International Journal of Research in Industrial Engineering

Paper Type: Research Paper

Evaluation of Household Expenditure in the United States: Pre-Covid and Post-Covid Statistical Analysis

Mobasshira Zaman* [ID]

Deoartment of Industrial and Systems Engineering, Northern Illinois University, United States; zaman.mobasshira@gmail.com.

Abstract

The COVID-19 pandemic has caused unprecedented disruption to the global economic structure, resulting in significant changes in spending patterns for households worldwide. Developed countries like the United States have been affected as well, struggling to return to pre-pandemic stable economic situations. This study focuses on the impact of the pandemic on household expenditure in the United States, using ANOVA to compare household expenses between the pre-COVID period in 2018 and the post-COVID period in 2021. The results of the study showed a significant increase in all types of household expenditure from pre-COVID to post-COVID periods, highlighting the correlation between the pandemic and changes in spending habits. This trend is further fueled by price increases in daily necessities, inflation of the dollar, and scarcity of goods. The analysis also revealed that the trend was increasing, emphasizing the need for immediate policy interventions to address the issue. Further research is needed to identify the specific types of expenditure driving this increase and the underlying reasons behind it. The implications of the study are significant for policymakers and economists as they underscore the need for effective interventions to stabilize household expenditure and promote economic recovery in the wake of the pandemic. The findings also highlight the importance of utilizing statistical methods such as ANOVA to evaluate complex economic systems and guide evidence-based policy interventions. As future research continues to explore the impact of the pandemic on economic structures worldwide, this study provides valuable insights into the specific changes in household expenditure in the United States, emphasizing the urgent need for targeted policy interventions to address these changes.

Keywords: Pre-post covid analysis, Household expense, Statistical analysis, Covid-19 economic impact, One-way ANOVA.

1 | Introduction

The COVID-19 pandemic began to impact the United States in early 2020 when the first virus cases were reported in the country. As the virus spread and cases increased, the US government declared a national emergency in March 2020, and many states implemented stay-at-home orders to slow the spread of the virus [1].

The COVID-19 pandemic has had a major impact on the global supply chain, leading to disruptions and challenges in multiple industries. Some of the effects include supply chain disruptions with lockdowns and border closures in place; many businesses have struggled to maintain their supply chains, leading to shortages of essential goods and supplies [2]. Additionally, the pandemic has increased demand for certain products, such as Personal Protective Equipment (PPE), household essentials, and cleaning supplies, leading to shortages and price increases [3]-[5]. Then, delays in

production and shipping with businesses operating at reduced capacity or shut down entirely have been significant delays in production and shipping, affecting the availability of goods and the speed at which they can be delivered [6], [7]. Again, in response to the pandemic, many businesses have shifted to local sourcing to reduce dependence on global supply chains and minimize the risk of supply chain disruptions [8]. Also, the pandemic has led to significant air, and sea transportation disruptions, with many flights and ships canceled, affecting the ability of goods to be transported and delivered [9], [10]. Overall, the COVID-19 pandemic has significantly impacted the global supply chain, leading to disruptions, delays, and challenges for businesses across multiple industries. However, there are also signs of recovery as the pandemic response continues and supply chains began to return to normal in 2021.

However, the pandemic left profoundly impacted the US economy and household finances [11]. According to a US Bureau of Labor Statistics report, household spending on groceries increased by nearly 20% between February and April 2020 as people stockpiled supplies and ate more meals at home [12]. At the same time, spending on travel and entertainment plummeted, with many businesses and venues closing to prevent the virus's spread. Healthcare costs also rose for many households as people sought medical treatment for COVID-19 and purchased PPE such as face masks and hand sanitizer. For those who lost their jobs or saw their hours reduced, the cost of housing became a significant burden as they struggled to make rent or mortgage payments. The shift to remote work and online learning has also increased demand for home office equipment, such as laptops and desks, and delivery services for groceries and other essentials. This has led to higher household expenses as they seek to adapt to the new normal created by the pandemic. The COVID-19 pandemic has significantly impacted household expenses in the United States, with changes to spending patterns driven by the need to stay safe, work and learn from home, and access essential goods and services.

Despite subsidies from the state and federal governments in 2020, the economic condition was alarming. Later the free covid vaccination and the spread of the pandemic reduction provided a much-stabilized livelihood for the people of the United States from 2021, which could be recognized as post covid period [13]. However, the expenses are still high, and this economic downturn would be portrayed in this paper. Domestic services expenditure, entertainment expenditure, housing expenditure, electricity expenditure, transportation expenditure, food expenditure, gasoline, and motor oil expenditure, health care expenditure, life insurance expenditure, maintenance, and repairs expenditure, mortgage interest expenditure, telephone services expenditure, televisions, radios, and sound equipment expenditure, utilities, fuels, and public services expenditure was evaluated from pre to post covid period (2018 to 2021). Evaluating data from 2018 would portray any natural temporal trend in these expenses as well as the unusual changes in expense change due to the pandemic.

The economic evaluation for expense changes was mostly done with algebraic equations in past studies. Very few studies focus on evaluating the change in expense using statistical methods. Hence, the objective of this study was to identify the expenditure change as an impact of the covid pandemic using the ANOVA method for households in the United States. Besides, the total household expense was also evaluated similarly to validate the trend of overall expenditure change.

A recent article published in the Review of Finance highlighted the importance of studying the impact of the pandemic on household finances [14]. The authors note that the pandemic has resulted in significant changes in employment, income, and consumption patterns, and these changes have disproportionately impacted low-income households. Understanding the changes in household expenditure patterns can help policymakers design effective policies to mitigate the economic impact of the pandemic. This paper is especially relevant given the unprecedented nature of the pandemic, and the resulting economic uncertainty will provide a detailed analysis of the changes in household expenditure patterns in the United States during the pandemic. The paper's statistical analysis provides valuable insights into the factors influencing household spending and can inform policymaking and financial planning decisions.

2 | ANOVA for Comaprison

Alireza et al. [15] randomized controlled clinical experiment was to evaluate how family members' presence—whether trained or not—affects patients' anxiety levels during invasive procedures in an emergency room. Ninety eligible patients participated in the study, which was divided into three equal groups: A (family member is trained), B (family member is untrained), and C (family member is absent). Before and after the operations, anxiety levels were assessed using the Spielberger State-Trait Anxiety Inventory (STAI). The findings showed that following the therapies, anxiety levels generally declined dramatically in all groups.

Singh et al. [16] investigated how, during these lockdown times, internet search activity connected to alcohol changed. Utilizing Google Trends and concentrating on four primary themes—alcoholic beverage types, ways to obtain alcohol, problems resulting from the disruption of the alcohol supply, and seeking assistance for alcohol use disorders—the study examined average relative search volumes during the pre-lockdown, lockdown 1.0, and lockdown 2.0 phases. A statistical technique called Analysis of Variance (ANOVA) is used to determine if the means of three or more independent groups differ in any statistically meaningful ways. ANOVA could be used to examine the differences in mean relative search volumes over the three specified time periods: pre-lockdown, lockdown 1.0, and lockdown 2.0, in the context of the study you described on the changes in online search interest for alcohol-related keywords during different lockdown periods in India. When compared to the pre-lockdown phase, the data showed a notable increase in internet interest related to the purchase of alcohol during lockdown 1.0, but not during lockdown 2.0.

Many other studies used one-way ANOVA to compare financial performances during Covid 19, for stock market performance [17], for exchange-traded funds [18], financial life of working individuals [19], education enterprise profit level [20], income [21]-[24], and so on.

3 | Data Preparation and Analysis

Almost 11500 public survey interview data was extracted from the US Bureau of Labor Statistics website. The data were merged and cleaned using python standard data cleaning format for data analysis (removing the duplicate entries, unusual entries, and null values) [25].

One-way ANOVA was used to find a significant difference between the expense level over the years. Data were grouped based on the year. Hence, there were four groups of interview data. Assumptions of the ANOVA method were tested before conducting the ANOVA analysis [26]. The data was independent, given that data were randomly collected from United States residents, the residuals of the dataset had consistent variance and mean, and the dataset was normally distributed. Statistical Package for the Social Sciences (SPSS) was used to conduct the one-way ANOVA to determine whether there are any statistically significant differences between the means of these four independent (unrelated) groups. The formula for one-way ANOVA was mentioned by Bewick et al. [27]:

$$F = \frac{SS_{between} - df_{between}}{SS_{within} - df_{within}},$$

where, F= F-statistic,

$SS_{between}$= sum of squares between groups,

SS_{within} = sum of squares within groups,

$df_{between}$ = degrees of freedom between groups,

$df_{within} =$ degrees of freedom within groups.

4 | Result

Table 1 shows the mean expenditure for 2018 and 2019 and the p-value for mean comparison, *Table 2* shows the mean expenditure for 2019 and 2020 and the p-value for mean comparison, and *Table 3* shows the mean expenditure for 2020 and 2021 and p-value for mean comparison for the different household expense. In *Table 1*, only for alcoholic beverage expenditure and maintenance and repairs expenditure, the expense of 2019 was significantly higher than 2018 (p-values < 0.04).

However, in *Table 2*, expenditure for 2020 was significantly higher for housing, electricity, transportation, food, gasoline and motor oil, healthcare, telephone services, utilities, fuels, and public services (p-values < 0.05). Expenditure for households kept increasing in 2021 as well. For all types of household expenses. For 2021 (*Table 3*), all types of household expenditures significantly increased from 2020.

Fig. 1 shows a stacked bar chart for different types of expenditure, indicating that total household expenditure increased with time and increased severely because of covid and portrayed post-covid economic struggles. *Fig. 2* shows the temporal rise of different household expenditures in a granular form.
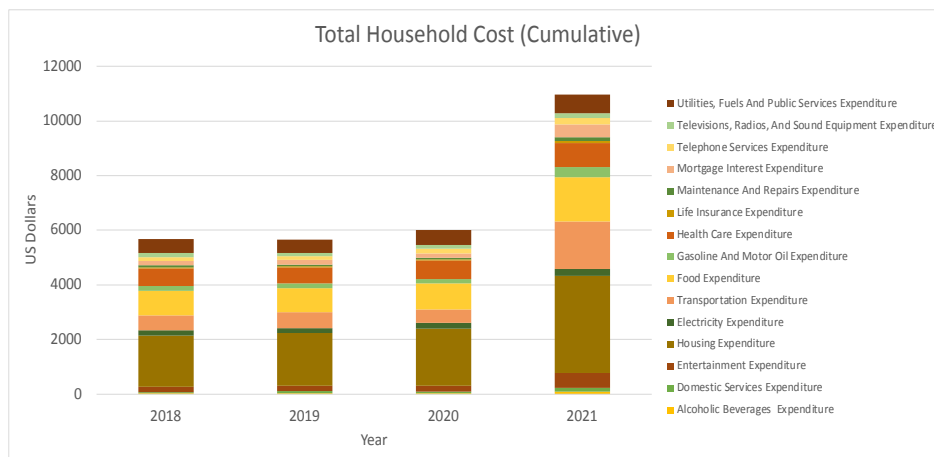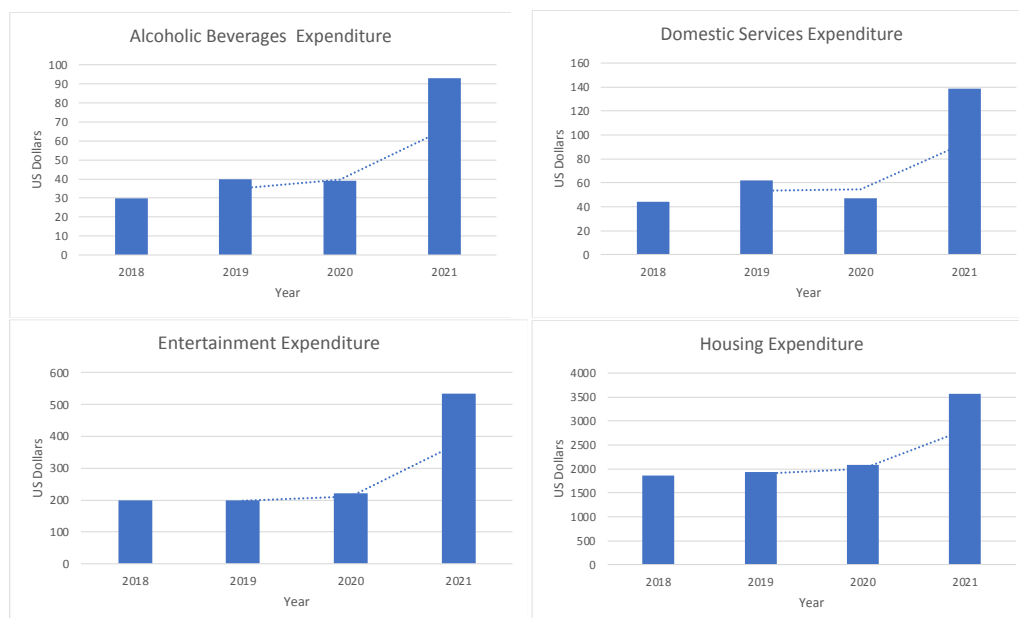

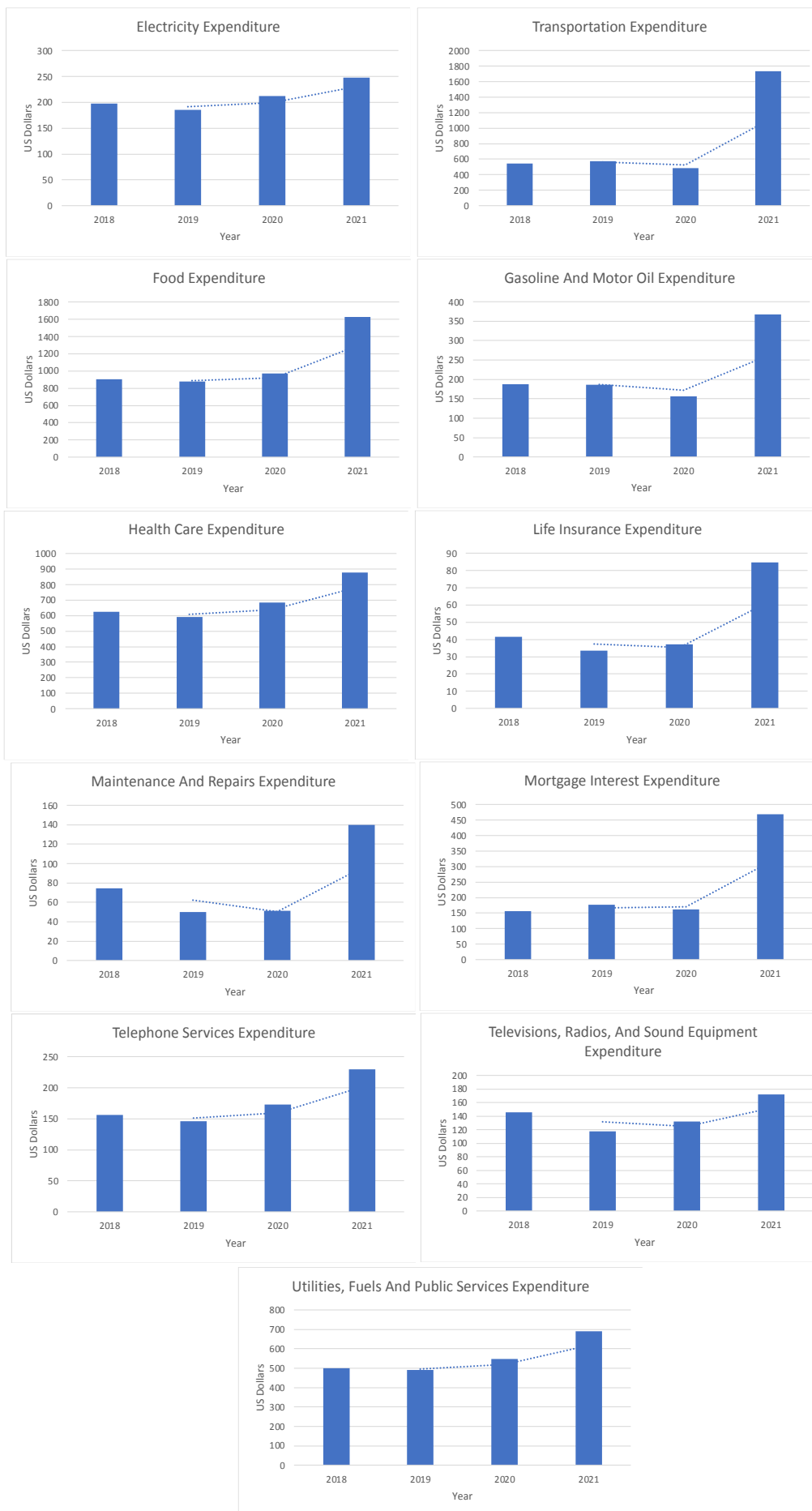**Fig. 1. Stacked bar chart showing the temporal rise of household expenditures.**

Fig. 2. Bar chart showing the temporal rise of different types of household expenditures.

Table 1. Statistical analysis of household expenditure for years 2018 and 2019.

Year	2018	2019	p-Value
Alcoholic beverages expenditure	29.794	39.883	0.032*
Domestic services expenditure	44.139	62.155	0.153
Entertainment expenditure	197.846	198.884	0.939
Housing expenditure	1860.826	1929.871	0.356
Electricity expenditure	198.080	185.200	0.129
Transportation expenditure	544.836	576.297	0.495
Food expenditure	903.342	876.952	0.445
Gasoline and motor oil expenditure	187.125	186.797	0.977
Health care expenditure	626.398	591.307	0.344
Life insurance expenditure	41.500	33.530	0.218
Maintenance and repairs expenditure	74.715	49.931	0.035*
Mortgage interest expenditure	156.103	177.483	0.349
Telephone services expenditure	155.954	146.193	0.197
Televisions, radios, and sound equipment expenditure	146.193	117.540	0.966
Utilities, fuels and public services expenditure	499.062	491.558	0.698

* p-values < 0.05

Table 2. Statistical analysis of household expenditure for years 2019 and 2020.

Year	2019	2020	p-Value
Alcoholic beverages expenditure	39.883	39.281	0.910
Domestic services expenditure	62.155	47.374	0.287
Entertainment expenditure	198.884	221.991	0.156
Housing expenditure	1929.871	2088.663	0.045*
Electricity expenditure	185.200	212.540	0.003*
Transportation expenditure	576.297	481.107	0.048*
Food expenditure	876.952	969.346	0.014*
Gasoline and motor oil expenditure	186.797	156.977	0.010*
Health care expenditure	591.307	683.854	0.015*
Life insurance expenditure	33.530	37.240	0.575
Maintenance and repairs expenditure	49.931	51.167	0.903
Mortgage interest expenditure	177.483	162.113	0.501*
Telephone services expenditure	146.193	172.889	0.001*
Televisions, radios, and sound equipment expenditure	117.540	132.221	0.078
Utilities, fuels and public services expenditure	491.558	547.915	0.005*

* p-values < 0.05

Table 3. Statistical analysis of household expenditure of year 2020 and 2021.

Year	2020	2021	p-Value
Alcoholic beverages expenditure	39.281	92.996	<0.001*
Domestic services expenditure	47.374	138.476	<0.001*
Entertainment expenditure	221.991	533.944	0.001*
Housing expenditure	2088.663	3566.852	<0.001*
Electricity expenditure	212.540	247.620	<0.001*
Transportation expenditure	481.107	1735.793	<0.001*
Food expenditure	969.346	1627.559	<0.001*
Gasoline and motor oil expenditure	156.977	366.956	<0.001*
Health care expenditure	683.854	877.348	<0.001*
Life insurance expenditure	37.240	84.580	0.033*
Maintenance and repairs expenditure	51.167	140.176	<0.001*
Mortgage interest expenditure	162.113	468.633	<0.001*
Telephone services expenditure	172.889	229.344	<0.001*
Televisions, radios, and sound equipment expenditure	132.221	172.204	0.001*
Utilities, fuels and public services expenditure	547.915	689.431	<0.001*

* p-values < 0.05

5 | Discussion

Covid 19 pandemic has largely affected the socioeconomic conditions of the United States. Post-covid period adopted more virtual and self-sufficient methods for production, business, services, and so on. The alarming point is, replacing globalization with localization has caused the pandemic's structurally damaging effects on the global economy [28]. Even developed countries like the United States face the adverse effects of dollar inflation, job scarcity, supply chain demand, and rising cost for daily necessities [29], [30].

Similarly, household costs in the United States skyrocketed, especially after a prolonged disruption in the economic structure price of everything increased. The survey data showed that in 2021, all types of household expenditure increased. The expenditure at the family level did not return to the pre-covid condition, rather higher than in the previous year, 2020. The alcoholic beverages, life insurance, and motor oil cost was reported to be significantly higher than the previous year in 2021.

From this study, we can observe the trend of expenditure increment. This price hike in people's daily life is also impacting social life [31], so economic conditions and cost need to be stabilized as soon as possible. However, what type of expenditure affected the total expenditure and the reason for the increase in different types of expenditure should be evaluated.

6 | Conclusion

The covid-19 pandemic has caused significant disruptions in the US economy, leading to widespread job losses and reduced economic activity. Despite this, family household expenditure has actually increased in the post-covid period, surpassing previous years. This trend highlights the need for effective policies to maintain a balanced social and economic footing. The authorities must consider the short and long-term impacts of their policies on households, businesses, and the economy as a whole. The development of policies that address income inequality, support small businesses, and promote economic growth will be critical to ensuring a stable and sustainable recovery from the pandemic.

References

[1]   Moreland, A., Herlihy, C., Tynan, M. A., Sunshine, G., McCord, R. F., Hilton, C., ... & Popoola, A. (2020). Timing of state and territorial COVID-19 stay-at-home orders and changes in population movement—United States, March 1–May 31, 2020. *Morbidity and mortality weekly report*, *69*(35), 1198. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7470456/

[2]   Butt, A. S. (2021). Strategies to mitigate the impact of COVID-19 on supply chain disruptions: a multiple case analysis of buyers and distributors. *International journal of logistics management*. DOI:10.1108/IJLM-11-2020-0455

[3]   Singh, S. K., Khawale, R. P., Chen, H., Zhang, H., & Rai, R. (2022). Personal protective equipments (PPEs) for COVID-19: a product lifecycle perspective. *International journal of production research*, *60*(10), 3282–3303. DOI:10.1080/00207543.2021.1915511

[4]   Paul, S. K., & Chowdhury, P. (2021). A production recovery plan in manufacturing supply chains for a high-demand item during COVID-19. *International journal of physical distribution and logistics management*, *51*(2), 104–125. DOI:10.1108/IJPDLM-04-2020-0127

[5]   Aday, S., & Aday, M. S. (2020). Impact of COVID-19 on the food supply chain. *Food quality and safety*, *4*(4), 167–180. DOI:10.1093/fqsafe/fyaa024

[6]   Dirzka, C., & Acciaro, M. (2022). Global shipping network dynamics during the COVID-19 pandemic's initial phases. *Journal of transport geography*, *99*, 103265. DOI:10.1016/j.jtrangeo.2021.103265

[7]   Saleheen, F., & Habib, M. M. (2022). Global supply chain disruption management post Covid 19. *American journal of industrial and business management*, *12*(03), 376–389. DOI:10.4236/ajibm.2022.123021

[8]   Xu, Z., Elomri, A., Kerbache, L., & El Omri, A. (2020). Impacts of COVID-19 on global supply chains: facts and perspectives. *IEEE engineering management review*, *48*(3), 153–166.

[9]   Sudan, T., & Taggar, R. (2021). Recovering supply chain disruptions in post-COVID-19 pandemic through transport intelligence and logistics systems: India's experiences and policy options. *Frontiers in future transportation*, *2*, 660116. DOI:10.3389/ffutr.2021.660116

[10] Bouali, S., Douha, S., & Khadri, N. (2020). To what extent is air freight affected by the Corona virus pandemic? *Journal of sustainable development of transport and logistics*, *5*(2), 98–108.

[11] Sharif, A., Aloui, C., & Yarovaya, L. (2020). COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: fresh evidence from the wavelet-based approach. *International review of financial analysis*, *70*, 101496. DOI:10.1016/j.irfa.2020.101496

[12] Bauer, L., Broady, K., Edelberg, W., & O'Donnell, J. (2020). Ten facts about COVID-19 and the US economy. *Brookings institution*, *17*. https://www.hamiltonproject.org/assets/files/FutureShutdowns_Facts_LO_Final.pdf

[13] Alagoz, O., Sethi, A. K., Patterson, B. W., Churpek, M., Alhanaee, G., Scaria, E., & Safdar, N. (2021). The impact of vaccination to control COVID-19 burden in the United States: a simulation modeling approach. *PLoS one*, *16*(7), e0254456. DOI:10.1371/journal.pone.0254456

[14] Baker, S. R., Farrokhnia, R., Meyer, S., Pagel, M., & Yannelis, C. (2020). Income, liquidity, and the consumption response to the 2020 economic stimulus payments. *SSRN electronic journal*, *17*. DOI:10.2139/ssrn.3587894

[15] Alireza, Z. F., Ali, A. J., & Tayebeh, N. B. (2019). Comparison the effect of trained and untrained family presence on their anxiety during invasive procedures in an emergency department: a randomized controlled trial. *Turkish journal of emergency medicine*, *19*(3), 100–105.

[16] Singh, S., Sharma, P., & Balhara, Y. P. S. (2021). The impact of nationwide alcohol ban during the COVID-19 lockdown on alcohol use-related internet searches and behaviour in India: an infodemiology study. *Drug and alcohol review*, *40*(2), 196–200. DOI:10.1111/dar.13187

[17] Wielechowski Michałand Czech, K. (2021). Companies' stock market performance in the time of COVID-19: alternative energy vs. main stock market sectors. *Energies*, *15*(1), 106. https://www.mdpi.com/1996-1073/15/1/106

[18] Folger-Laronde, Z., Pashang, S., Feor, L., & Elalfy, A. (2022). ESG ratings and financial performance of exchange-traded funds during the COVID-19 pandemic. *Journal of sustainable finance and investment*, *12*(2), 490–496. DOI:10.1080/20430795.2020.1782814

[19] Goyal, K., Kumar, S., Rao, P., Colombage, S., & Sharma, A. (2021). Financial distress and COVID-19: evidence from working individuals in India. *Qualitative research in financial markets*, *13*(4), 503–528. DOI:10.1108/QRFM-08-2020-0159

[20] Xu, Q., Zhang, L., & Zhang, L. (2021). The influence of coronavirus on the profitability of educational enterprises. *2021 3rd international conference on economic management and cultural industry (ICEMCI 2021)* (pp. 2626–2631). Atlantis Press. https://www.atlantis-press.com/proceedings/icemci-21/125966264

[21] El Khamlichi, S., Maurady, A., & Sedqui, A. (2022). Comparative study of COVID-19 situation between lower-middle-income countries in the eastern Mediterranean region. *Journal of oral biology and craniofacial research*, *12*(1), 165–176. DOI:10.1016/j.jobcr.2021.10.004

[22] Ridzuan, A. R., Saidin, N. F., Hassan, H., Rahman, Z. A., Othman, N., Zulkarnain, A., & Luthfia, A. (2022). The level of stress among different household income during covid-19. *AIP conference proceedings* (Vol. 2617, No. 1). AIP Publishing. DOI: 10.1063/5.0119796

[23] Islam, M. M., & Alharthi, M. (2022). Impact of COVID-19 on the quality of life of households in Saudi Arabia. *International journal of environmental research and public health*, *19*(3), 1538. DOI:10.3390/ijerph19031538

[24] Sun, Q., Zhou, W., Kabiri, A., Darzi, A., Hu, S., Younes, H., & Zhang, L. (2020). *COVID-19 and income profile: how people in different income groups responded to disease outbreak, case study of the United* States. http://arxiv.org/abs/2007.02160

[25] Klosterman, S. (2019). *Data science projects with Python a case study approach to successful data science projects using Python, pandas, and scikit-learn*. Packt Publishing Ltd.

[26] Garson, G. D. (2012). *Testing statistical assumptions*. Statistical Associates Publishing.

[27] Bewick, V., Cheek, L., & Ball, J. (2004). Statistics review 9: one-way analysis of variance. *Critical care*, *8*(2), 130–136. DOI:10.1186/cc2836

[28] Song, L., & Zhou, Y. (2020). The COVID-19 pandemic and its impact on the global economy: what does it take to turn crisis into opportunity? *China and world economy*, *28*(4), 1–25.

[29] Drucker, P. F. (1985). The changed world economy. *Foreign aff.*, *64*, 768. https://heinonline.org/HOL/LandingPage?handle=hein.journals/fora64&div=53&id=&page=

[30] Jackson, J. K., Weiss, M. A., Schwarzenberg, A. B., Nelson, R. M., Sutter, K. M., & Sutherland, M. D. (2021). Global economic effects of COVID-19. *Congressional research service*. https://sgp.fas.org/crs/row/R46270.pdf

[31] Roll, S., Chun, Y., Kondratjeva, O., Despard, M., Schwartz-Tayri, T. M., & Grinstein-Weiss, M. (2022). Household spending patterns and hardships during COVID-19: a comparative study of the U.S. and Israel. *Journal of family and economic issues*, *43*(2), 261–281. DOI:10.1007/s10834-021-09814-z