

Covid-19 Impact and Population Density

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[Abstract] This study analyzes employment data during 2020. Industry-wide and overall employment data across different regions in the U.S. are analyzed. Population density plays a big role during this pandemic. Employment in densely populated areas is more affected than less populated areas. The employment population ratio decreases 7.57% in the most populated areas, while it decreases 3.37% in the least populated areas during 2020. While employment decreases across all sectors, leisure and hospitality is by far the most affected industry. Financial activities, trade, transportation, and utilities fare the best during this pandemic.

[Keywords] Covid-19, employment, population density

Introduction

The current Covid-19 pandemic has a profound impact on the economy through reduction of the labor force, modification of human behavior, and school closures, to name a few factors. Smith, Keogh-Brown, Barnett, and Tait (2009) concluded that the pandemic influenza itself, even with its high fatality pandemic with high levels of infection, would reduce GDP by less than 4.5%. The study also pointed out that school closures and prophylactic absenteeism, whether imposed by the government or the result of fear of infection, could greatly increase the economic impact. US 2020 GDP is 20.93 trillion in comparison with 2019's 21.43 and 2018's 20.58 trillion. If we assume the same growth rate in 2020 without the pandemic, our 2020 GDP should be 22.32 instead of 20.93 trillion. We lost about 6.2% GDP due to the pandemic. This extreme loss of production was caused by the pandemic itself directly and by widespread school closures, prophylactic absenteeism. Forced business closures or reduced capacity and modified human behaviors were two factors that exacerbated the destruction. We reduced dining out and traveling, which greatly impacted the leisure and travel industry. Many small businesses, including retail, services, and restaurants were ordered to shut down. Sporting activities were mostly cancelled, and graduation ceremonies went online. Global travel restrictions are still mostly in place. The social impacts pointed out by Qiu, Rutherford, Mao, and Chu (2016-2017) have become a reality. The US economy is quite resilient considering the severity of the impact.

In March 2021, the U.S. Census Bureau published Udalova's analysis on the initial impact of Covid-19 on the U.S. economy. The analysis used April 2020 data and concluded that job losses were widespread across regions and age groups. This study is going to look at the impact on the whole labor market and on specific industries. This study analyzes 2020 US economic data, including employment-to-population ratio, industry-specific impact, and population density's role in a pandemic economy.

Literature Review

A pandemic's impact can be caused by an infectious disease itself. The pandemic can have profound impact on people's psychology. It can disrupt the economy because of the disease itself and because of changing behaviors of society. The pandemic can also disrupt the economy by implemented public policies, such as forced business closures and interrupted supply chains due to travel bans. There are ongoing debates whether business closures and other stringent policies actually work to control the virus. Population density can also play a big role in an infectious disease's impact. This study does not focus on public policies or psychology. This study focuses on the effect of population density's role in local jobs and the economy.

Many researches have been done on psychological impact of the pandemic. The *Journal of General Psychology* published a special issue on the psychological effects of the COVID-19 pandemic. Psychological issues can be caused by staying home (Bozdağ, 2021) and social distancing (Ford, 2021).

Jones (2021) discussed strategies employers can implement to improve employees’ mental health.

Several researches analyzed supply chain impact of the pandemic. Bassett, Lau, Giordano, Suri, Advani, and Sharan (2021) highlighted the importance of local organizations and connections and risks in over-reliance on global trade networks during the pandemic. Li, Chen, Collignon, and Ivanov (2021) concluded that it is important to differentiate between forward and backward disruption propagation.

Job and wage losses during the pandemic are important indicators of the economy. Friedson, McNichols, Sabia, and Dave (2021) studied California shelter-in-place orders and concluded that there were about 649 to 703 job losses per life saved, and about 14 to 16 job losses per case averted. Lynn (2021) concluded that the tipping model remains a viable means of employee compensation even during the pandemic, since the average tip percentage for face-to-face transactions at full-service restaurants only decreased by one to two percentage points. The stock market was another important indicator of the economy that drew a lot of attention, as well (Ftiti, Ben Ameer, & Louhichi, 2021; Anh & Gan, 2021; Chakrabarti, Jawed, & Sarkhel, 2021).

Methodology

Monthly data of 2020 were obtained from the U.S. Census Bureau. The North American Industry Classification System (NAICS) is used by the U.S. Census Bureau, which is provided in the Appendix. We categorized states/districts in five groups based on population density. Group One has population density of more than 500 people per square mile. Group Two has 250 to 500 people per square mile. Group Three has 100 to 250 people per square mile. Group Four has 50 to 100 people per square miles. Group Five has less than fifty people per square mile. Monthly data are presented as percentages of population employed in a specific industry, and cumulative changes from January are also presented. Dividing states/districts into five groups helps discern population density impacts on industry/employment. General patterns are identified during this process. State data is used in regression models to further validate our findings. Regression models are run using the natural log of a state’s population density as an independent variable. Dependent variables are employment changes from January to December in percentage terms. Industries and overall employment indicators are analyzed.

Results

Monthly industry-wide data for 2020 is shown as a percentage of the population employed in a specific industry.

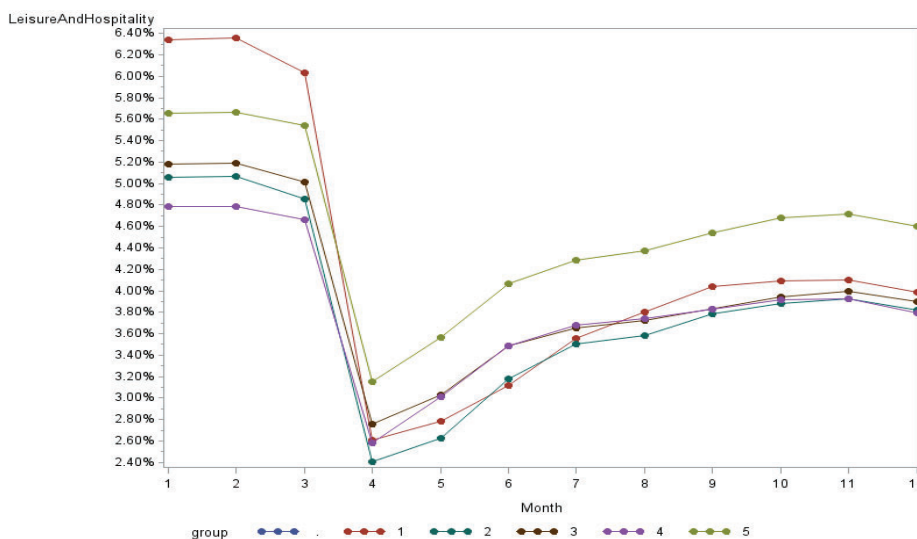


Figure 1. Percentage of Population Employed in Leisure and Hospitality

Leisure and hospitality is the most impacted industry in this pandemic. Figure 1 shows leisure and

hospitality employment during the pandemic. Five groups from the most densely populated to the least densely populated are presented. Densely populated areas with more than 500 people per square mile are the most impacted by the pandemic compared with other less populated states. Group 1 with more than 500 people per square mile has 6.34% of the population working for leisure and hospitality in the beginning of 2020. It drops to 3.98% by the end of the year, which is a 37.21% decrease. Other states (Groups 2-5) start in January at 5.17% and end in December at 4.03%, which is a 22.06% decrease. Out of the five groups, the least populated states with less than 100 and less than 50 people per square mile fare the best. Group 5, with less than 50 people per square mile, has 5.66% of the population working for leisure and hospitality in January. It drops to 4.60% by December, a 18.63% decrease. This is in comparison with Group 1's 37.21% decrease. Leisure and hospitality, as a whole, employs 5.41% of the nation's population in January, 2020. It is 4.02% in December, a 25.61% decrease.

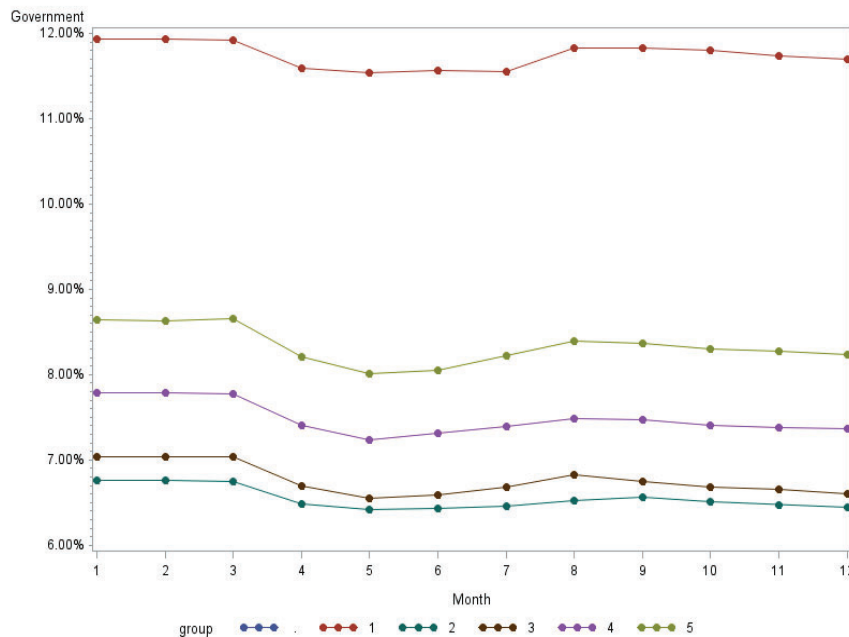


Figure 2. Percentage of Population Employed in Government

Figure 2 shows that government employment has very little fluctuation compared with the leisure and hospitality industry. It is noticeable that densely populated areas have a smaller percentage of the population employed by the government with the exception of Group 1. Washington D.C. has more than 33% of the population working for the government, which significantly skewed Group 1's average. If we exclude Washington D.C, Group 1 has only 6.58% and 6.13% of the population working for the government in January and December, respectively. In Group 2, the government employs 6.76% and 6.44% of the population in January and December, respectively.

In Group 1, the government, including Washington D.C, employs 11.93% and 11.70% of the population in January and December, respectively. This is a 1.97% decrease. In Group 2, the government employment has a 4.78% decrease. Groups 3, 4, and 5 have a decrease of 6.27%, 5.44%, and 4.83%, respectively. Population density and government employment loss do not show clear association. The most populated group, Group 1, fares the best, while Group 3 (population of 100 to 250 people per square mile) fares the worst for government employment. Government employment, as a whole, fares much better than leisure and hospitality employment. Government employment, as a whole, drops from 8.43% to 8.03%, compared with leisure and hospitality's 5.41% and 4.02%. In 2020, government employment decreases by 4.36%, while leisure and hospitality employment decreases by 25.61%.

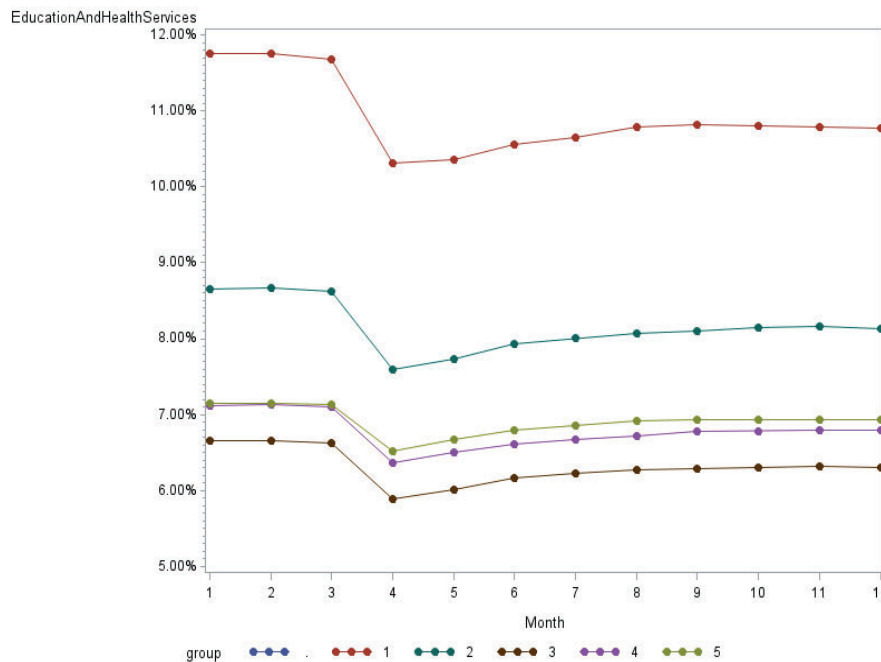


Figure 3. Percentage of Population Employed in Education and Health Services

Figure 3 illustrates education and health services employment in 2020. In Group 1, education and health services employs 11.75% and 10.77% of the population in January and December, respectively. It is a decrease of 8.38%. In Group 2, education and health services employs 8.65% and 8.13% of the population in January and December, respectively. It is a decrease of 6.05%. The education and health services employment loss gets smaller as population density decreases. The least populated group, Group 5, suffers the least loss. Group 5, education and health services, employs 7.15% and 6.93% of the population in January and December, respectively. It is a decrease of 3.06%. The industry, as a whole, has an employment loss of 5.84%. Prolonged school closures and avoidance of seeking treatment might have contributed to the more pronounced loss in the more populated areas.

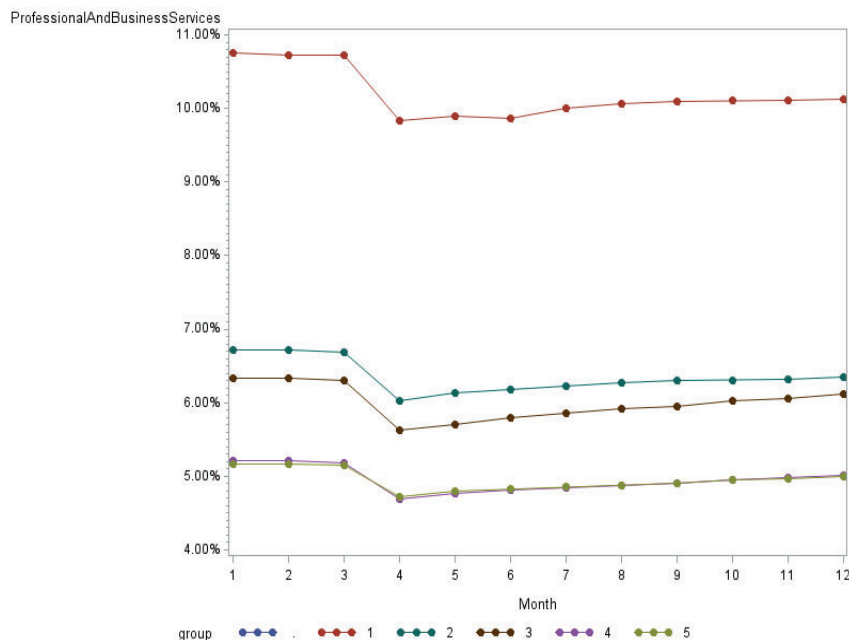


Figure 4. Percentage of Population Employed in Professional & Business Service

Figure 4 shows professional and business service employment in 2020. Group 1, again, is leading the loss with 10.75% of the population employed in the industry in January and 10.13% by end of the year, a decrease of 5.82%. It is also worth noting that Group 1 has the highest percentage of people employed in professional and business services. In Group 2, professional and business services employ 6.71% and 6.35% of population in January and December, respectively. Group 2 loses 5.44% of the labor force in professional and business service in 2020. Groups 3, 4, and 5 have 3.29%, 3.88%, and 3.12% loss, respectively. The industry, as a whole, loses 4.57% its labor.

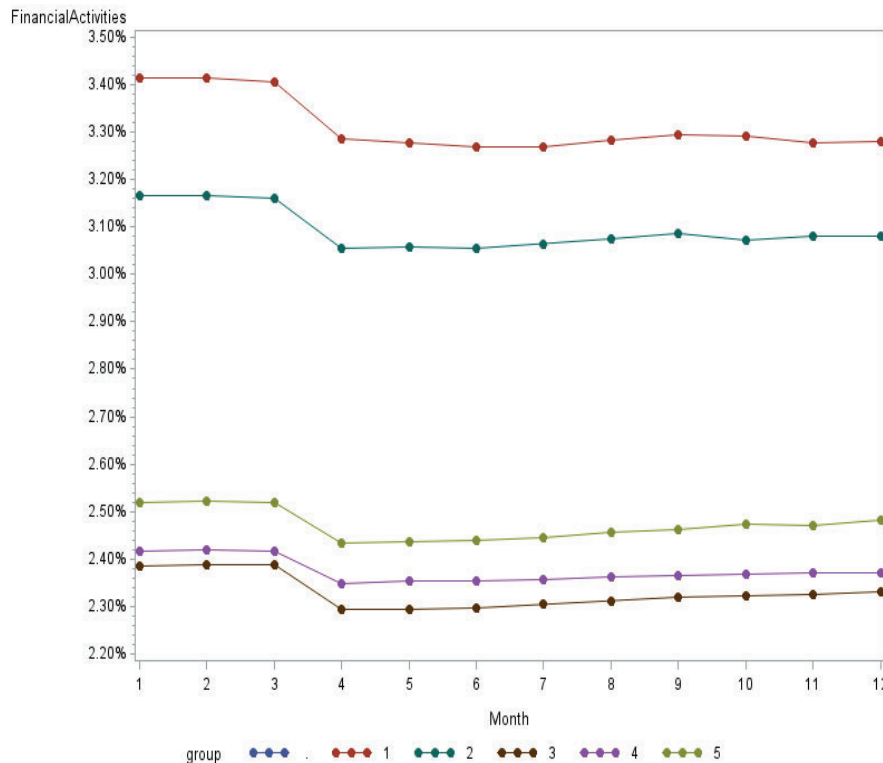


Figure 5. Percentage of Population Employed in Financial Activities

Figure 5 illustrates financial activities employment in 2020. The industry shows the same trend as other industries: the more populated areas lose more of its labor force compared with the less populated areas. It ranges from a 3.95% loss for Group 1 to a 1.54% loss for Group 5. The industry stands out as a pandemic proof industry. It only loses 2.59% of its labor force in 2020, which is significantly lower than other industries. Figure 5 shows another trend: the more populated areas, with a population of 250 people per square mile or more, have significantly more people employed in financial activities industry than the other three groups.

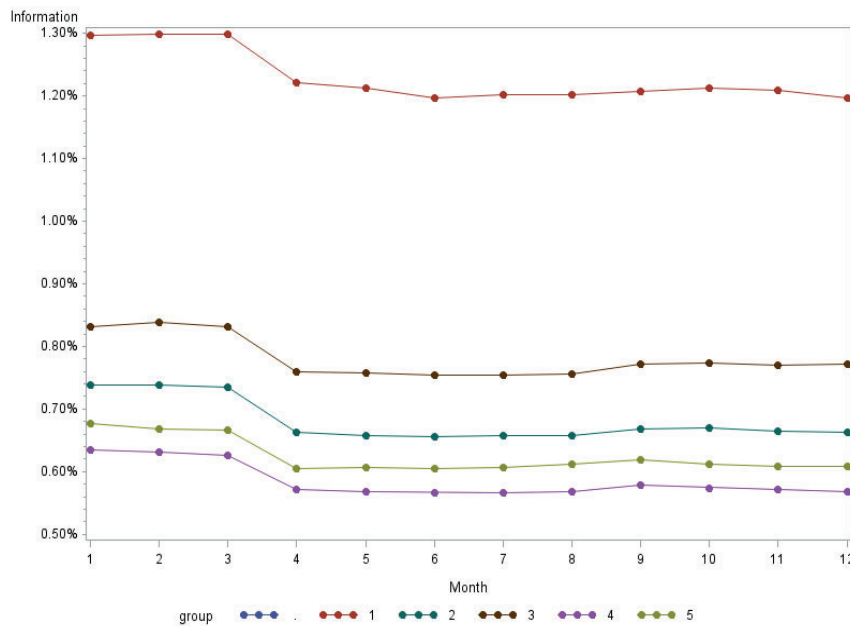


Figure 6.
Percentage of Population
Employed in Information

Figure 6 shows information industry employment in 2020. This industry employs less than 1% of the population. It might come as a shock to learn that this industry, as a whole, loses 8.91% of its labor in 2020. Remote working, online meeting, and remote classes should have boosted this industry. However, the industry includes a broad range of services. The movie subsector in this industry has suffered tremendously during the pandemic.

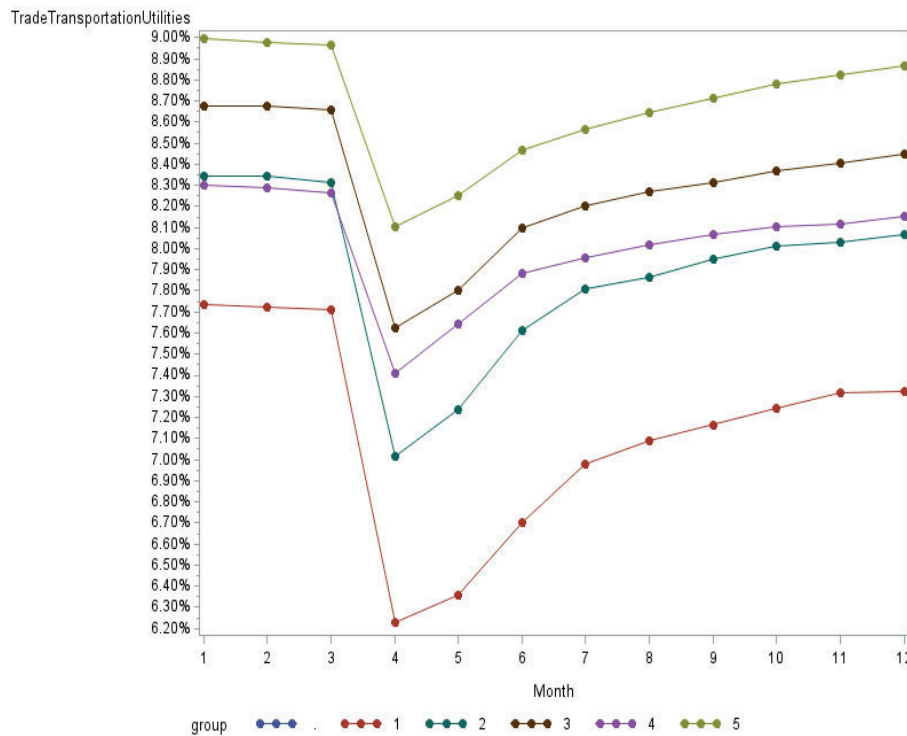


Figure 7.
Percentage of Population
Employed in Trade,
Transportation, and
Utilities

Figure 7 shows trade, transportation, and utility employment in 2020. More populated areas have a lower percentage of people employed in this industry. One reason might be that transportation and utility infrastructures are better utilized in more populated areas. The industry shows the same trend as most other industries, with more populated areas losing more of its labor force than the less populated areas. Group 1 loses 5.27% of its labor force. Group 5 loses 1.46% of its labor force. The industry, as a whole, fares better than most other industries except financial activities. It loses 2.83% of its labor force and financial activities loses 2.59%. It might come as a surprise for the relatively small losses, since public transportation was hit hard by the pandemic.

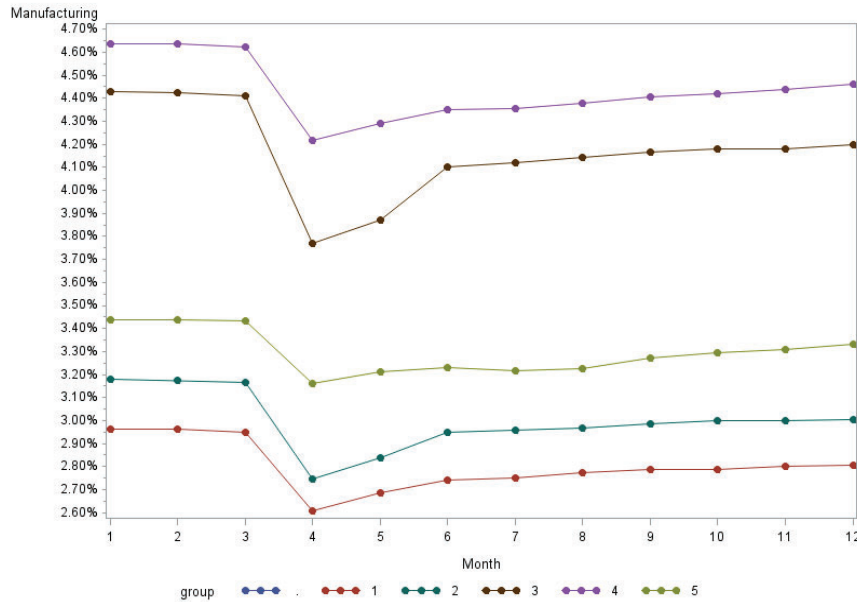


Figure 8. Percentage of Population Employed in Manufacturing

Figure 8 illustrates employment changes for the manufacturing industry. Generally speaking, as Figure 8 shows, the less populated areas fare better than the more populated areas. This is the same trend as most other industries. Groups 4 and 5 lose less than 4% of their labor force in this industry, while Groups 1, 2, and 3 lose more than 5%. The industry as a whole, sheds 4.51% of its labor force. The industry, as a whole, only employs 3.56% of the population by December, 2020.

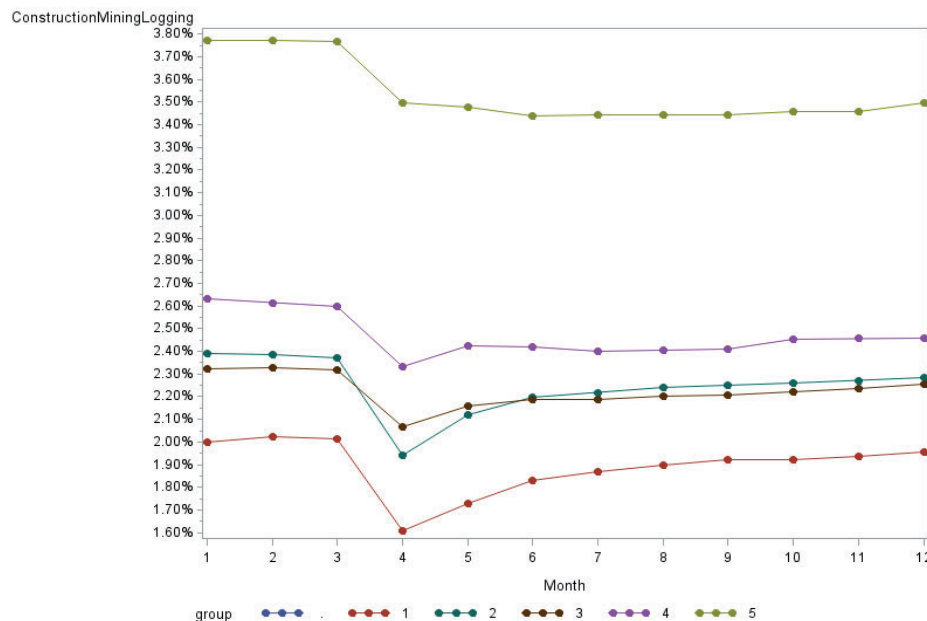


Figure 9. Percentage of Population Employed in Construction, Mining, and Logging

Figure 9 shows construction, mining, and logging employment in 2020. The industry shows a unique trend when compared to other industries. The less populated areas have significantly more people employed in this industry. Group 5 has 3.49% of the population employed in construction, mining, and logging. Group 1 has 1.95% of its population employed in this industry. The industry also suffers more in the less populated areas. Group 5 loses 7.3% of its labor, while Group 1 only loses 2.32% of its labor. The policy changes in the mining industry could have contributed to the unique trend. The industry, as a whole, loses 5.06% of its labor force.

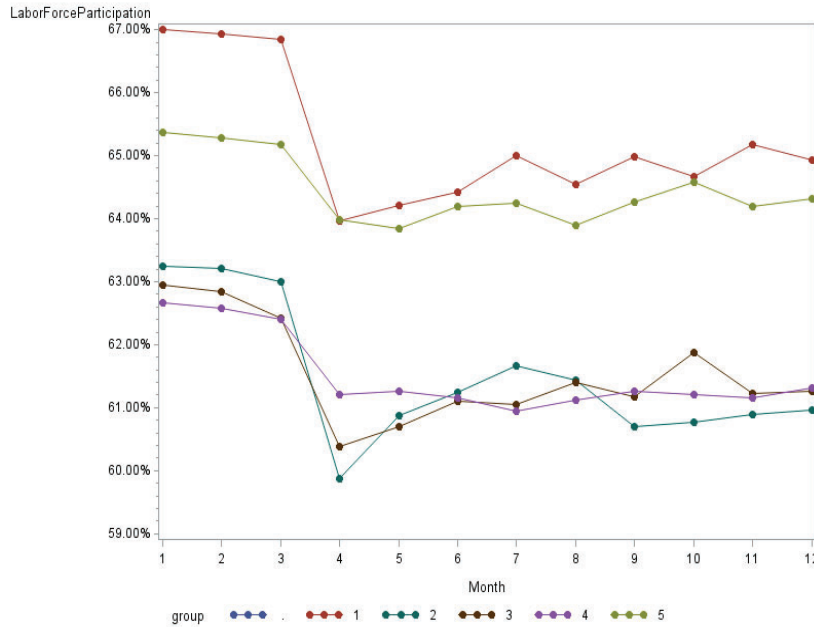


Figure 10. Monthly Labor Force Participation Rate

Figure 10 shows the labor force participation rate in 2020. It is interesting to note that the most and least populated areas experiencing the highest labor force participation rate, while Groups 2, 3, and 4 are similar in their labor force participation rate. Group 1, the most densely populated area, has a labor force participation rate of 67% in January. It drops to 64.94% in December. However, Group 1 continues to have the highest labor force participation rate in December despite the drop. Group 2 experiences the biggest labor force participation decrease. It has 63.25% of its population in the labor force in January. It drops to 60.97% by December, a 3.61% decrease. Group 2, at 60.97%, also has the lowest labor force participation rate by December. Overall, the labor force participation rate decreases the most in the more densely populated areas. Labor force participation rate, as a whole, decreased 2.62% in 2020.

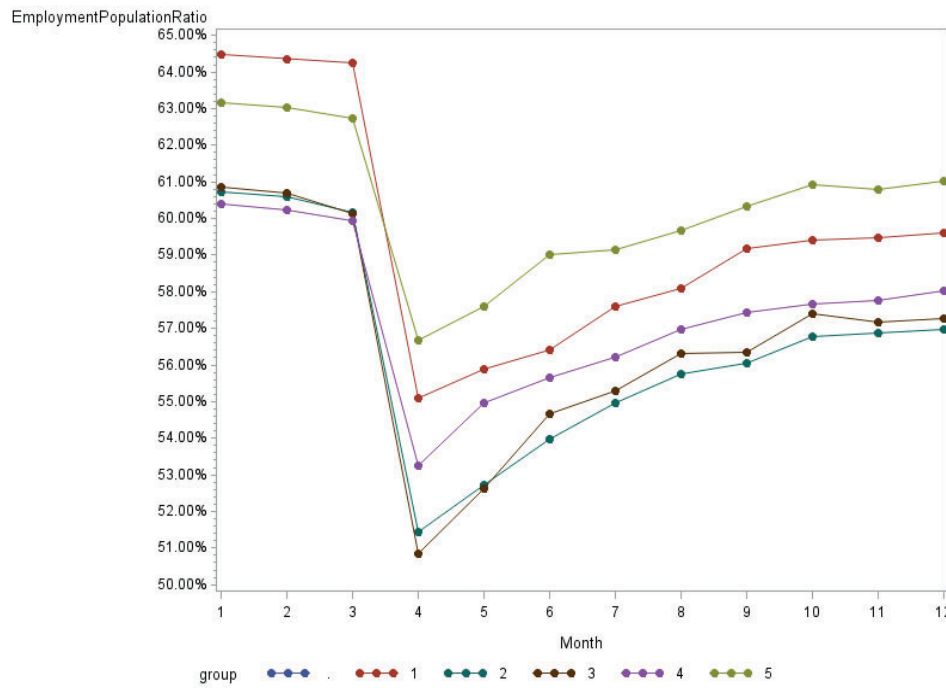


Figure 11. Monthly Employment Population Ratio

Figure 11 illustrates the employment population ratio in 2020. The employment population ratio shows a trend very similar to the labor force participation rate. Groups 1 and 5, the most and least populated areas, have the highest employment population ratios. The more densely populated areas have the highest decreases of the employment population ratio. Group 1 starts in January at a 64.48% employment population ratio and drops to 59.60% in December. It is a 7.57% decrease. Group 5, the least populated area, experiences the lowest loss of 3.37%. The employment population ratio decreases 5.4% overall.

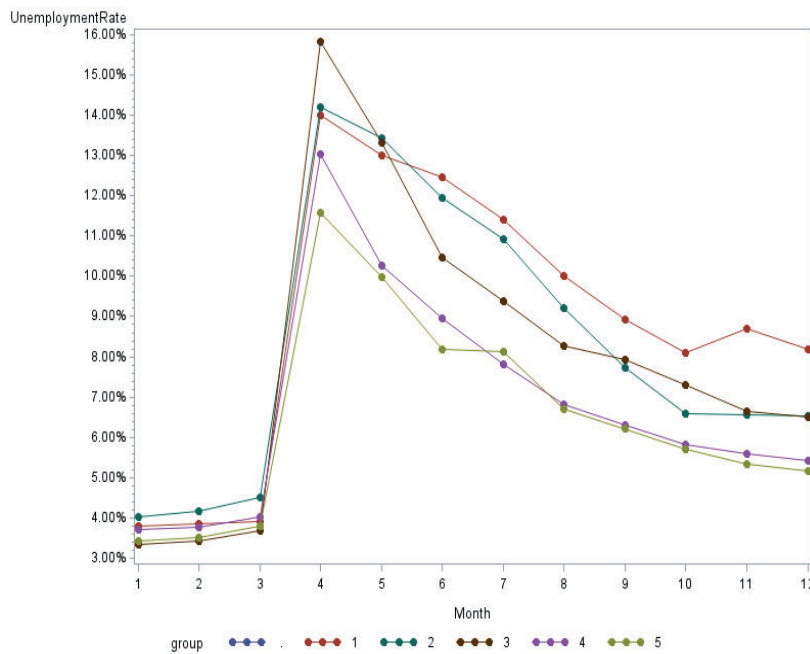


Figure 12. Monthly Unemployment Rate

As Figure 12 illustrates, the unemployment rate, overall, is 3.65% in January and 6.37% in December. It is an increase of 74.46%. Because of how the unemployment rate is calculated, even an increase of 74.46% might not catch the full impact of the pandemic. It follows the general pattern of the more densely populated areas losing more jobs than the less populated areas.

Table 1
2020 Industry Specific and Overall Employment Summary

		Leisure and Hos.	Govt.	Edu. Health Svcs.	Prof. Biz. Svcs.	Financ Act.	Info.	Trade, Trans. Utilities	Mfg.	Constr. Mining logging	Labor Force Particip. Rate	Employ. Popu. Ratio	Unemploy Rate
Gp 1	Jan.	6.34%	11.93%	11.75%	10.75%	3.42%	1.30%	7.73%	2.96%	2.00%	67.00	64.48	3.78
	Dec.	3.98%	11.70%	10.77%	10.13%	3.28%	1.20%	7.33%	2.81%	1.95%	64.94	59.60	8.20
	Chg.	-37.21%	-1.97%	-8.38%	-5.82%	-3.95%	-7.73%	-5.27%	-5.25%	-2.32%	-3.07%	-7.57%	116.93%
Gp 2	Jan.	5.06%	6.76%	8.65%	6.71%	3.17%	0.74%	8.34%	3.18%	2.39%	63.25	60.72	4.02
	Dec.	3.82%	6.44%	8.13%	6.35%	3.08%	0.66%	8.07%	3.01%	2.28%	60.97	56.98	6.53
	Chg.	-24.46%	-4.78%	-6.05%	-5.44%	-2.76%	-10.42%	-3.28%	-5.50%	-4.38%	-3.61%	-6.15%	62.66%
Gp 3	Jan.	5.18%	7.04%	6.66%	6.32%	2.38%	0.83%	8.68%	4.43%	2.32%	62.95	60.86	3.32
	Dec.	3.90%	6.60%	6.31%	6.12%	2.33%	0.77%	8.45%	4.20%	2.26%	61.26	57.26	6.51
	Chg.	-24.74%	-6.27%	-5.29%	-3.29%	-2.25%	-7.20%	-2.63%	-5.24%	-2.86%	-2.69%	-5.92%	96.13%
Gp 4	Jan.	4.79%	7.79%	7.12%	5.21%	2.42%	0.63%	8.30%	4.64%	2.63%	62.66	60.41	3.71
	Dec.	3.80%	7.36%	6.79%	5.01%	2.37%	0.57%	8.15%	4.46%	2.46%	61.32	58.03	5.41
	Chg.	-20.65%	-5.44%	-4.68%	-3.88%	-1.90%	-10.47%	-1.81%	-3.76%	-6.50%	-2.14%	-3.93%	45.84%
Gp 5	Jan.	5.66%	8.65%	7.15%	5.16%	2.52%	0.68%	9.00%	3.44%	3.77%	65.38	63.17	3.42
	Dec.	4.60%	8.23%	6.93%	5.00%	2.48%	0.61%	8.87%	3.33%	3.49%	64.32	61.04	5.17
	Chg.	-18.63%	-4.83%	-3.06%	-3.12%	-1.54%	-10.15%	-1.46%	-3.04%	-7.30%	-1.61%	-3.37%	51.35%
Over all	Jan.	5.41%	8.43%	8.27%	6.83%	2.78%	0.84%	8.41%	3.73%	2.62%	64.25	61.93	3.65
	Dec.	4.02%	8.03%	7.79%	6.52%	2.71%	0.76%	8.17%	3.56%	2.49%	62.56	58.58	6.37
	Chg.	-25.61%	-4.36%	-5.84%	-4.57%	-2.59%	-8.91%	-2.83%	-4.51%	-5.06%	-2.62%	-5.40%	74.46%

Table 1 summarizes the population density impact on industry and overall employment. Overall, although all industries are affected by the pandemic, leisure and hospitality is by far the most affected industry with 25.61% of employment loss. Financial activities; and trade, transportation, and utilities are the two industries with least employment loss at 2.59% and 2.83%, respectively. Employment-to-population ratio is down by 5.4%, while the labor force participation rate is down by 2.62%. Unemployment rate is up 74.46%. Due to the calculation method of unemployment rate, it might not catch the full impact of the pandemic. Densely populated areas are more impacted by the pandemic in a wide range of industries, including leisure and hospitality; education and health services; professional and business services; financial activities; trade, transportation, and utilities; and manufacturing. The exceptions are government; information; construction, mining, and logging.

Table 2

Population Density Impact on Employment during Pandemic Regression Model Results

Depn. Variable	Leisure and Hos.	Govt.	Edu. Health Svcs	Prof Biz Svcs	Financ Act.	Info.	Trade, Trans Utilities	Mfg.	Constr. Mining Logging	Labor Force Particip. Rate	Employ Populat. Ratio	Unemploy Rate
Adj. R-Square	0.1635	-0.0208	0.3952	0.0095	-0.0046	0.0055	0.0356	0.2220	0.0675	0.079	0.2348	0.0706
P Value	0.0021	0.9561	<0.0001	0.2312	0.3824	0.2650	0.1001	0.0003	0.0381	0.027	0.0002	0.0347
Parameter Estimate	-0.0306	-0.0001	-0.0093	-0.0036	-0.0024	0.0057	-0.0064	-0.0150	0.0104	-0.0043	-0.0091	0.1287

Table 2 summarizes the population density impact on industry and overall employment using the natural log of a state's/district's population as the independent variable. The dependent variable is a change of employment from January to December 2020. For industry-specific data, the change is calculated using a percentage of the population employed in a certain industry instead of the number of people employed. For every 1% increase of population density, the leisure and hospitality industry employment losses increase by 0.0306%; education and health services employment losses increase by 0.0093%; manufacturing employment losses increase by 0.0150%; construction, mining, and logging employment losses actually decrease by 0.0104%; the labor force participation rate losses increase by 0.0043%; the employment population ratio losses increase by 0.0091%; the unemployment rate increases up by 0.1287%. All the above impacts are significant at $p < 0.05$. The results are consistent with our conclusions of dividing states into five groups based on population density.

Conclusion

Population density plays a significant role during pandemics. More populated areas face bigger job market destruction during a pandemic across most industries. The leisure and hospitality industry deserves special assistance during a pandemic. It is by far the most affected industry with 25.61% of its labor force loss during 2020. Pandemic response strategies in densely populated areas might need to be different than in sparsely populated areas to reduce shock to the economy. The CDC has a national strategy and a framework for pandemic influenza. However, locally, each state might need to adjust to their unique situations.

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Appendix

- The leisure and hospitality supersector consists of the arts, entertainment, and recreation; and accommodation and food services.
- The education and health services supersector consists of educational services, health care, and social assistance.
- The professional and business services super sector consists of professional, scientific, and technical services; management of companies and enterprises; and administrative, support, and waste management and remediation services.
- The financial activities supersector consists of finance and insurance, and real estate, rental, and leasing.
- The information sector consists of the publishing industries (except internet); motion picture and sound recording industries; broadcasting (except internet); telecommunications; data processing, hosting, and related services; and other information services.
- The trade, transportation, and utilities supersector consists of wholesale trade, retail trade, transportation and warehousing, and utilities.
- The manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products.
- The construction sector consists of the construction of buildings, heavy and civil engineering construction, and specialty trade contractors.
- The natural resources and mining supersector consist of agriculture, forestry, fishing and hunting; and mining, quarrying, and oil and gas extraction.