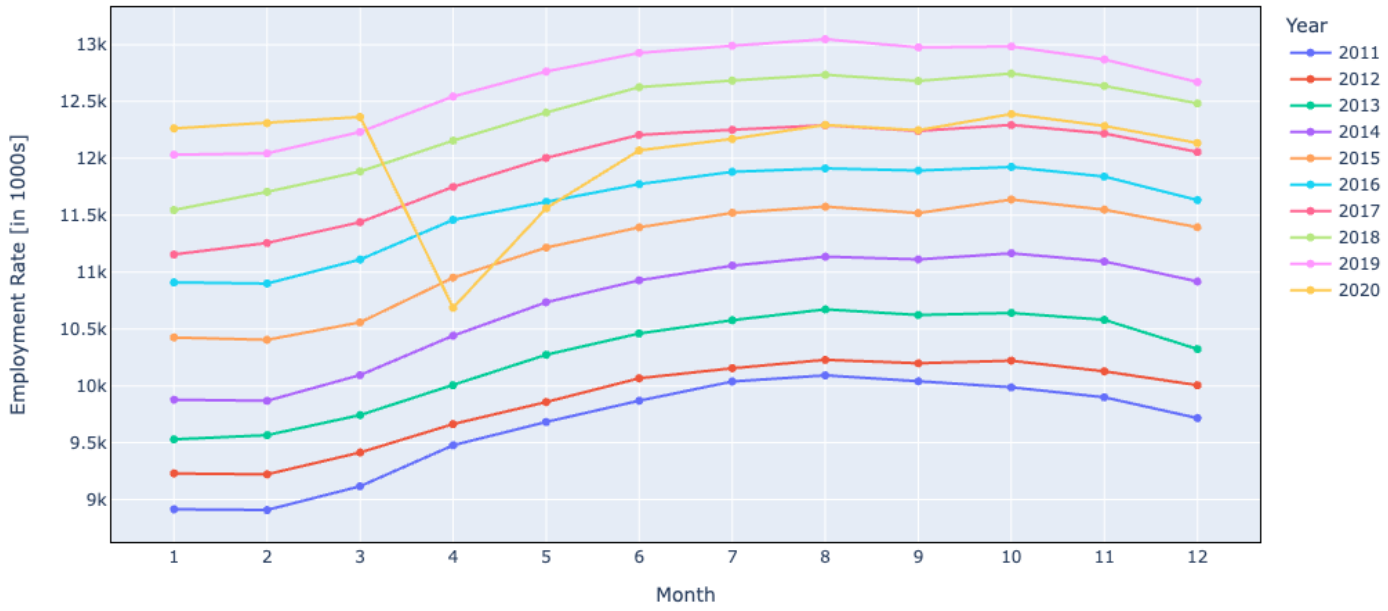
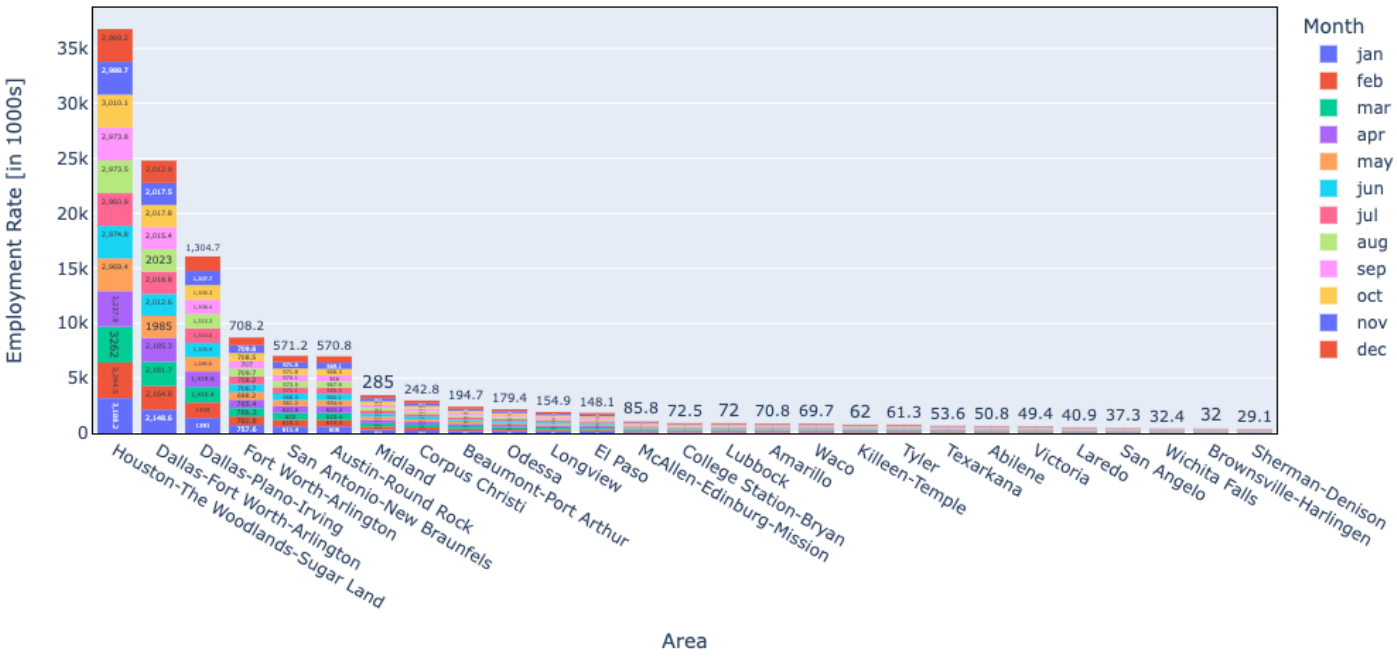


Figure 4: Seasonal Employment rate for each year in the last decade

Graph: The above graph represents Seasonal Employment rate for each year in the last decade starting from year 2011 to year 2020.

Analysis: we can observe that the same trend followed by different years from 2011-2019 where the hiring rate peaked during the summer and fall months and slight drop in winter months. Year 2020 followed a different trend where there was a drop in employee rate in April due to covid before recovering from may 2020 to the 2017 level employment rate. This drop was due to covid that lead to halt in residential construction, Global supply chain issues worldwide.

Figure 5: Seasonal Employment rate for the last decade in Texas



Graph: The above graph represents seasonal employment variation during the last decade in the state of Texas.

Analysis: We can observe that the highest employment rate is in the Houston-The Woodlands-Sugar Land metro area and also has the highest and lowest employment rates in the month of March and October respectively. And the lowest recorded employment rate in the decade is in the Sherman-Denison area. (The highest number of employees were hired during March in the Houston area and the lowest in Sherman-Denison)

4.2 Covid-19 and its Impact on Employment Trends in the Construction Sector

General Overview:

In January of 2020, the United States reported its first case of the Novel Coronavirus, also known as Covid-19. By March of 2020, the outbreak was officially declared a pandemic by WHO. Covid-19 has had a massive impact on just about everything, personal lifestyles, social and workplace regulations, etc.

The construction sector, amongst other sectors, was drastically affected in many ways by the Covid-19 pandemic. To better understand the trend, the employment data for all states across the time period of 2011 to 2021 is plotted in Figure 6. Upon analyzing the plot, a general trend can be observed. There is a gradual increase followed by a decrease in employment jobs throughout each year, corresponding to seasonal variations. This trend is repeated throughout the years with a gradual increase in overall employment until 2019. In 2020, the year Covid-19 was declared a pandemic, January, February and March seem to follow the trend with an increase in employment numbers. However, there is a dramatic dip in April, 2020. The months after April seem to follow a similar seasonal variation pattern as observed previously, except there is an overall decrease in employment numbers in comparison to the years before 2020.

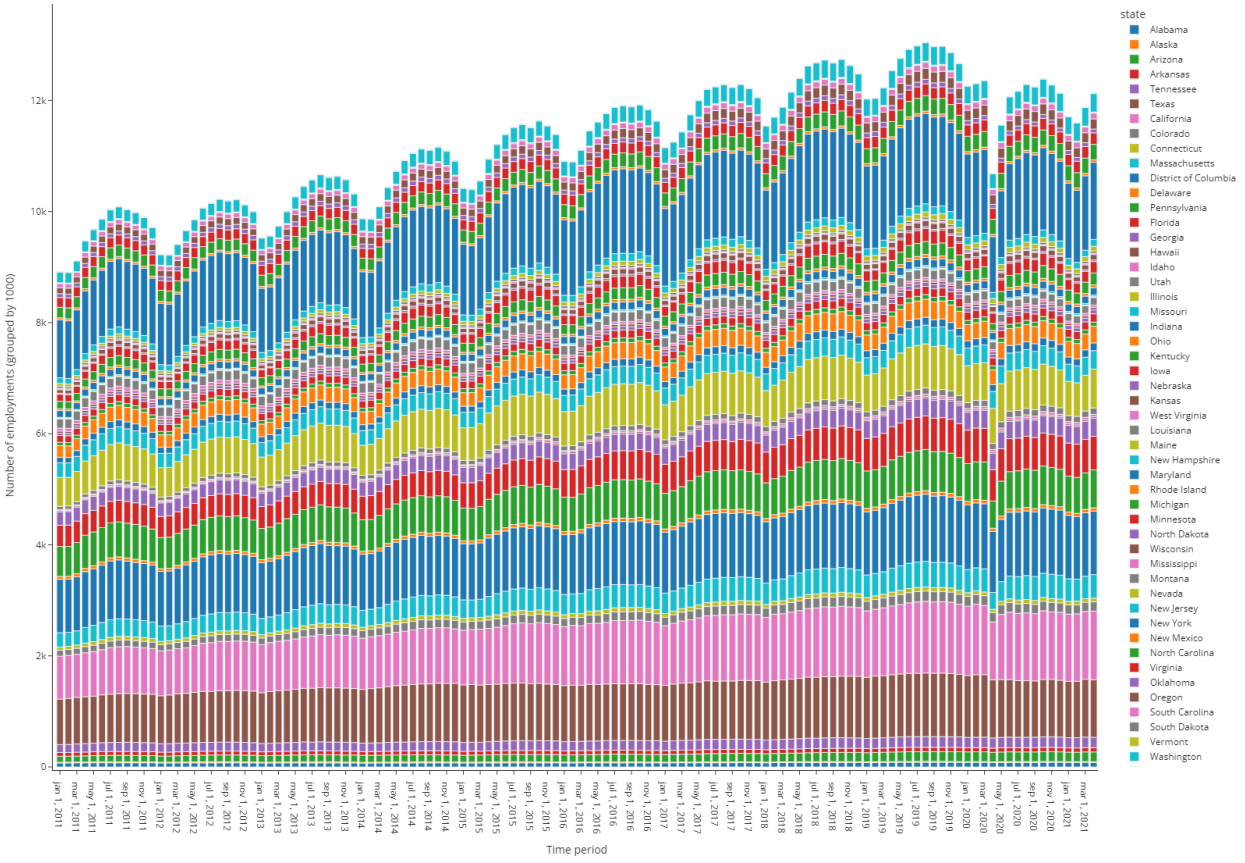


Figure 6: Employment trends in construction sector across all US states and D.C. (2011 - 2021)

The Covid-19 pandemic called for the introduction of stringent regulations to prevent the spread of the virus and ensure a safe working environment. However, these regulations slowed down workflow, resulting in project delays and cancellations, and disruptions in the supply chain. Construction workers were also reported to have a lower vaccination rate, resulting in more workers getting sick, further delaying projects. Personal protective equipment (PPE) was not adequately available for construction workers due to a high PPE demand in the healthcare industry to protect healthcare workers from the virus. All these factors reduced employment opportunities in the construction sector significantly, explaining the substantial dip in employment numbers observed in Figure 6.

Employment in the Construction Sector across US States and D.C. During the Pandemic: A Closer Look

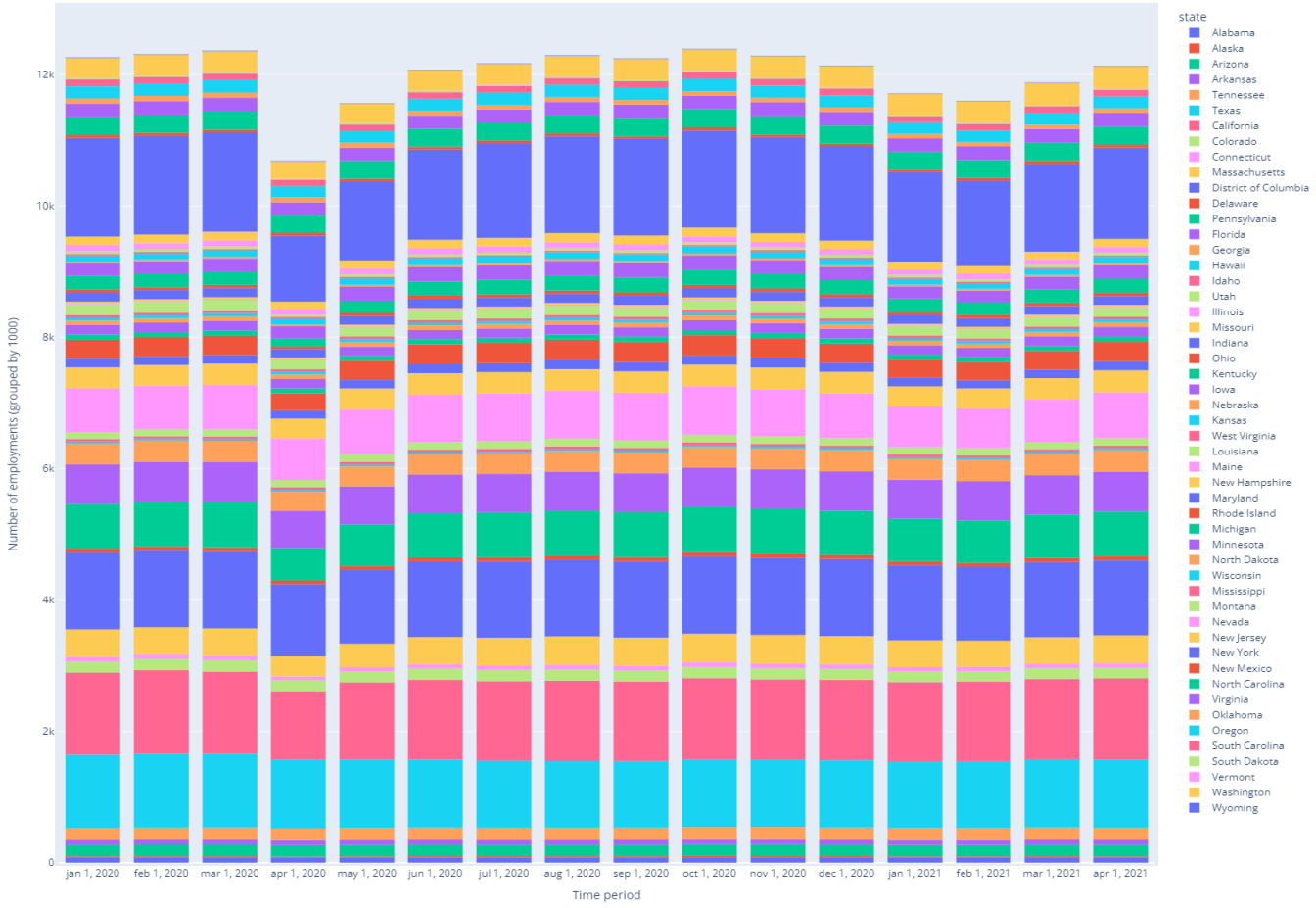


Figure 7: Employment trends in construction sector across all US states and D.C. during Covid-19 pandemic (2020 - 2021)

During the pre-covid years (2011 - 2019), a consistent trend was observed. However, an inconsistency in this trend appeared during the covid time period (2020 - 2021), implying that the pandemic had an effect on the employment trend in the construction sector. Figure 7 provides a closer look at the employment numbers across all US states during the pandemic.

It is clear that there are certain states that stand out as large contributors to the overall employment in the construction sector. New York proves to be the largest contributor to cumulative employment numbers in the construction sector during the covid period, followed by California, District of Columbia, Texas and Illinois. A complete ordered visualization of the US states and D.C., and their contribution to employment numbers during the pandemic can be observed in Figure 8.

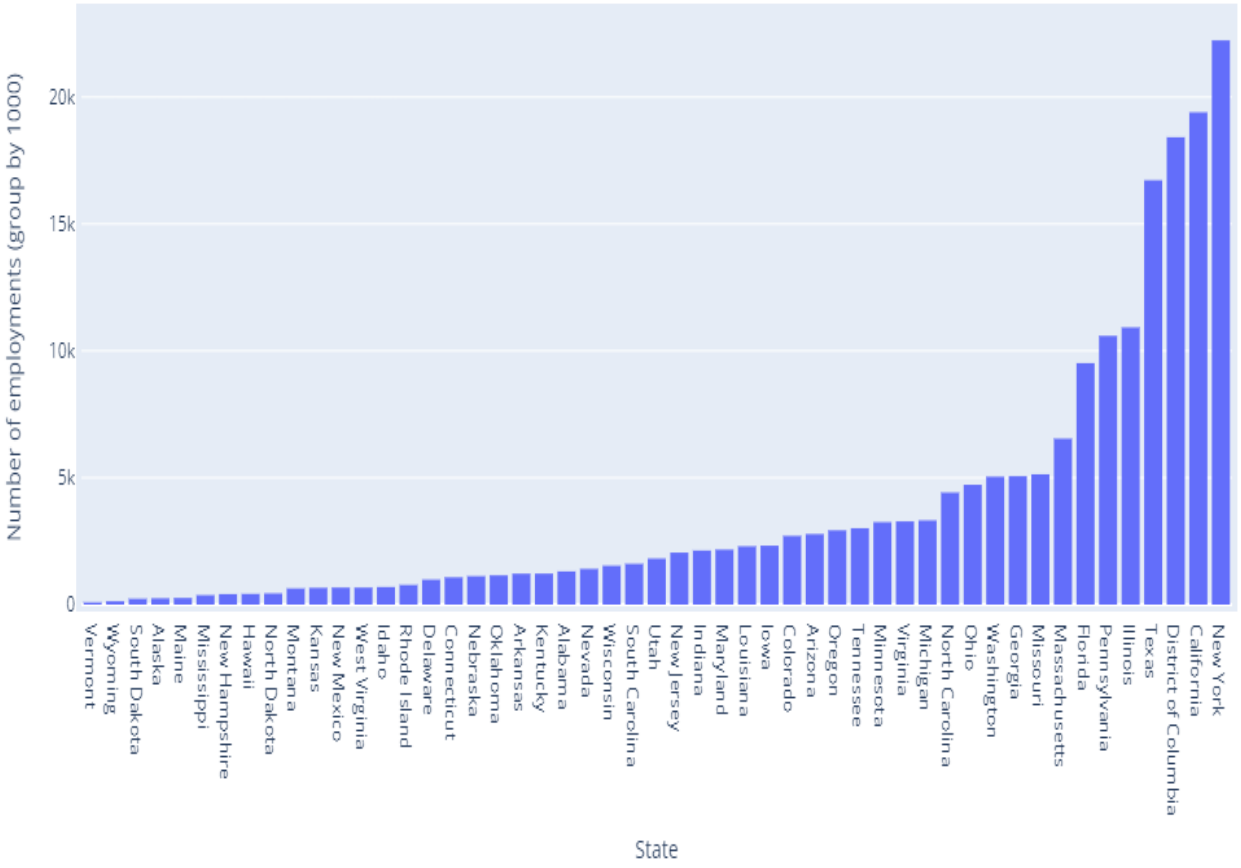


Figure 8: US states employment contribution (ordered) to construction sector during Covid-19 pandemic (2020 - 2021)

New York, California, Texas and Illinois come under the top 6 most populated states in the US in 2020. While a higher population may naturally mean higher employment numbers, the District of Columbia (D.C.) proves that there is more to it. Coming in as the third largest contributor to construction jobs during the pandemic, D.C. is the third least populated district. Upon taking a closer look, the construction sector in D.C. was booming pre-pandemic, with many significant expansion projects underway such as the expansion of the Reagan National Airport and the Union Market. Another way it contributed to construction jobs was through residential housing projects. Being the capital of the United States, D.C. has a large government and military presence moving in, creating a high demand for housing. While the district definitely took a hit

during the pandemic, it stayed relatively stable as the expansion and housing projects remained ongoing during Covid-19.

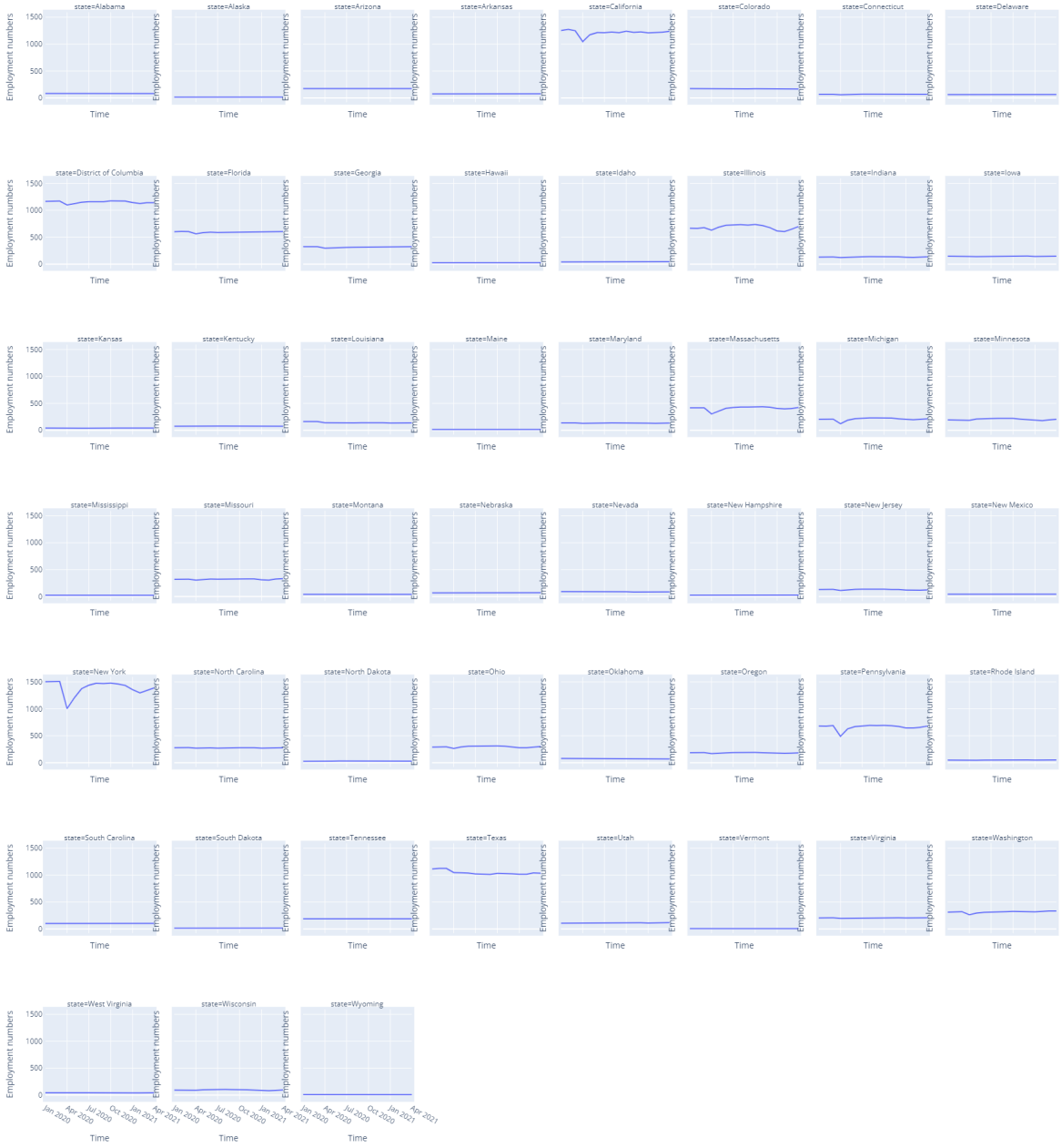


Figure 9: Employment trends across all 50 US states and D.C. during Covid-19 pandemic (2020 - 2021)

Figure 9 provides a closer look into employment trends across each of the US states and D.C. during the pandemic. Comparing inferences from Figure 8, it can be noted that the states with higher contributions to the employment numbers in the construction sector show dramatic dips in

employment numbers, particularly during the first wave of the pandemic. There is no apparent change during the second wave. The largest percentage gains were noted in Idaho, Utah and South Dakota. This could be due to the migration of population into the state due to a more affordable cost of living, reuniting with families, etc.

Covid-19 Impact on Construction Employment Trends across US Cities: A Comparison

To understand the impact of the pandemic on construction jobs in US cities, a comparison can be drawn between employment numbers before and during the pandemic. Figure 10 displays the top 10 cities with the highest construction employment numbers during April 2019. Figure 11 displays the top 10 cities with the highest construction employment numbers during April 2020. While the top cities in both categories remain the same, it can be observed that there is a shift in ranking.

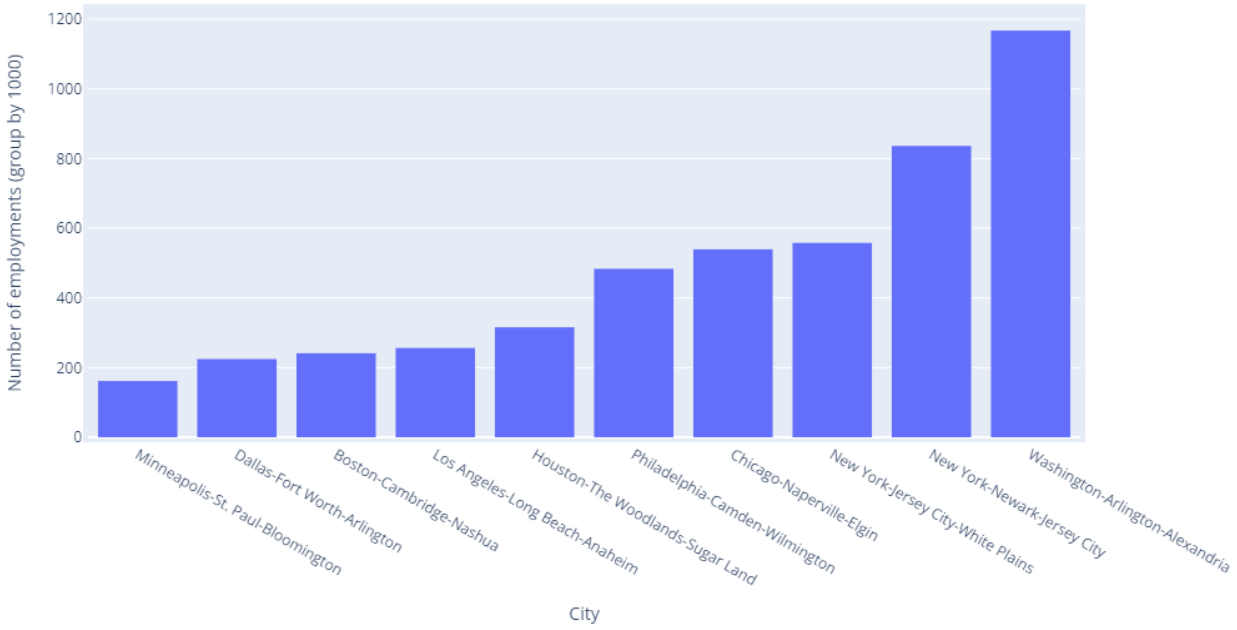


Figure 10: Top 10 cities with highest construction jobs in April 2019 (pre-covid)

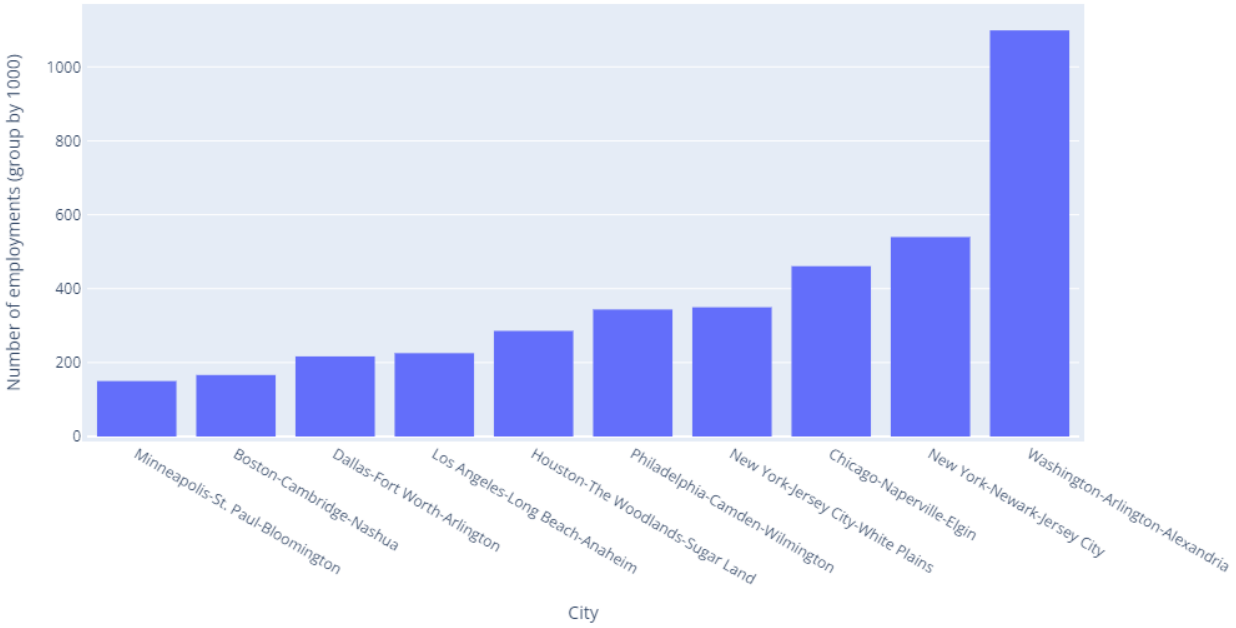


Figure 11: Top 10 cities with highest construction jobs in April 2020 (during covid)

Prior to the pandemic, New York-Jersey City-White Plains ranked the third highest in terms of construction jobs, while Chicago-Naperville-Elgin ranked the fourth. However a year later, during the pandemic, Chicago-Naperville-Elgin replaced New York-Jersey City-White Plains as the third highest, pushing New York-Jersey City-White Plains to the fourth rank. Similarly Boston-Cambridge-Nashua, initially ranking eighth highest prior Covid-19, moves down to the ninth highest while Dallas-Fort Worth-Arlington moves up from ninth to eighth highest construction employment numbers during the pandemic.

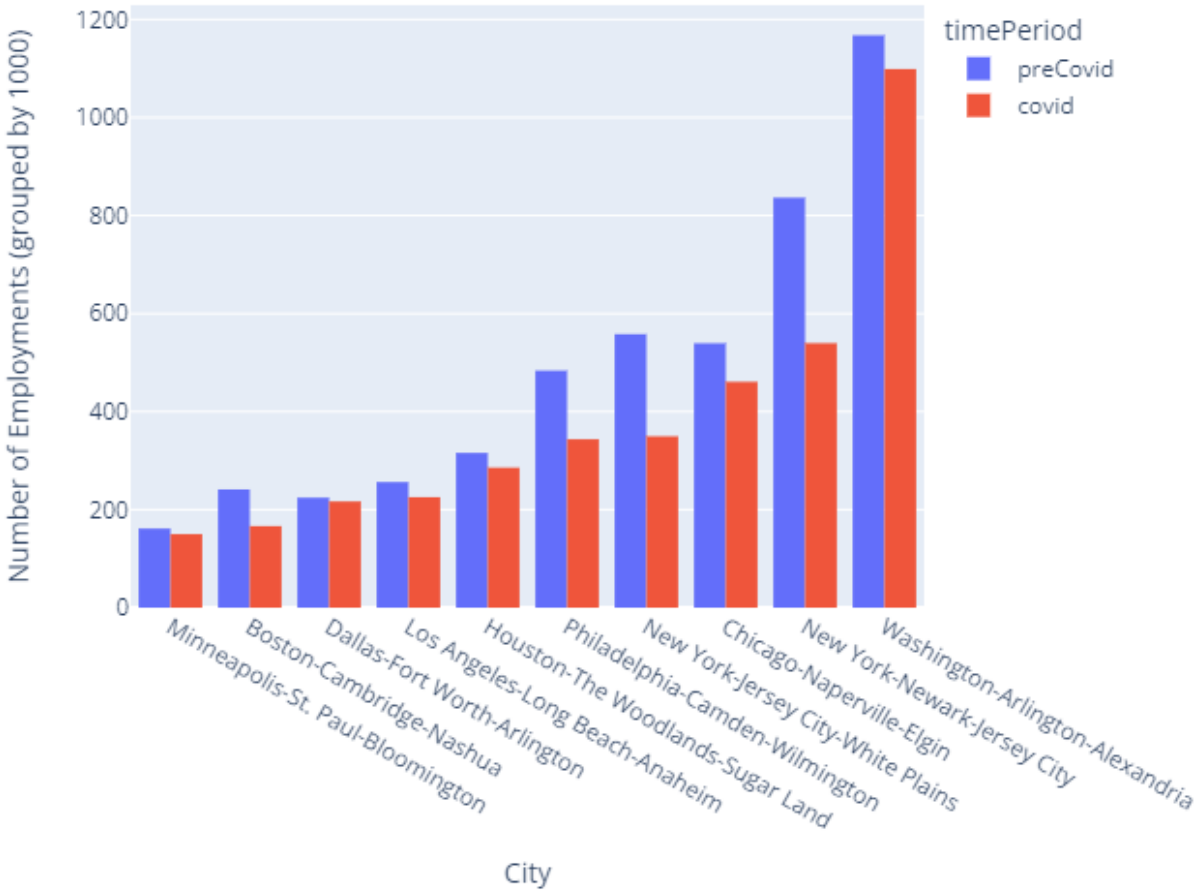


Figure 12: Comparison of employment numbers in top 10 cities pre-covid and during covid

Figure 12 illustrates a side by side comparison of each of the top 10 cities' employment numbers during and prior to the pandemic. It can be observed that New York-Jersey City-White Plains and New York-Newark-Jersey City show a significant drop in construction employment numbers between the two time periods. It was reported that construction permits in New York dropped by a significant 19.8% from 2019 to 2020, resulting in project delays and cancellations. This substantiates the steep difference in construction jobs between the two time periods and the drop in rank of New York-Jersey City-White Plains to the fourth highest in construction jobs in April 2020, as observed in Figure 11. Philadelphia-Camden-Wilmington can also be seen to have a significant difference in construction jobs. In March 2019, an order was passed in Pennsylvania to cease all construction projects unless they contributed to scientific research and development services, and technical services. It was also explicitly stated that construction material

wholesalers must close shop, which would cause a shortage of construction supplies for ongoing projects, resulting in delays or cancellations. This order would negatively impact construction jobs in Philadelphia-Camden-Wilmington, explaining the drastic drop in construction employment numbers after the pandemic was declared.

4.3 Sudden changes in employment Number in Construction Sector

General Overview:

Sudden changes in the construction sector affect construction jobs for various unexpected reasons, like weather, labor shortage, missing or wrong data, and budget inaccuracies.

A better comprehension of how the construction jobs in the top metropolitan areas got affected in a decade has been visualized and observed a few drastic changes that resulted in the downfall/ rise of construction jobs. There has been a consistent uptrend in the employment for the metropolitan areas until the year 2019, a drop in the early 2020, and drastic fall in 2021.

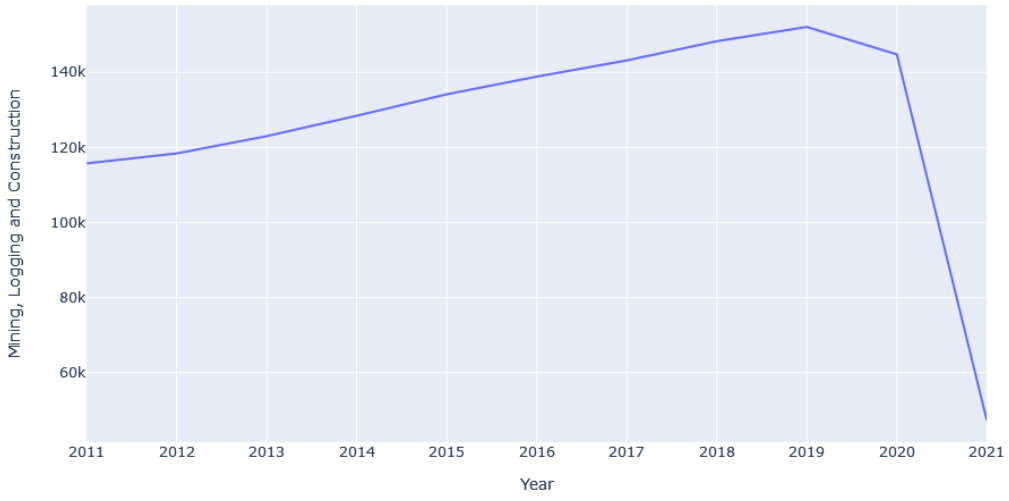


Figure 13: Change in Employment Numbers over a decade

- **Line Graph**: The above plot demonstrates employment trend analysis of the metropolitan data. The horizontal axis depicts continuous progression of a decade while the vertical axis reports the values of employment number for construction sector, a metric of interest across the progression.

- **Analysis**: We see an uptrend in employment until the year 2019, whereas there was a decrease in the employment in the year 2020 and a drastic fall in the year 2021.

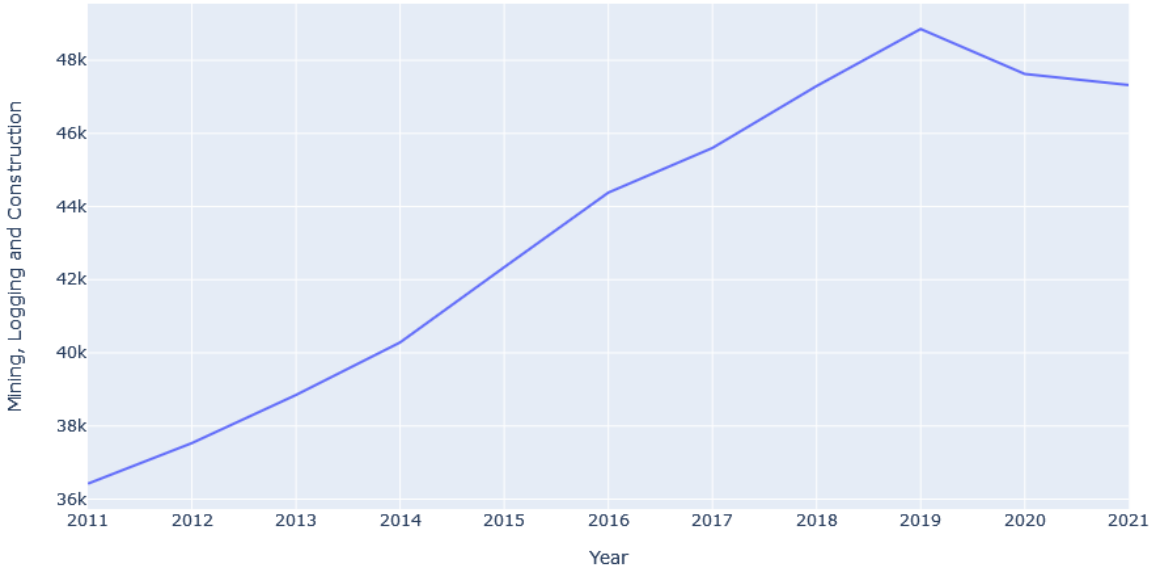


Figure 14: Change in Employment Number for the first four months of the decade

- **Line Graph**: The above plot demonstrates employment trend analysis of the metropolitan data. The horizontal axis depicts continuous progression of the first four months of a decade while the vertical axis reports the values of employment numbers for the construction sector.

- **Analysis**: From plot 1, the drastic reduction in the year 2021 is due to lack of data for the year, i.e., only four months is available from the dataset. Therefore, we analyzed the data considering only the first four months of the decade against construction sector employment. We see an uptrend in employment until the year 2019, whereas there is a decrease in employment in the years 2020 and 2021.

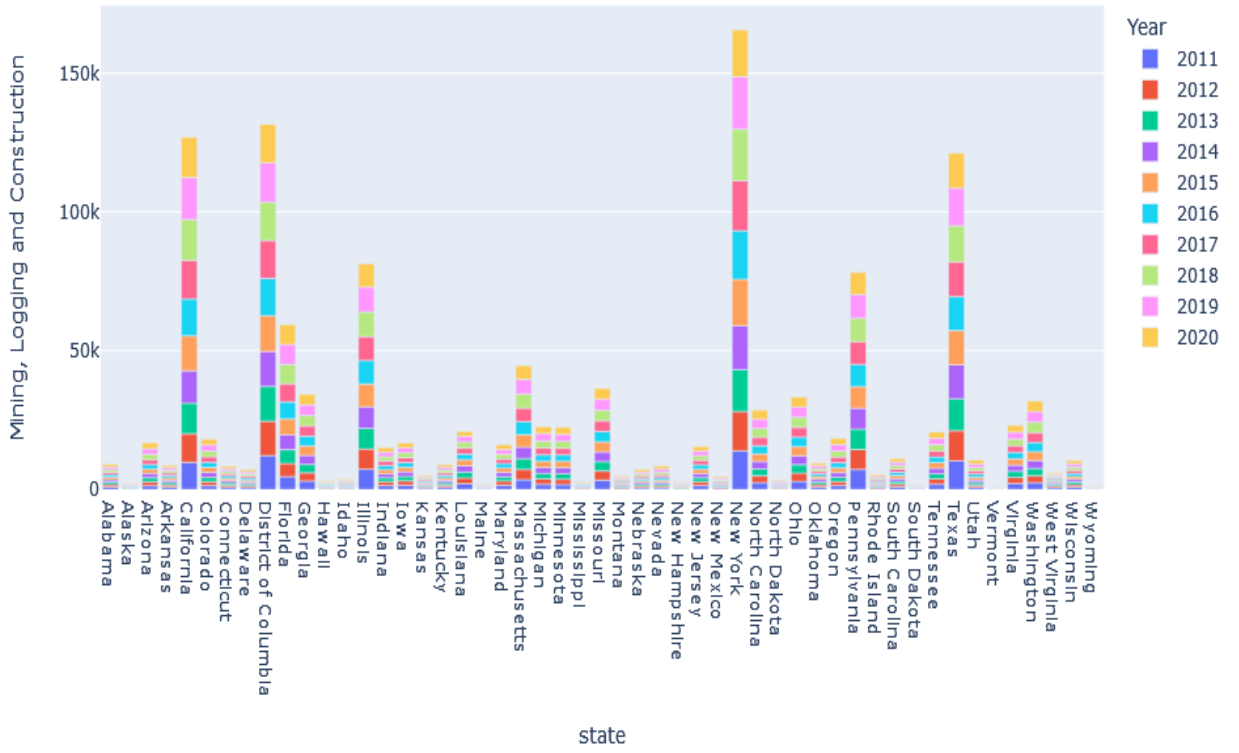


Figure 15: Total Construction jobs in all metropolitan areas

- **Bar Graph**: The above plot demonstrates employment trend analysis of the metropolitan data. The horizontal axis depicts all the states in the United States, while the vertical axis reports the values of employment numbers for the construction sector, across the years 2011-20.

- **Analysis**: We see a good employment number for the states, New York, District of Columbia, California, Texas, Florida, Pennsylvania and Illinois across the years 2011-20.

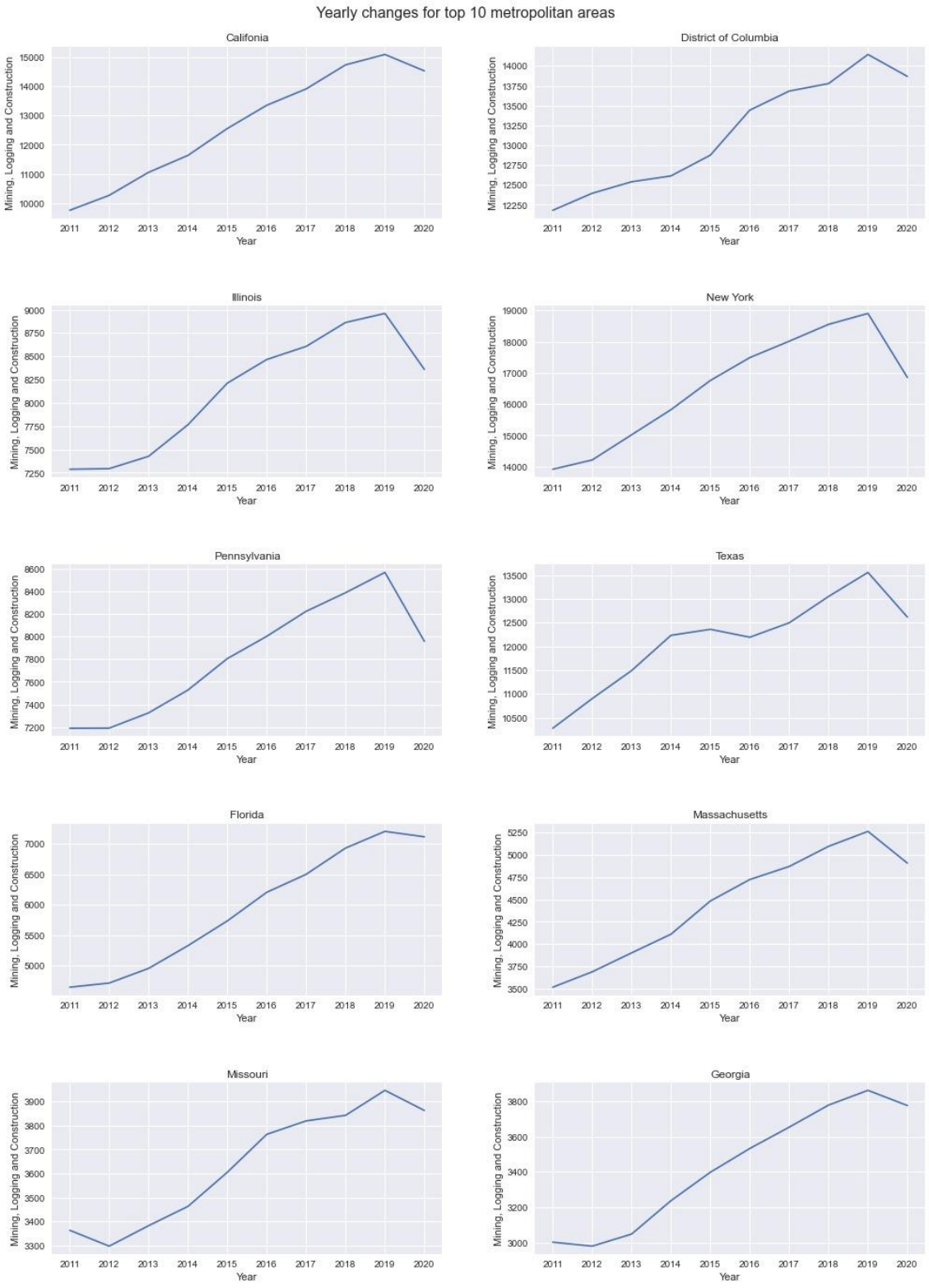


Figure 16: Yearly changes for top 10 metropolitan areas

- **Line Graph**: The above plot demonstrates employment trend analysis across major states of the metropolitan data. The horizontal axis depicts continuous progression of a time range 2011-2020, while the vertical axis reports the values of employment numbers for the construction sector that contribute to total non-farm employment.

- **Analysis**: We observed the trend as a continuous increase until the year 2019 and a decrease in the employment in the year 2020 for the top metropolitan states.

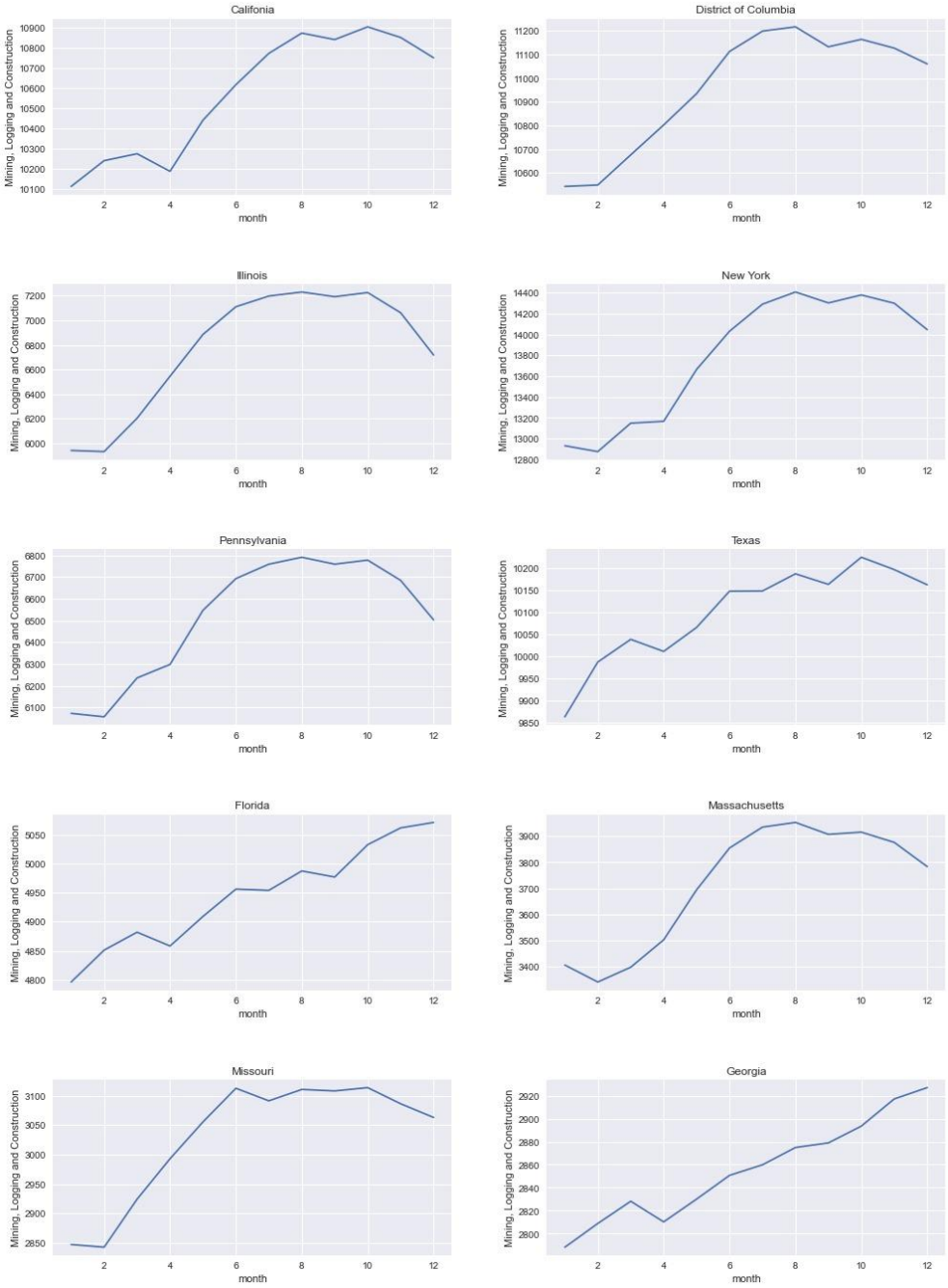


Figure 17: Monthly changes for top 10 metropolitan areas

- **Line Graph:** The above plots demonstrate employment trend analysis of top 10 metropolitan states across 12 months of the data. The horizontal axis depicts continuous progression of months, while the vertical axis reports the values of employment numbers for the construction sector that contribute to total non-farm employment.

- **Analysis:** We visualized the trend for each state for the years 2011-20 across all the months. Texas and Florida experienced a similar trend until October, NewYork, Massachusetts, Pennsylvania and District of Columbia experienced a similar trend till the month of August and slight changes after that. The drop between the months February and April across major states was due to the early stage of Covid-19.

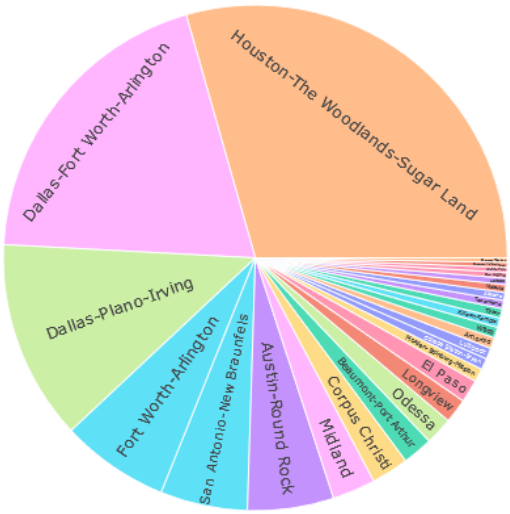


Figure 18: Metropolitan areas in Texas

- **Pie Chart:** The above chart represents employment trend analysis for Texas State, plot against the employment values of the construction sector and the cities of the state.

- **Analysis**: We noticed a higher employment in the metropolitan area Houston-Woodlands-Sugar Land, followed by Dallas-Fort Worth-Arlington, while the Sherman-Denison area holds the least employment.

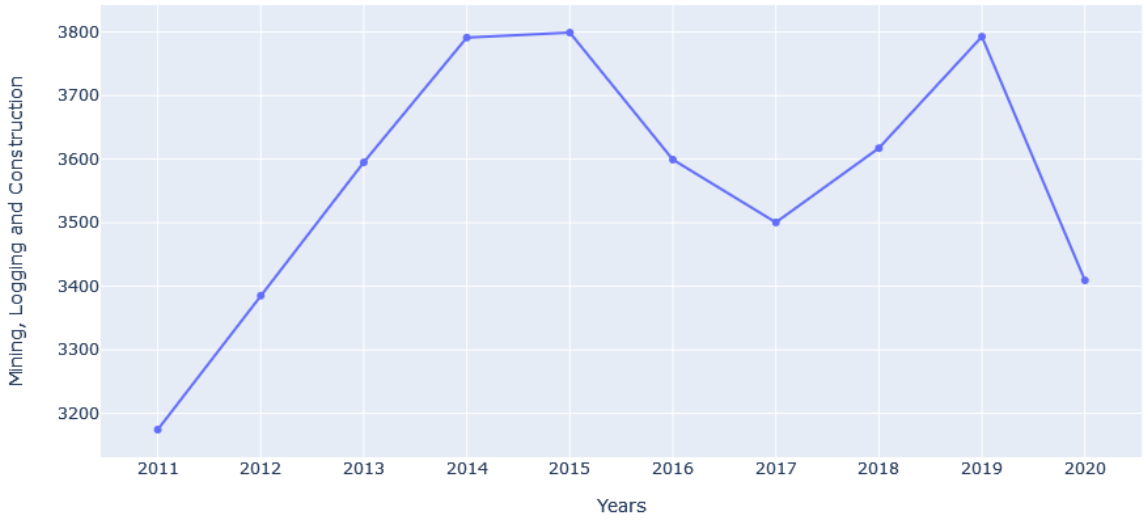


Figure 19: Total number of employees in Houston over years

- **Line Graph**: The above line graph represents employment data for Houston-The Woodlands-Sugar Land metropolitan area, plot against continuous time frame in years 2011-20, while the vertical axis reports the values of employment number for construction sector of the specified metropolitan area.

- **Analysis**: We see an increase in employment until the year 2015, a decrease in the years 2016 and 2017, and an increase in the years 2018 and 2019, and a drop in the year 2020.

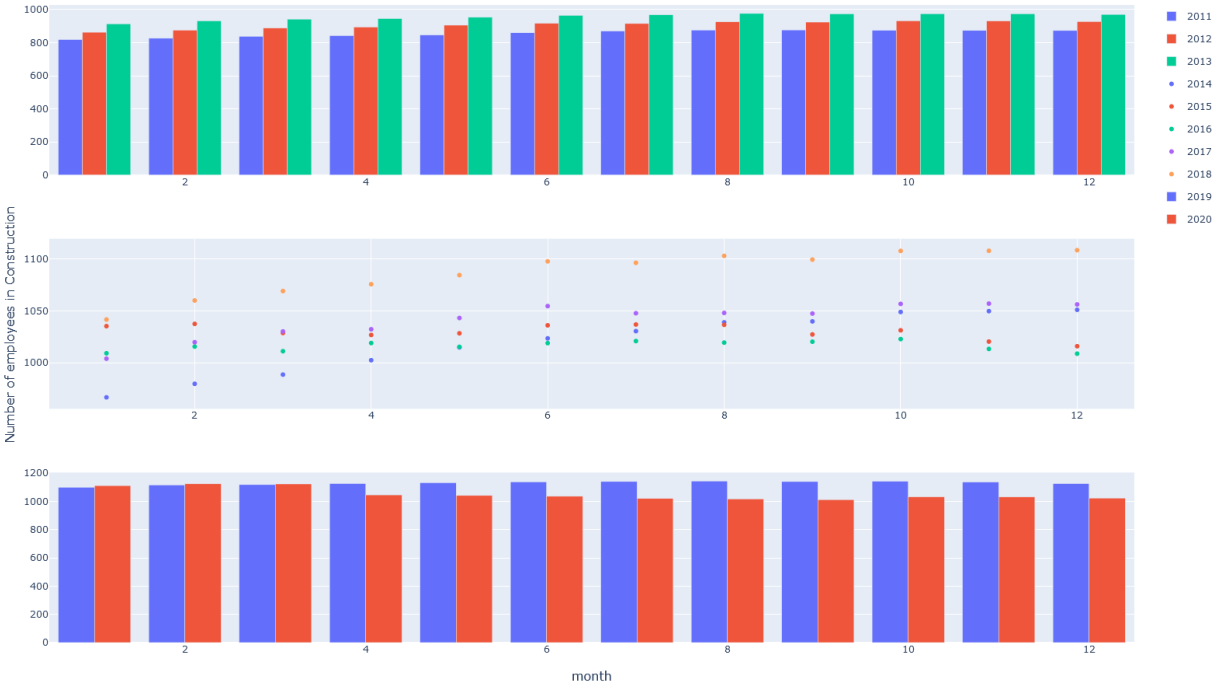


Figure 20: Yearly changes for Texas state

- **Line/ scatter/ bar Graphs**: We categorized the year range 2011-20 into three segments to ease the comparison. The segment one represents a line graph of employment for Texas across the months of 2011, 2012 and 2013. The second segment represents a scatter plot of employment for Texas across the months of years 2014-18. And the final segment represents a bar graph of employment in Texas across the months of years 2019 and 2020.

- **Analysis**: We observed the highest employment during the months of August in the year 2013. The employment was highest in all the months of the year 2018, and a decrease in the employment in 2020 compared to 2019.

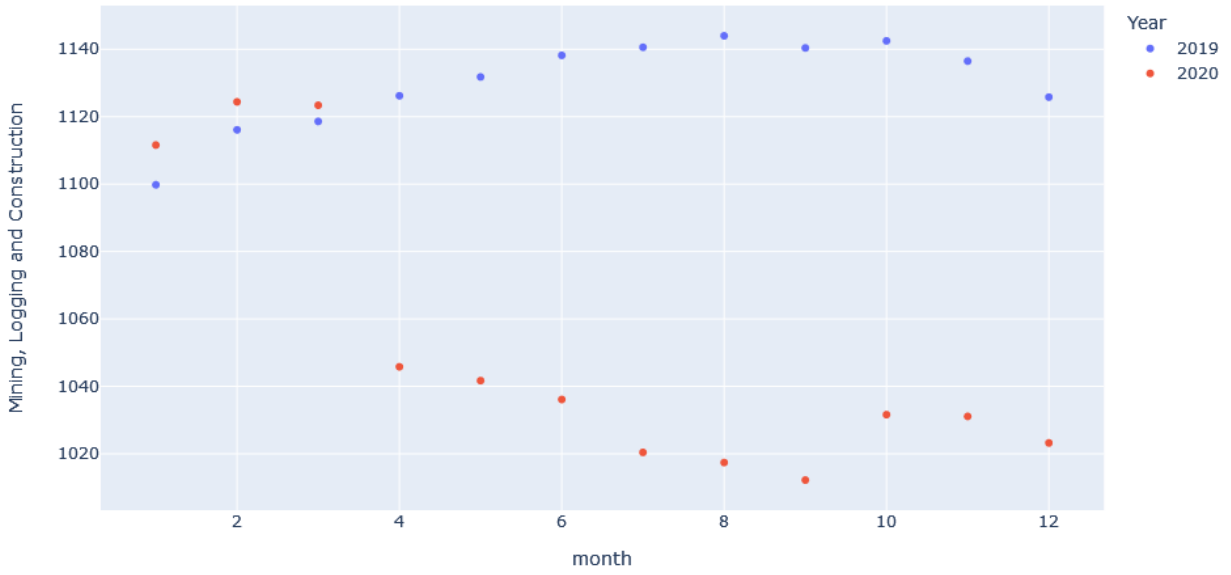


Figure 21: Change in employment number in Texas during COVID period

- **Scatter Plot**: The above plot demonstrates employment trend analysis for Texas state during the years 2019 and 2020 (period of COVID-19). The horizontal axis depicts the months of a year, while the vertical axis reports the values of employment numbers for the construction sector that contribute to total non-farm employment of Texas state.

- **Analysis**: We see a higher employment in the months of January, February, and March of the year 2020, and a consistent downward trend from April to September, and a raise in the last three months of the year. In the year 2019, we see an increasing trend in the number of employees until August, followed by a drop in September, an increase in October, and a downfall since then.

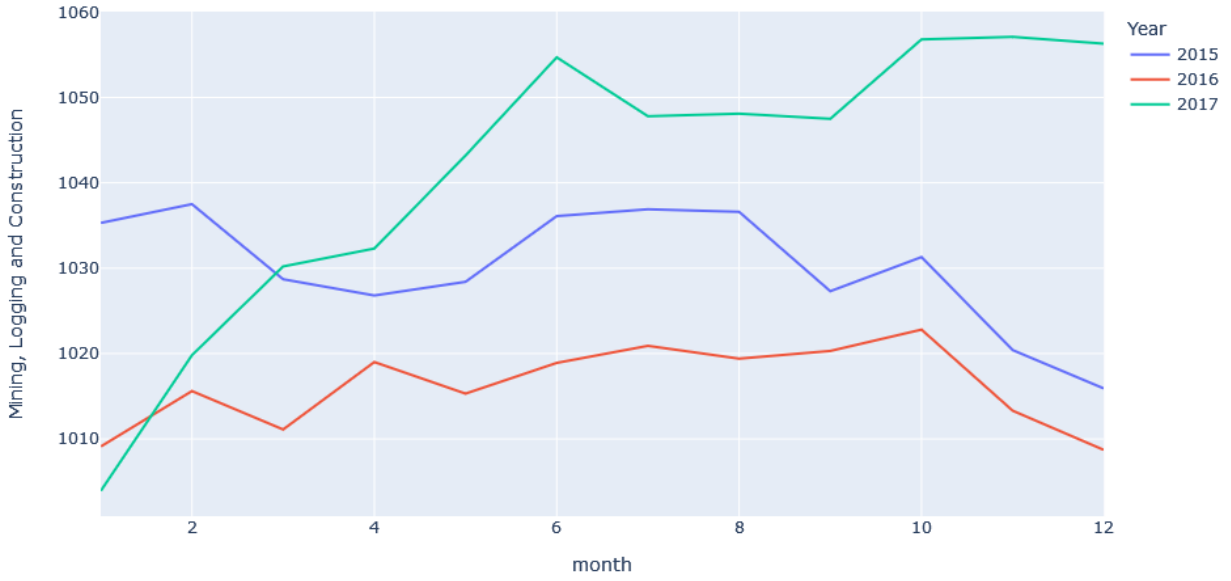


Figure 22: Change in employment number in Texas during oil bust

- **Line Graph**: The above line graph represents employment data for Texas State, plot against 12 months of the years 2015-17, while the vertical axis reports the values of employment number for construction sector.

- **Analysis**: This comparison plot across the years 2015-17 explains the drop in the employment due to oil bust which affected employment over the period. However, the survival of this period was substantial with the highest rise[8] in the number of construction jobs in the year 2018.

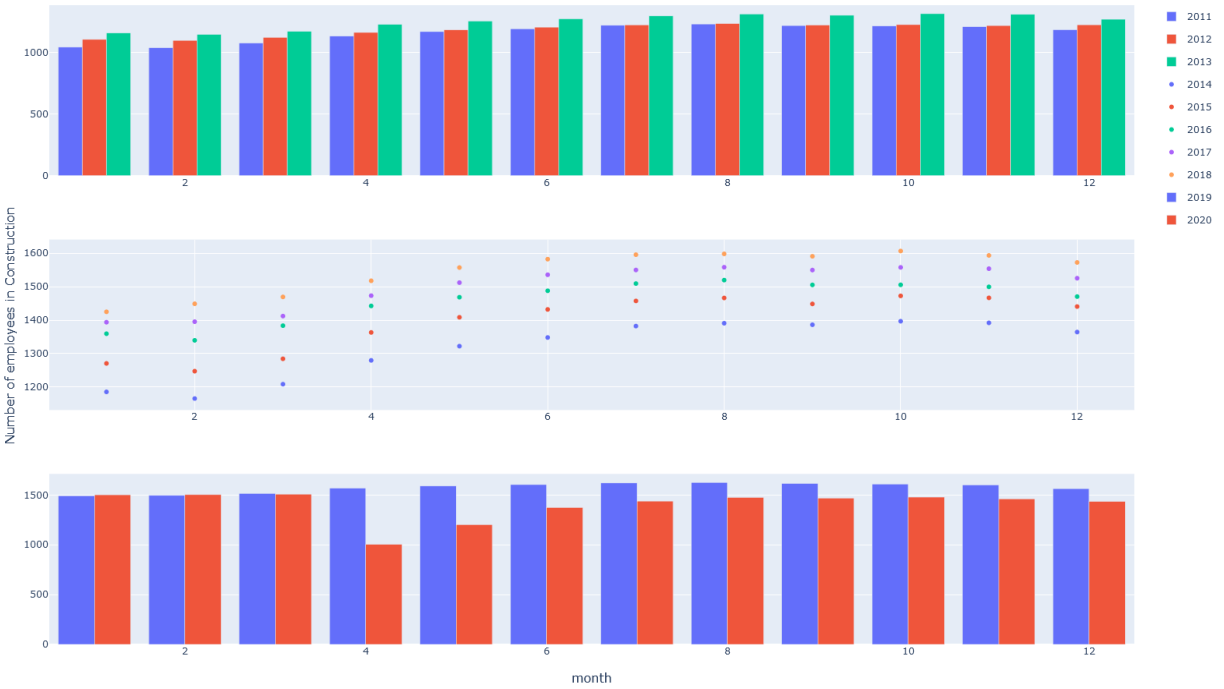


Figure 23: Yearly changes for NewYork State

- **Line/ scatter/ bar Graphs**: We categorized the year range 2011-20 into three segments to ease the comparison. The segment one represents a line graph of employment for New York state across the months of 2011, 2012 and 2013. The second segment represents a scatter plot of employment for NY state across the months of years 2014-18. And the final segment represents a bar graph of employment in New York across the months of years 2019 and 2020.

- **Analysis**: We observed an increasing trend in employment for all the years until the month October and a downfall during the months November and December. We see a little change during the first three months of the years 2019 and 2020, and a drastic fall in the fourth month of 2020, and an increase until October of 2020, and a downfall in November and December. The employment was highest during August of all the years.

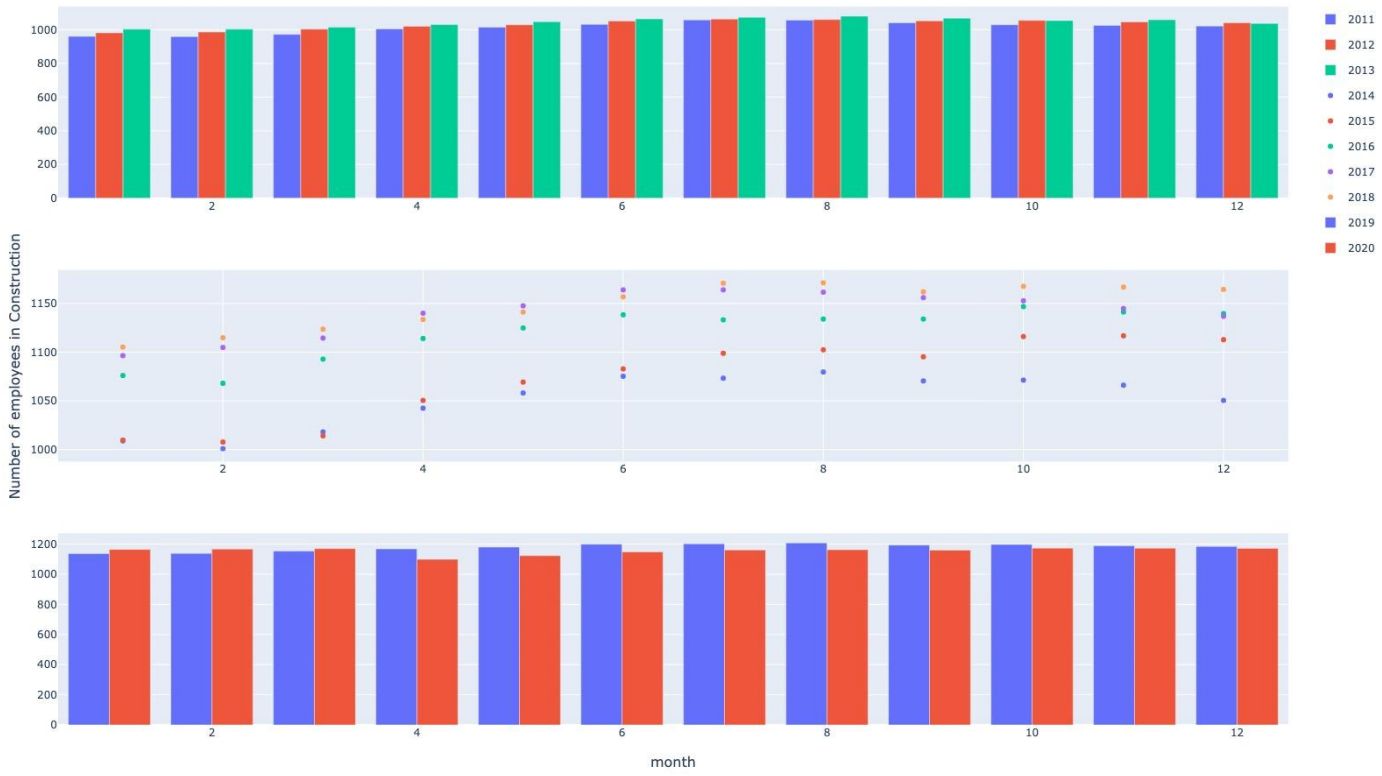


Figure 24: Yearly changes for District of Columbia

- **Line/ scatter/ bar Graphs**: We categorized the year range 2011-20 into three segments to ease the comparison. The segment one represents a line graph of employment for the District of Columbia across the months of 2011, 2012 and 2013. The second segment represents a scatter plot of employment for D.C. across the months of years 2014-18. And the final segment represents a bar graph of employment in the District of Columbia across the months of years 2019 and 2020.

- **Analysis**: We observed an increasing trend in employment for all the years until the month August, and a downfall since then. The employment was higher during April, May and June of 2017 when compared to 2018. We see higher employment during the first three months of 2020 compared to 2019, with a small drop in April 2020, the employment experienced an increasing trend from then. The employment was highest during August of all the years.

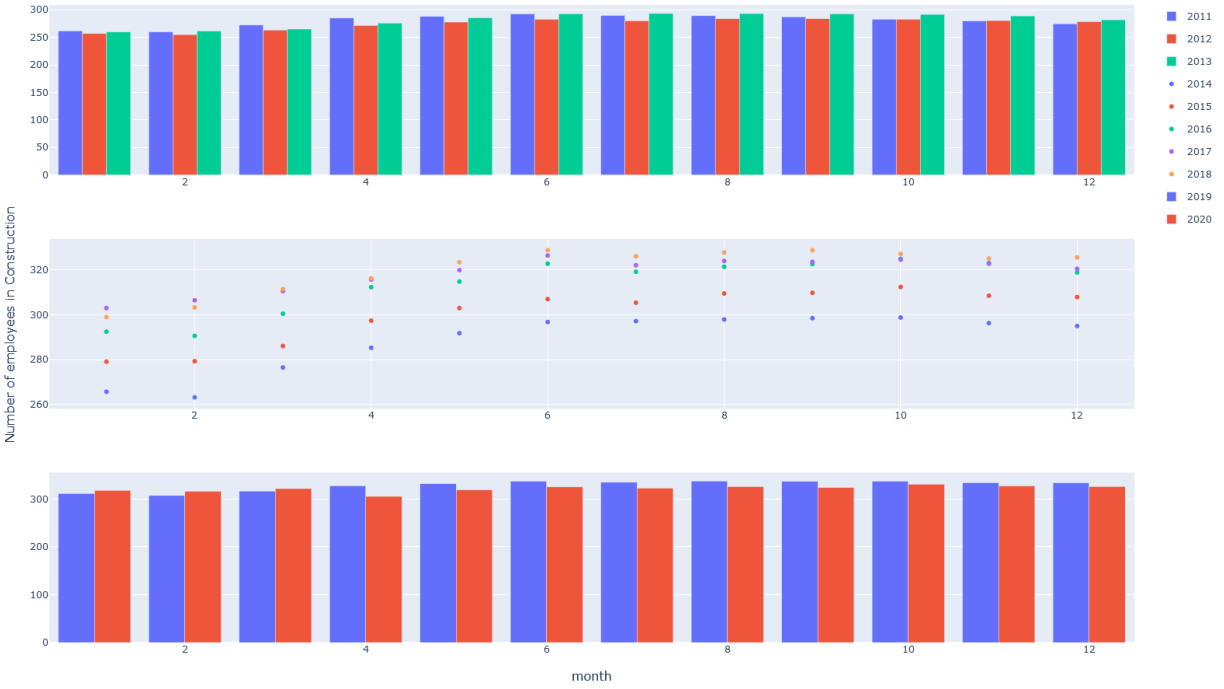


Figure 25: Yearly changes for Missouri State

- **Line/ scatter/ bar Graphs**: We categorized the year range 2011-20 into three segments to ease the comparison. The segment one represents a line graph of employment for the Missouri state across the months of 2011, 2012 and 2013. The second segment represents a scatter plot of employment for Missouri across the months of years 2014-18. And the final segment represents a bar graph of employment in Missouri across the months of years 2019 and 2020.

- **Analysis**: We observed an increasing trend in employment for the years 2012 and 2013 until August in comparison with 2011, where 2011 experienced an increase trend until August and a downfall since then. The employment was higher during January and February of 2017 when compared to 2018. We see higher employment during the first three months of 2020 compared to 2019, with a small drop in April 2020, the employment experienced an increasing trend from then until November. The employment was highest during June 2013, June and September of 2018 and August 2019.

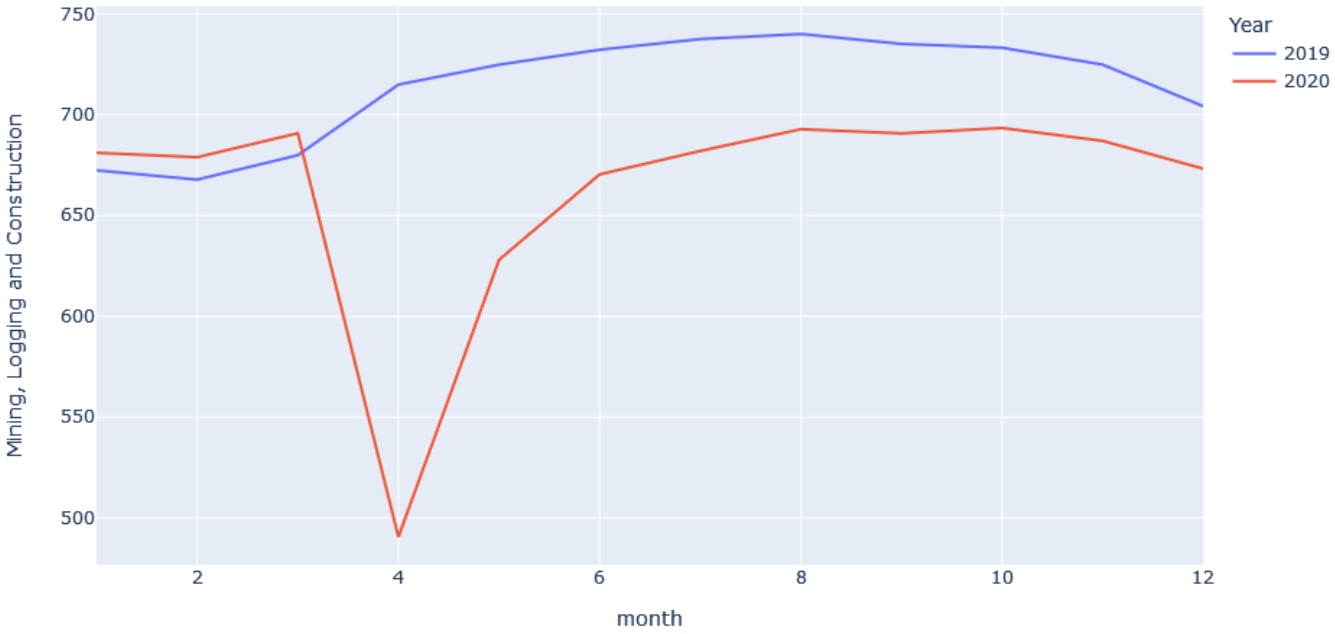


Figure 26: Change in employment in Pennsylvania during COVID

- **Line Graph**: The above line graph represents employment data for Pennsylvania, plot against 12 months of the years 2019-20 (period of COVID-19), while the vertical axis reports the values of employment number for construction sector.

- **Analysis**: The line graph explains the impact of covid-19 in the employment during April 2020 that resulted in the drastic drop in the employment.

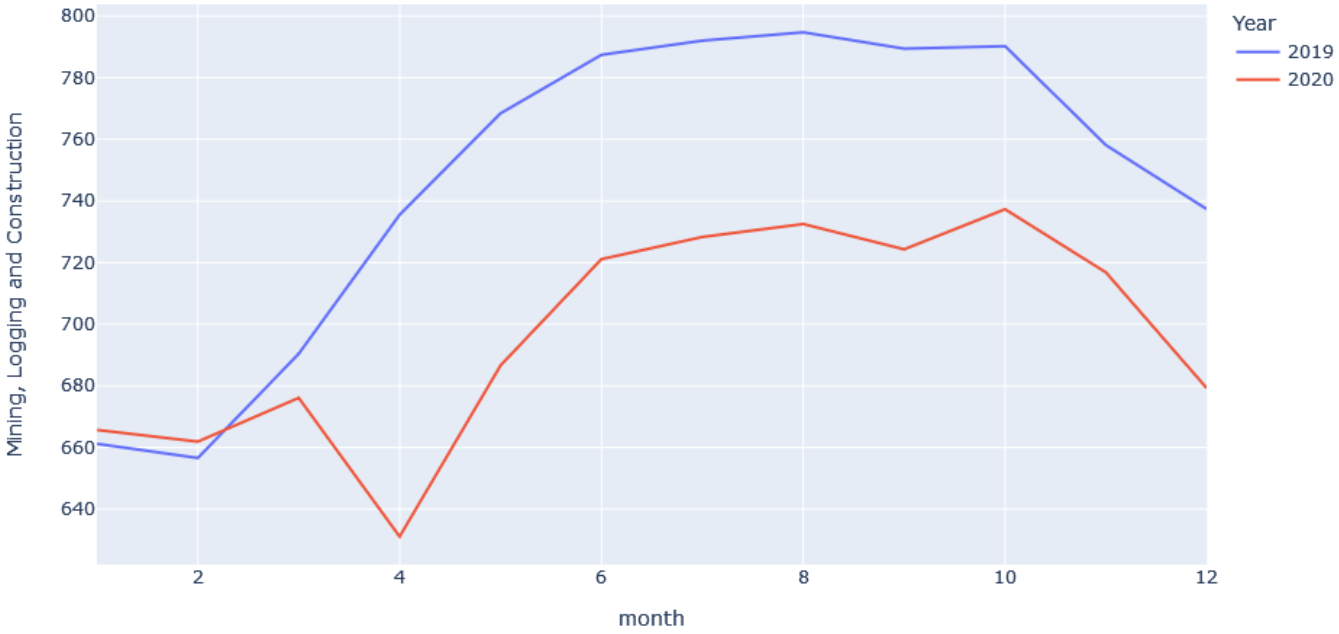


Figure 27: Change in employment in Illinois during COVID

- **Line Graph**: The above line graph represents employment data for Illinois state, plot against 12 months of the years 2019-20 (period of COVID-19), while the vertical axis reports the values of employment number for construction sector.

- **Analysis**: The line graph explains the impact of covid-19 in the employment during April 2020 that resulted in the drastic drop in the employment.

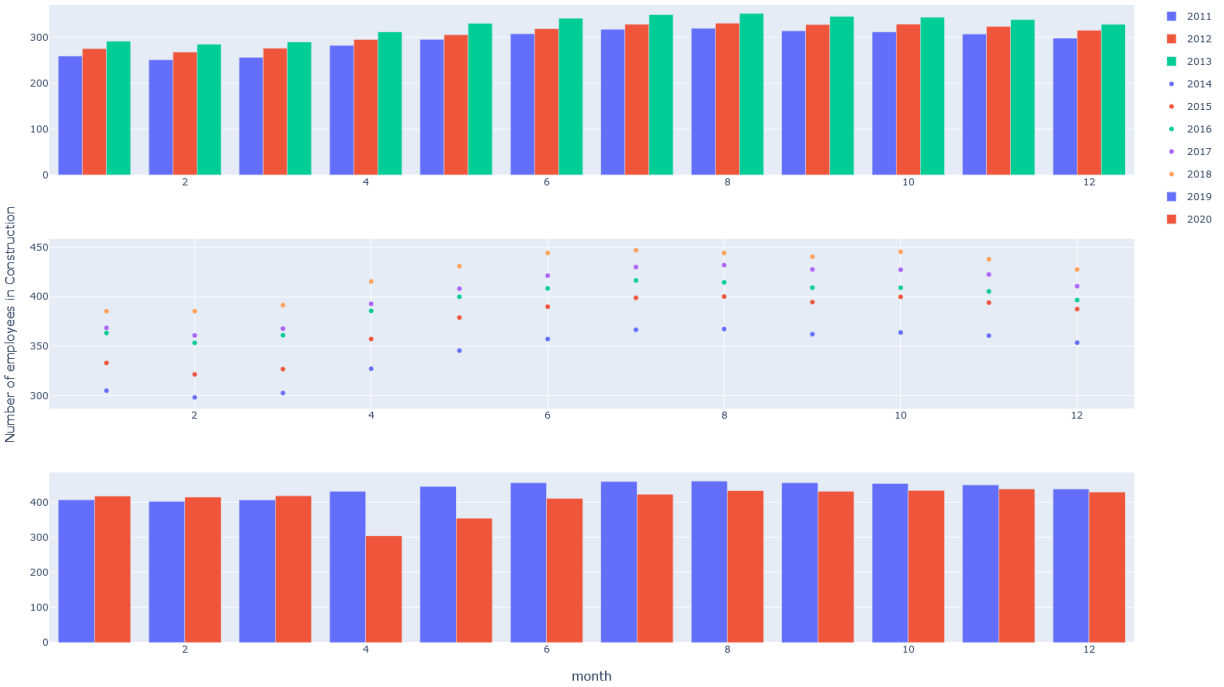


Figure 28: Yearly changes for Massachusetts

- **Line/ scatter/ bar Graphs**: We categorized the year range 2011-20 into three segments to ease the comparison. The segment one represents a line graph of employment for Massachusetts across the months of 2011, 2012 and 2013. The second segment represents a scatter plot of employment for Massachusetts across the months of years 2014-18. And the final segment represents a bar graph of employment in Massachusetts across the months of years 2019 and 2020.

- **Analysis**: We observed an increasing trend in employment for the years 2011-13 until August and a decrease from then on. The employment followed an increasing pattern with a drop in the second month of the years 2014-18 until July, and a downfall from then on with a little hike during October. We see higher employment during the first three months of 2020 compared to 2019, with a drop in April 2020, followed by an increasing pattern until August, with a drop in Sep, followed by an increasing trend from then on until Nov. The employment was highest during Aug 2013, July 2018 and August 2019.

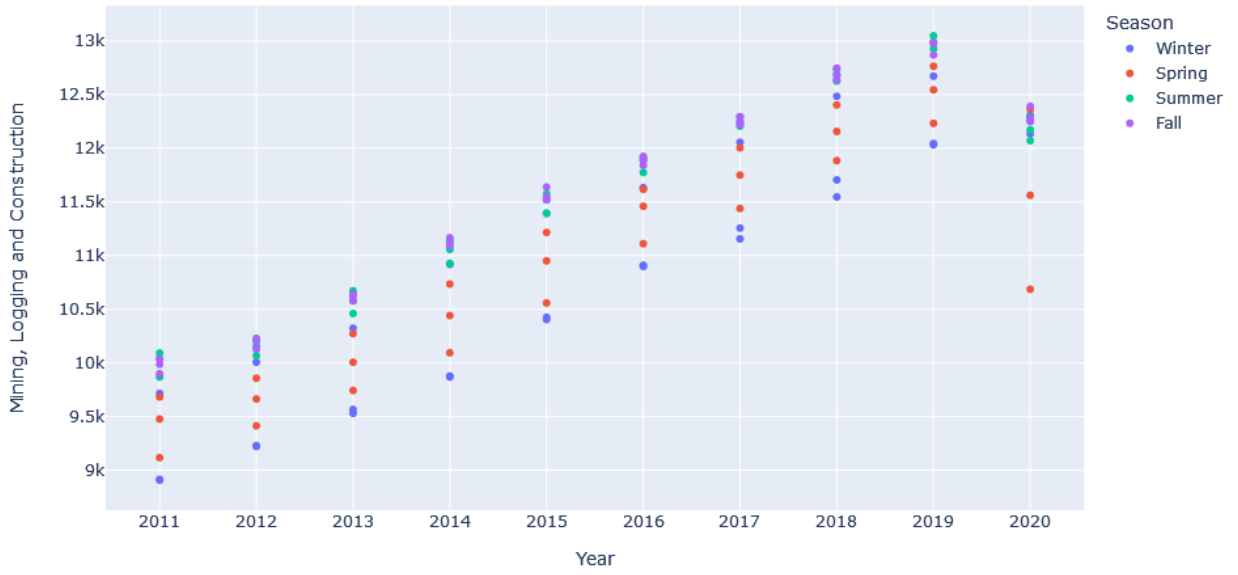


Figure 29: Change in employment at different seasons

- **Scatter Plot**: The above plot demonstrates employment analysis across seasons of the metropolitan data. The horizontal axis depicts the time series from 2011 - 2020, while the vertical axis reports the values of employment numbers for the construction sector that contribute to total non-farm employment.

- **Analysis**: We see an increasing trend in employment during Winters, across the years 2011-2019, and a drop in the year 2020. An increasing trend in employment was observed during Spring, across the years 2011-2019, and a drastic fall in the year 2020. Similar pattern was seen for the Fall however, during summers a higher employment has been noticed for the years 2011 and 2019 with an uptrend till 2019 and a drop in 2020.

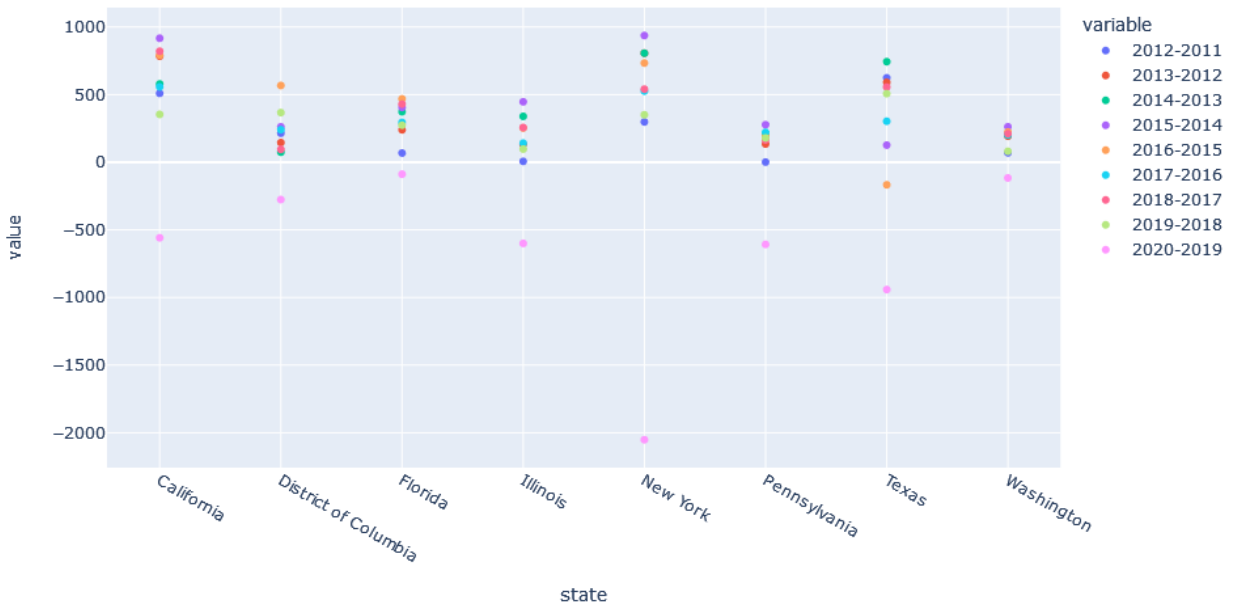


Figure 30: Actual change in the employment number for different states over the years

- **Scatter Plot**: The above plot demonstrates change in employment analysis of major states across the years of the metropolitan data. The horizontal axis depicts states, while the vertical axis reports the change in values of employment numbers for the construction sector.

- **Analysis**: We noticed a greater change in employment during 2020-2019 for New York State, being the first state impacted with covid-19, when compared to all other states, followed by Texas, Illinois and Pennsylvania, California, District of Columbia, Washington, and Florida.

4.4 Long-term overall trend

General Overview:

The employment rates in any sector cannot be constant in any metropolitan area over various time periods. The same applies for the construction sector. The employment rates may either decrease or increase in a particular point of time in a particular location. These can be affected by various factors which include people migration to other cities, health hazards(Covid - 19 pandemic), weather conditions, increase or decrease in new projects, recession in the economy and many more.

The below visualizations show the employment rates for the states in the US over the time period 2011 - 2020 and also various scenarios where we observe some interesting trends and deviation from its usual trend in the employment rate.

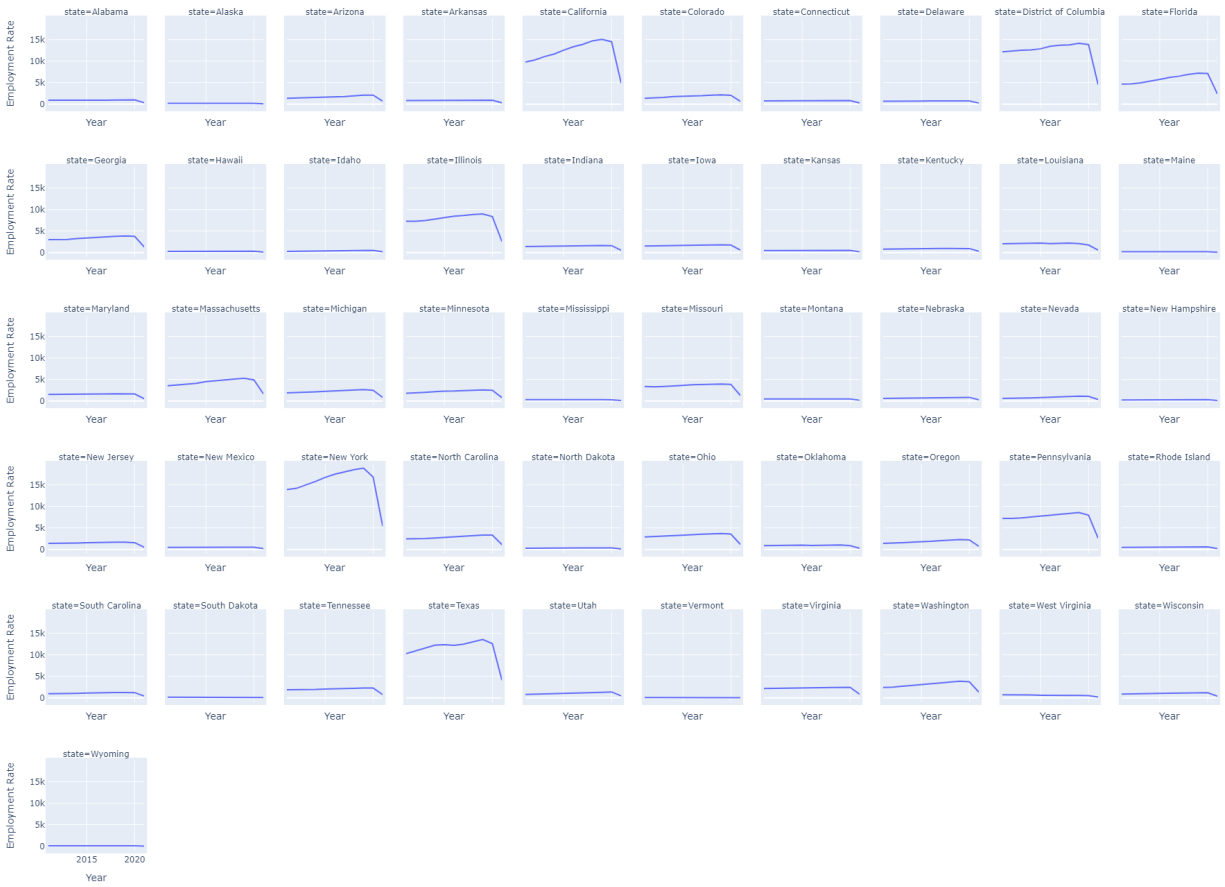


Figure : Overall Employment trend in construction across all states from 2011 - 2020

Figure 31: Overall Employment trend in construction sector across all states (2011-2020).

- **Line Graph** : The Line graph above demonstrates the overall trend across various states in the employment rate for the construction sector over time period 2011 - 2020 . The x-axis shows the time frame i.e. from 2011 to 2020 and the y-axis reports the change in the employment rate.

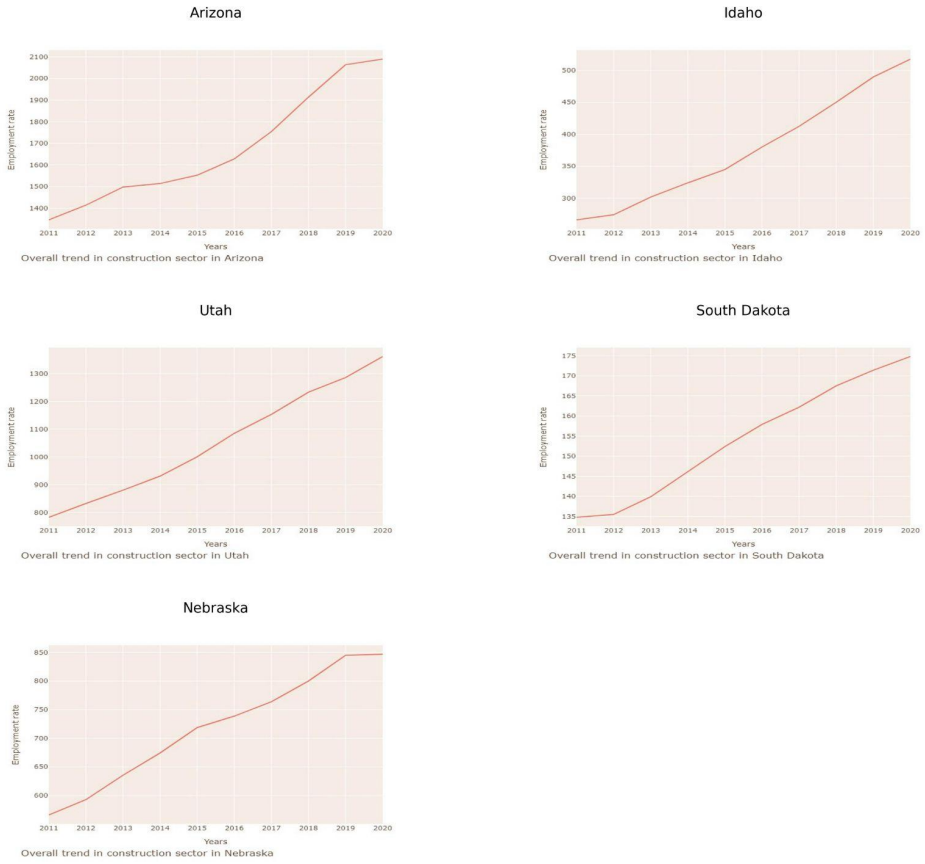


Figure 32: Overall trend of the states that shows increase in employment sector over time period (2019 - 2020).

- **Line Graph** : The Line graph above demonstrates the overall trend across various states that shows an increase in the employment rate for the construction sector over time period 2019 - 2020 . The x-axis shows the time frame i.e. from 2011 to 2020 and the y-axis reports the change in the employment rate.

- **Analysis** : We can observe an increase in employment rate in 2020 for these states. We can see that Arizona has the highest employment rate when compared to other states [17],[18].

Figure 33: Overall trend in employment rate for the state of Texas in the construction sector over the time period 2011 - 2020.

- **Line Graph** : The above line graph demonstrates the overall trend for the state of Texas in the employment rate for the construction sector over time period 2011 - 2020. The x-axis shows the time frame and y-axis reports the change in the employment rate.

- **Analysis**: We can observe a positive correlation between years and employment rate. As the year increases, we can see an increase in the employment rate except for the time range 2015 - 2016 and 2019 - 2020 .

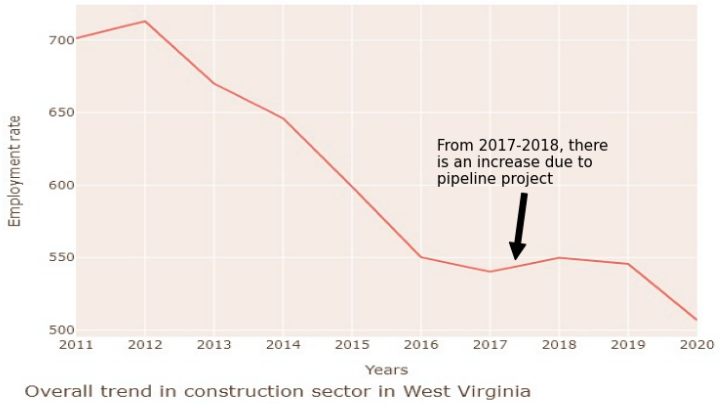


Figure 34: Overall trend in employment rate for the state of the state of West Virginia in the construction sector over the time period 2011 - 2020.

- **Line Graph** : The above line graph demonstrates the overall trend for the state of West Virginia in the employment rate for the construction sector over time period 2011 - 2020. The x-axis shows the time frame and y-axis reports the change in the employment rate.

- **Analysis** : There is a constant decrease in the employment rate starting from the year 2012 in West Virginia except between the period 2017 - 2018 [15],[16].

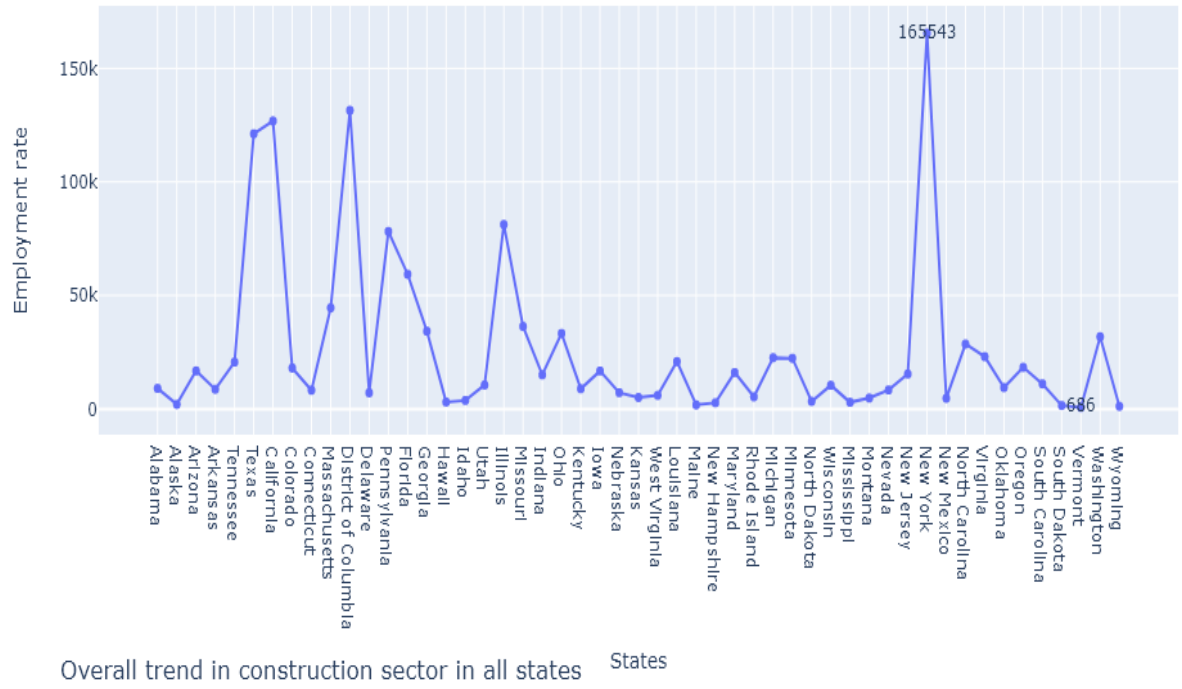


Figure 35: Employment rate for all states in the construction sector from 2011 to 2020.

- **Line Graph** : The above line graph demonstrates the overall trend of employment rate in all the states for the construction sector over time period 2011 - 2020. The x-axis shows the states and y-axis reports the employment rate.

- **Analysis** : The overall employment rates for New York is the highest with 165,543 and Vermont has the lowest rate with 686, when compared with the other states present in the US.

5. Conclusion

In the last decade, many factors affected the employment rate in the construction sector. That includes seasonal variations, Covid effect and rapid industrialization in high growth areas that fueled an increase in employment rate in areas like Houston Sugar Land, New York and District of Columbia.

For example, Seasonal variations in the country determine the upward or downward trend in the rate of construction jobs in the country. In a usual construction year, We observe an upward trend in the rate of construction jobs in the fall and summer months and a drop or downward trend during the months of winter. This downward trend can be attributed to the weather disturbances in winter months that impact the construction work to stop for a few weeks leading to low hiring[20]. However, during the summers, the employment topped in the years 2011 and 2019 compared to all other seasons.

This seasonal variation remained fairly consistent until the Covid-19 pandemic was declared in 2020. While the variation pattern could still be observed, there was a significant drop in overall employment numbers across the United States. One of the many factors causing this drop was the introduction of stringent regulations to prevent the spread of the Covid-19 virus. Moreover, a dramatic dip in employment numbers was observed in April, 2020. WHO declared the Covid-19 virus a pandemic in March of 2020, causing construction businesses and projects all over the US to either cease, or function under strict mandates. This sudden change would negatively impact the construction jobs all across the US, causing the dip observed in April of 2020.

There are some states that have not been affected by this Covid-19 pandemic and we can see the increase in employment throughout the time period 2011 to 2020. These states include Arizona, Idaho, Utah, South Dakota, Nebraska. The reasons for this constant increase is different for different cities like continuing construction activities with safety measures in Arizona and people migrating to other states, which directly increases the construction jobs in that location.

During the time period of 2011-2012, Missouri state has seen a downfall in construction jobs due to misclassifying employees as an independent contractor [21] and as said by Ken Simonson, the association's chief economist, "The expansion appears poised to continue for residential and private nonresidential construction," Simonson said in a release. "But investment in infrastructure and public buildings is still on a downward path. That will keep employment down in states (like Missouri) with a large federal presence." [22]

We observed that Texas state is showing some interesting changes over the years. Research showed that Texas downfall in jobs during 2015-2016 is due to oil bust [23] where Houston city is the main impact for the overall [24]. Due to Hurricane in 2017 and because of no necessity as

said by Patrick Jankowski, regional economist [25], "We have enough office space, the boom (in) petrochemical plant construction is winding down, and industrial space is responding to the market," hence jobs were lost. However, ending October 2018, Houston exceeded the construction jobs [26] recovering from previous year's hurricane Harvey, which devastated commercial and residential properties with record flooding. Harvey caused immense damage which led to an aftermath of high demand for construction services. The survival was great with the highest number of construction jobs in 2018. Also due to new metro projects [8][12].

The other areas had been affected by the Covid-19 pandemic that came into existence in the early 2020's, which was the only sudden change for the other metropolitan states that forced loss of employment, especially the first impacted NewYork state has experienced much loss in jobs.

Futhermore, from our analysis of the long term overall trend, we observed an interesting trend in West Virginia where there is a constant decrease in the employment rates except for the time frame 2017-18. The reason behind this constant decrease was the recession that took place in the state. The sudden increase in the employment rate in that particular period 2017-18 was due to the start of a new pipeline project.

In general [27], due to increase in population and industrialization, there has been an increase in need for new construction jobs. Hence employment in the industry grew over years. But many people didn't know about the ample opportunities in this industry, yet some young people take upon hourly jobs in construction which do not require a traditional four-year degree, giving young people a path to a career that does not require taking on student loan debt. However, it is said that "Contractors foresee plenty of projects to bid on, and nearly three-fourths of firms expect to add workers, but most are finding it hard to find qualified workers to hire" by Ken Simonson [28], the association's chief economist. We observed that when there is an increase in the material costs, contractors tried to hire less people as well as for less pay comparatively. Finally, Covid-19 has shown us how much effect any kind of pandemic may have on the employment rates as well as on the world economy.

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