Consumer sentiments in automotive purchases before and after COVID-19: a text-mining study

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Abstract: The COVID-19 pandemic has led to shortages in the automotive industry due to a limited supply of semiconductor chips, which has created a nonlinear dynamic and chaotic business environment in the industry. This leads to the following important yet unanswered questions: 1) Is there a divergence in consumer emphases placed on the car buying process prior to and after COVID-19?; 2) How do consumer sentiment patterns affect their ratings of car dealerships prior to and after COVID-19? To answer these questions, we utilise a text-mining approach and perform an ordered probit regression analysis. Results illustrate the following. First, the sentiment keyword 'fast' had a positive impact on consumer online ratings after COVID-19, whereas 'clean' had a positive impact on consumer online ratings before COVID-19. Third, the sentiment keyword 'wait' had a negative impact on consumer online ratings after COVID-19. Fourth, the sentiment keyword 'willing' had a negative impact on consumer online ratings both before and after COVID-19. Finally, the sentiment keyword 'mess' had a negative impact on consumer online ratings both before and after COVID-19.

Keywords: automotive purchase; COVID-19; consumer sentiments; text mining.

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1 Introduction

In the sales context, firms have long been competing by fulfilling consumer needs through competitive pricing and appropriate sales approaches. Sales organisations, however, must effectively manage exogenous factors, such as changing consumer needs, technological advancement, and regulations, to maintain competitive advantage. While many exogenous factors present constant challenges to sales organisations, they have often been viewed by sales organisations as anticipated changes (Hartmann and Lussier, 2020). The emergence of COVID-19, meanwhile, has brought immediate, chaotic, and unprecedented changes at a global scale to sales organisations. For instance, the initial shutdowns and subsequent social distancing practices have resulted in reductions in workplace activities and transformations in operational and sales practices (Hoeft, 2021). Although sales organisations have attempted to be adaptive to mitigate the challenges that COVID-19 has created, an ongoing phenomenon is supply chain distributions and

shortages (Remko, 2020), ranging from food to automobiles, experienced by the sales industry.

As sales organisations navigate through supply chain distributions and shortages, they continue to have to manage consumer satisfaction through proper approaches undertaken by salespeople (Kazancoglu and Demir, 2021). Without any doubt, COVID-19 has substantially intensified the complexity of customer demands that salespeople may need to address during COVID-19. A prominent example is the automobile shortage faced by the automobile industry propagated by the semiconductor chip shortage. As such, automotive sales organisations as well as consumers have been coping with limited supplies, limited car model selections, and a long waiting period. While the automotive industry is expected to be impacted by a COVID-19 disruption through 2023 or even 2024 (Ramani et al., 2022), the demand for automobiles is expected to rise sharply as people turn from mass-transit to personal cars due to the fear of COVID-19 (Norouzi, 2021). Even though a number of linear theoretical underpinnings, such as theory of planned behaviour, (e.g., Vafaei-Zadeh et al., 2022), norm activation model, (e.g., Hamzah and Tanwir, 2021), and utility theory, (e.g., Yuan et al., 2022), have been utilised to understand the basis of consumers' automotive purchase decisions, the supply-demand paradox caused by COVID-19 implies that past linear theories might not be sufficient to explain consumers' automotive purchase decisions. Additionally, automotive sales organisations (hereafter, car dealerships) certainly can be benefited by better understanding whether there are shifts in what consumers expect from the car buying process prior to and after COVID-19. As COVID-19 has created a nonlinear dynamic and chaotic business environment in the automotive industry, it seems reasonable to expect that automotive consumers' attitudes and behaviour are no longer repeated, systematic, and linear. In other words, it becomes important to analyse consumers' expectations of car the selling process prior to and after COVID-19 from a chaos theoretical perspective. Hence, this study seeks to answer the following two research questions. First, is there a divergence in consumer emphases placed on the car buying process prior to and after COVID-19? Second, how do consumer sentiment patterns affect their ratings of car dealerships prior to and after COVID-19? Thereby, this study compares consumer reviews of the sales aspect of car dealerships posted on public websites prior to and after COVID-19.

To answer the research questions, this study adopts the basic premise of chaos theory applied to the context of supply chain, which is that small disruptions in supply chain make the chain become highly volatile, thereby creating distinct behavioural patterns in the industry (Levy, 1994). As COVID-19 has changed how individuals and business organisations interact, it can be assumed that there might be unique attitudinal and behavioural patterns prior to and after COVID-19 exhibited by automotive consumers. As such, this study seeks to identify these distinct patterns via textual data and sentiments expressed in consumer online textual reviews provided on DealerRater.com. DealerRater.com is chosen because it provides clear processes and guides allowing consumers to write about the car dealer, not the products (cars) (Golara et al., 2021), which is suitable for the main objective of this study. The contribution of this study is twofold. Theoretically, this study extends the existing research that adopts a linear perspective to understand how the supply chain disruptions resulting from COVID-19 may affect the established sales processes of automobiles through a nonlinear, complex, and chaotic theoretical lens. Practically, findings from this study may provide managers

of car dealerships and other relevant sales organisations crucial insight into how to fulfil consumer needs during systemic disruptions in supply chains post-COVID-19.

In the next section, details of the methodology and findings are provided. This is followed by a discussion of theoretical contributions and managerial implications. Section 4 discusses the limitations of this study and recommendations for future research. The last section provides a brief concluding remark of this study.

2   Methods

2.1   Sample data and analytic procedure

As noted previously, the main objective of this study is to examine whether there are possible shifts in consumer emphases in the car buying process prior to and after COVID-19. Data of this study were collected from consumer online reviews posted from January 1st, 2017 to August 25th, 2022 on DealerRater.com. We randomly selected a total of 28,917 consumer online reviews for 63 car dealers representing eight different car brands located in five states (see Table 1 for a summary).

2.2   Readability analysis

Before conducting text mining and sentiment analysis, we performed readability analysis, which implicates the quality of consumer online reviews. In general, readability is related to the number of sentences, words, complex words, complexity of words, and number of syllables in a word (Hou and Ma, 2022). As such, the more readable a consumer online review is, the more useful the review is. To perform a readability analysis, we followed prior research, (e.g., Lu et al., 2013) and calculated the automated readability index, simple measure of Gobbledygook, Gunning Fog Index, and Flesch-Kincaid readability tests. Results from the analysis indicated that most of the collected consumer online reviews were valid for conducting text mining.

2.3   Text mining analytics application program interfaces (APIs)

We utilised the following text analytics APIs to analyse consumer online reviews. Below each of the APIs is described briefly.

1   Twinword API – topic tagging analysis (https://www.twinword.com/api/topic-tagging.php) was used to discover keywords and possible topics in consumer reviews. We identified a total of 3,487 keywords and 2,909 topics.

2   Twinword API – sentiment analysis (https://www.twinword.com/api/sentiment-analysis.php) was employed to discover the sentiment of consumer reviews. We recorded the types of the identified sentiments, which could be positive, neutral, and negative, as well as the keywords of the identified sentiments.

3   Opinion finder (https://mpqa.cs.pitt.edu/opinionfinder/opinionfinder_2/opinionfinder_2_0/opinionfinder_2_0_README.txt) was deployed to discover the degree of subjectivity of a consumer online review.

4   Paralleldots API (https://www.paralleldots.com/emotion-analysis) was used to calculate the possible types of emotion, such as happy, sad, excited, bored, angry, and fear, in consumer online reviews.

2.4   Descriptive statistics

As mentioned previously, our data contained 63 car dealers representing eight different car brands located in five states. Table 1 summarises the descriptive statistics. Additionally, we categorised consumer online reviews of the eight car brands into different price levels, including economy, business, and luxury car brands based on the average car transaction prices released by the Kelley Blue Book (https://www.prnewswire.com/news-releases/new-vehicle-prices-set-record-in-july-2022-according-to-kelley-blue-book-as-inventory-improves-year-over-year-and-luxury-share-remains-elevated-301603225.html). Table 2 depicts the consumer online reviews categorised by the economy, business, and luxury car brands.

Table 1   Consumer online reviews: dealership locations and car brands

State	Make	Distinct count of dealerID (dealer)	Distinct count of review ID	Avg. rating
CA	Audi	2	105	4.59
	BMW	6	1,437	4.86
	Chevrolet	7	654	4.26
	Honda	6	1,821	4.53
	Mercedes Benz	1	815	4.98
	Porsche	3	105	4.64
NJ	Chevrolet	3	243	4.84
	Honda	3	4,425	4.70
	Mercedes Benz	1	1,797	4.82
	Nissan	3	195	4.53
	Porsche	1	10	3.00
NY	BMW	2	117	4.12
	Chevrolet	9	248	4.46
	Honda	3	1,934	4.86
	Mercedes Benz	2	486	4.79
	Nissan	3	584	4.68
	Porsche	1	180	4.93
TX	BMW	3	974	4.76
	Chevrolet	6	2,047	4.92
	Ferrari	1	459	4.96
	Honda	5	4,860	4.86
	Mercedes Benz	2	945	4.79
	Nissan	4	734	4.53
	Porsche	2	32	3.88
WI	Chevrolet	4	3,710	4.76

Table 2   Consumer online reviews: economy, business, and luxury brands

Luxury brand	Make	Distinct count of review ID	Distinct count of dealerID (dealer)	Avg. rating
Economy	Chevrolet	6,902	29	4.75
	Honda	13,040	17	4.76
	Nissan	1,513	10	4.59
Business	Audi	105	2	4.59
	BMW	2,528	11	4.79
	Mercedes Benz	4,043	6	4.84
Luxury	Ferrari	459	1	4.96
	Porsche	327	7	4.67

In addition, we compared the number of consumer online reviews posted before and after COVID-19. As shown in Figure 1, there were reductions in the number of consumer online reviews in 2020, which was the starting year of COVID-19. As many business organisations had temporarily closed during some part of 2020, this finding was not surprising. We further found that the number of consumer online reviews in 2021 showed an increase across all sample states. This could be attributed to the increases in automotive sales due to some lessening in COVID-19-related restrictions and consumers' receipt of Economic Impact Payments resulting from the CARES Act and COVID-Related Tax Relief Act of 2020 in the USA. It is noteworthy that the 2022 consumer online reviews data were collected from January to August 2022.

2.5   Sentiment analysis

As mentioned earlier, the main purpose of this study is to understand whether there are different consumer emphases in the car buying process prior to and after COVID-19? To understand this, this study employed a sentiment analysis using the Twinword API – Sentiment Analysis. Using the Twinword API – Sentiment Analysis, we obtained a sentiment score, ranging from the positive sentiment (score > 0.05), negative sentiment (score < –0.05), or neutral sentiment (score between –0.05 and 0.05, for every analysed textual online review. Figure 2 shows the histogram of sentiment scores, which further indicated that most high online customer numerical ratings (i.e., a rating of 4 or 5) were accompanied by positive sentiments, whereas most low online customer numerical ratings, (i.e., a rating of 1 or 2) showed negative sentiments.

To further understand consumers' key sentiments and how these sentiments might affect consumers' ratings of the sales aspect of car dealerships prior to and after COVID-19, we utilised Twinword API – Sentiment Analysis to analyse online consumer textual reviews. Because the initial analysis yielded more than 3,500 keywords, we employed the parameter optimisation technique that is commonly used in machine learning and related fields to find the best values of the parameters (i.e., keywords). That is, parameter optimisation allowed us to find the values of each of the keywords and evaluate their predictive ability (Catal and Nangir, 2017). Using parameter optimisation, we first carefully removed non-adjective terms and extracted the following list of keywords from the dataset: 'clean', 'easy', 'fast', 'mess', 'slow', 'wait', and 'willing'.
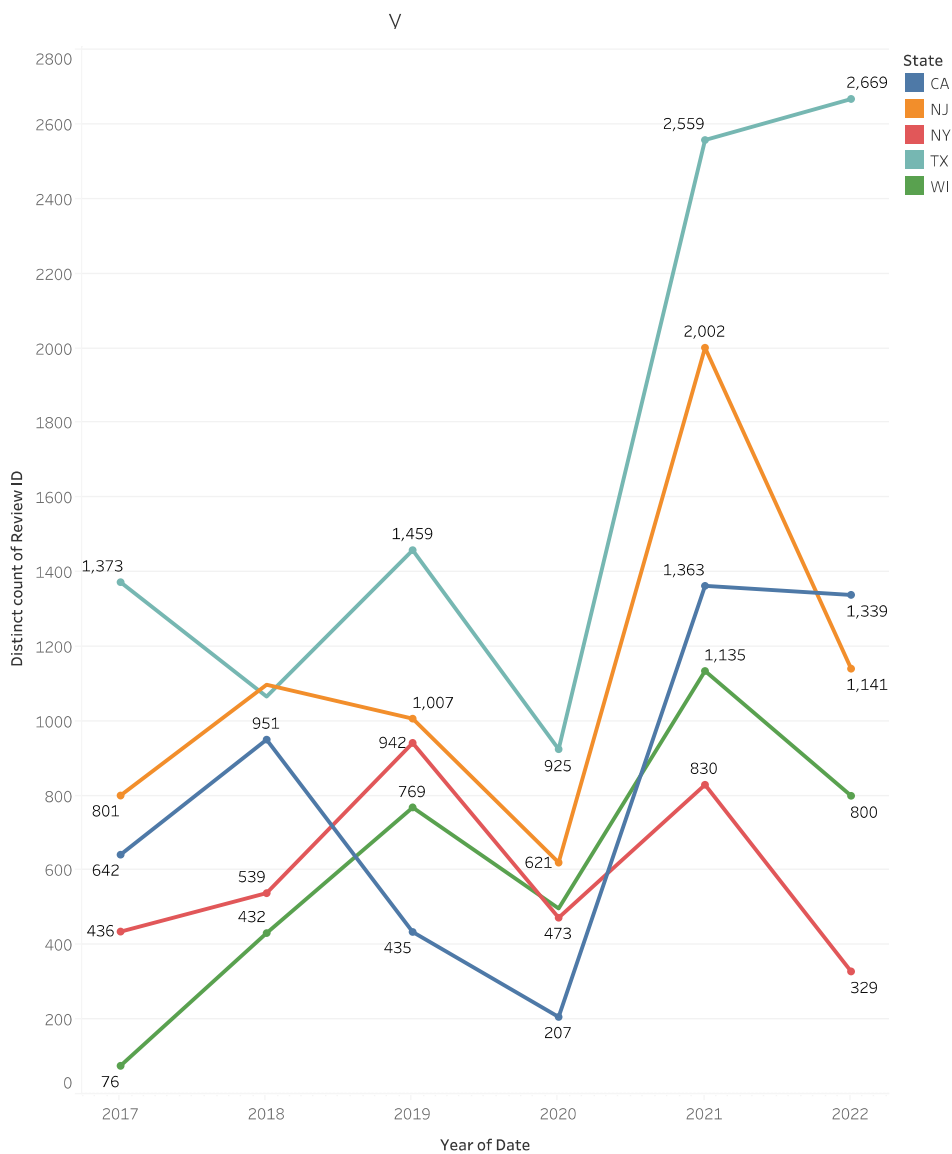
After identifying these keywords, we performed a one-sample t-test to assess whether there was a significant difference in the mean frequency of each of the keywords prior to and after COVID-19. As depicted in Table 3, the mean frequency of all the keywords was significantly different prior to and after COVID-19 ($p < 0.001$). As such, we included these keywords in the subsequent analyses.

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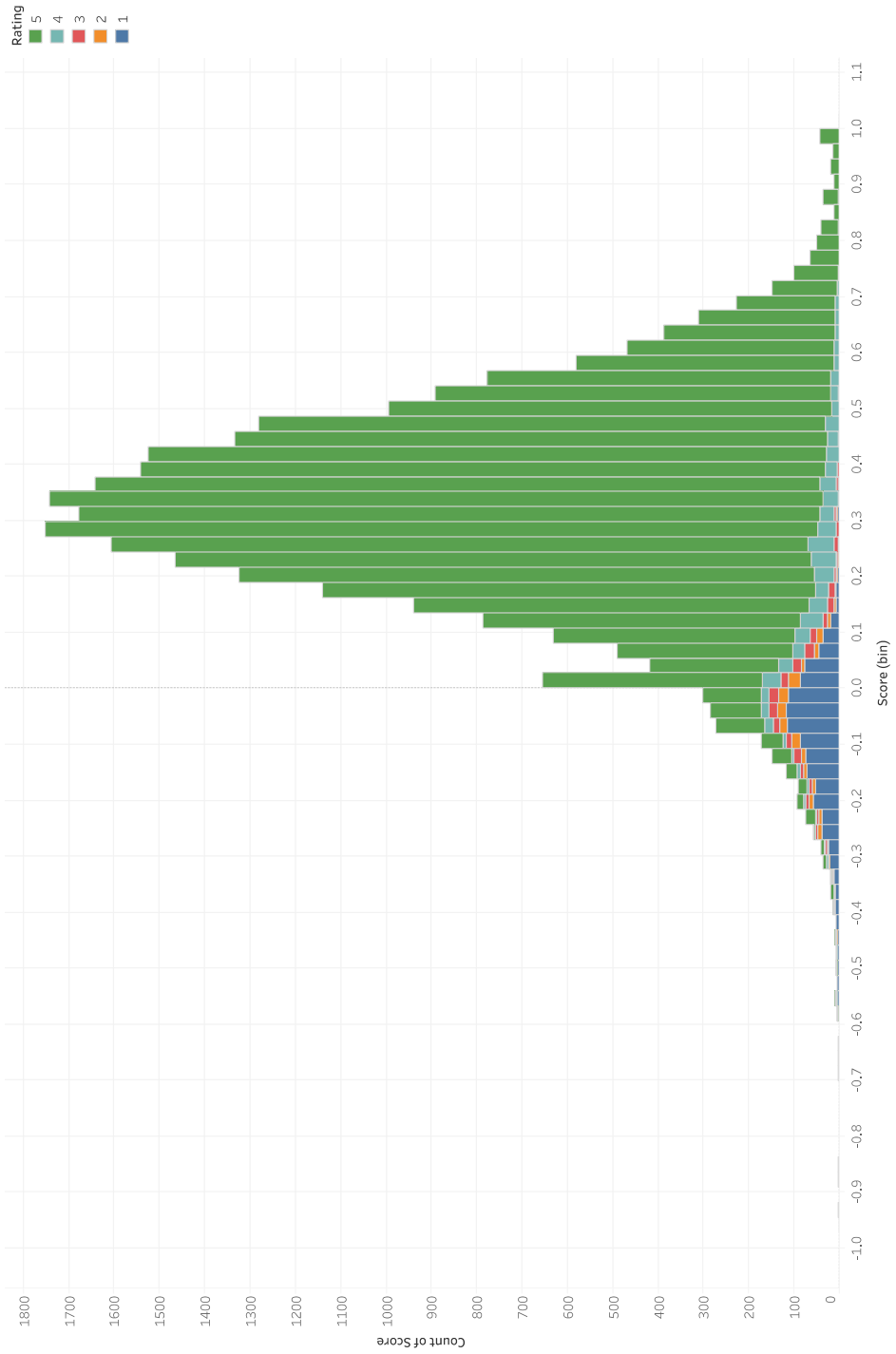
Table 3　　One-sample t-test: comparisons of means of frequency in sentiment keywords

		t	*df*	Significance		Mean difference	95% confidence interval of the difference	
				One-tailed	*Two-tailed*		*Lower*	*Upper*
After*	Fast	45.060	16,889	< 0.001	< 0.001	0.130	0.12	0.14
	Easy	45.224	16,889	< 0.001	< 0.001	0.154	0.15	0.16
	Clean	30.490	16,889	< 0.001	< 0.001	0.059	0.06	0.06
	Wait	29.597	16,889	< 0.001	< 0.001	0.070	0.07	0.07
	Willing	48.299	16,889	< 0.001	< 0.001	0.165	0.16	0.17
	Slow	5.390	16,889	< 0.001	< 0.001	0.002	0.00	0.00
	Mess	11.153	16,889	< 0.001	< 0.001	0.009	0.01	0.01
Before*	Fast	37.495	12,025	< 0.001	< 0.001	0.134	0.13	0.14
	Easy	50.752	12,025	< 0.001	< 0.001	0.297	0.29	0.31
	Clean	21.513	12,025	< 0.001	< 0.001	0.045	0.04	0.05
	Wait	22.767	12,025	< 0.001	< 0.001	0.063	0.06	0.07
	Willing	50.461	12,025	< 0.001	< 0.001	0.265	0.25	0.27
	Slow	4.246	12,025	< 0.001	< 0.001	0.001	0.00	0.00
	Mess	8.988	12,025	< 0.001	< 0.001	0.009	0.01	0.01

Note: Data range: after COVID-19: from 2020 to 2022; before COVID-19: from 2017 to 2019.

Table 4　　Ordered probit regression

	β		Std. error		Wald Chi-square		p-value	
	Before COVID	*After COVID*	*Before COVID*	*After COVID*	*Before COVID*	*After COVID*	*Before COVID*	*After COVID*
Fast	0.359	0.478	0.1991	0.1799	3.243	7.052	0.072	< 0.001
Easy	0.084	–0.062	0.0875	0.0496	0.915	1.586	0.144	0.072
Clean	0.625	0.441	0.2156	0.1647	1.506	7.152	< 0.001	0.007
Wait	–0.713	–0.325	0.1813	0.1314	15.484	6.116	0.001	< 0.001
Willing	–0.372	–0.296	0.0852	0.0505	19.027	34.297	< 0.001	< 0.001
Slow	–0.542	–0.677	0.9686	0.6826	0.313	0.985	0.198	0.433
Mess	–1.425	–1.241	0.3879	0.2730	13.489	20.687	< 0.001	< 0.001

Notes: Dependent variable: consumer online rating. An ordered category variable with 1, 2, 3, 4, and 5 rating.

To determine the effect of sentiment keywords on consumer online review ratings of car dealerships prior to and after COVID-19, we performed an ordered probit regression because of the ordinal nature of the data used in this study. In an ordered probit regression, the dependent variable is assumed to be normally distributed, and the coefficients of the independent variables are estimated using the maximum likelihood method, which are then used to make inferences about the dependent variable (Daykin and Moffatt, 2002). Results of the ordered probit regression indicated the following. First, the sentiment keyword 'fast' had a positive impact on consumer online ratings of a car

dealership after COVID-19. Such an impact, however, was not statistically significant prior to COVID-19. Second, the sentiment keyword 'clean' had a positive impact on consumer online ratings of a car dealership prior to COVID-19, not after COVID-19. Third, the sentiment keyword 'wait' had a negative impact on consumer online ratings of a car dealership after COVID-19, not prior to COVID-19. Fourth, the sentiment keyword 'willing' had a negative impact on consumer online ratings of a car dealership both prior to and after COVID-19. Such an effect, however, reduced in the post-COVID-19 timeframe. Fifth, the sentiment keyword 'mess' had a negative impact on consumer online ratings of a car dealership both prior to and after COVID-19. Finally, the sentiment keywords 'easy' and 'slow' were not predictive of consumer online ratings of a car dealership both prior to and after COVID-19. Table 4 summarises the results of the ordered probit regression.

3 Discussion

3.1 Contributions to the literature

Since the outbreak of COVID-19, there has been a consistent scholarly effort devoted to understanding the impact of COVID-19 on contemporary supply chains (Queiroz et al., 2022). For instance, some existing studies utilise a literature review approach, (e.g., Naz et al., 2022; Queiroz et al., 2022), whereas some other studies offer insights derived from preliminary lessons (e.g., Hald and Coslugeanu, 2022; Pimenta et al., 2022). Although the growing interest in examining supply chain disruptions due to COVID-19 is evident, greater scholarly research is still needed to understand the interplay of supply chains and consumer behaviours (Pujawan and Bah, 2022). Hence, through utilising a text-mining approach to understand consumers' sentiments during the purchase of automobiles that have been impacted by the COVID-19 pandemic, this study provides complementary findings to the existing literature.

Theoretically, this study also adds to an understanding of how the sentiments of consumers affect their online ratings and reviews during the COVID-19 pandemic. Although research in consumer online reviews during the COVID-19 pandemic has been growing, much of this effort has concentrated on exploring numerical ratings, (e.g., Sun et al., 2022; Zibarzani et al., 2022) or textual reviews (e.g., Davari et al., 2022; Nilashi et al., 2022). As such, we still lack an understanding of how consumer sentiments, as an implicit expression of consumer satisfaction or dissatisfaction, affect their numerical ratings. By examining consumer sentiments expressed in public online reviews, this study connects consumer sentiments with their online ratings in a less known business sector: the automotive sector. More importantly, this study may serve as a foundation for future researchers interested in exploring consumer behaviours in the context of COVID-19.

Another contribution this study makes is that it provides a nonlinear and dynamic perspective of automotive consumer purchase intentions. In particular, there has been an ongoing scholarly stream focusing on understanding consumer automotive purchase intentions utilising various theoretical underpinnings such as theory of planned behaviour, (e.g., Vafaei-Zadeh et al., 2022), theory of reasoned action, (e.g., Khan and Rahman, 2014), norm activation model, (e.g., Hamzah and Tanwir, 2021), stimulus-organism-response theory (Upadhyay and Kamble, 2023), and utility theory (e.g., Yuan et al., 2022). These theoretical underpinnings, however, tend to assume

simple linear relationships among variables without considering the complexity and dynamic of the environment. Using a chaotic theoretical underpinning, this study showcases how COVID-19 has reshaped consumers' emphases when making an automotive purchase decision.

3.2 *Implications for managerial practice*

It is undeniable that COVID-19 has brought about unexpected turmoil in each and every industry, and the automotive industry is not any different. The automotive industry must go through an adaptation phase to meet the expectations of its consumers as the pandemic's long-lasting effects continue. As shown in our exploratory analyses, consumers have been dealing with a limited automotive supply which has resulted in a longer waiting period for them to purchase an automobile after COVID-19. As such, managers are finding it even more difficult to fulfil and satisfy consumer needs. This study provides some insight into how managers may deal with long wait times and how to make the car purchasing process easy and simple for consumers in this new post-COVID-19 reality.

One way that managers can reduce the lead time induced by supply chain disruptions due to COVID-19 is by increasing the utilisation of the built-to-order (BTO) (i.e., order-to-delivery or pre-order strategy) (Forbes, 2022). BTO strategy involves building a product after a confirmed order is received from a consumer (Holweg and Pil, 2001). This strategy allows consumers to buy products that are tailored to their needs, which may have an upside for both consumers and car dealerships. On the dealership side, dealers do not need to stock as many automobiles, which help lower holding expenses. Additionally, rather than speculating on what to create and then transport to dealers, manufacturers can adjust outputs to match the actual market demands. On the consumer side, BTO can reduce lead time and allow the consumers to have the option of ordering the exact automobile they desire, including colour, interior, features, options, and wheels/tires. Not surprisingly, this strategy has already been successfully implemented by various companies like Dell Computers, BMW, and Compaq (Gunasekaran and Nagi, 2005). With 4 in 10 automotive shoppers planning to pre-order their next vehicle (Forbes, 2022), car dealers should also configure their websites to make it easier for consumers to navigate through the BTO process.

In addition to enhancing the use of the BTO strategy, car dealers can make the car purchasing process more efficient and digital. For instance, care dealers could allow consumers to sign all paperwork digitally and make down payments contact-free. Car dealers also could provide additional features like delivery of the car at the consumer's driveway. This could not only make the purchasing process more efficient for the buyer, but also would better serve the need of each individual consumer. However, car dealerships should not completely disregard the direct involvement of a real salesperson, particularly throughout the insurance and financial processes. To streamline the digital buying experience for consumers, car dealerships could take inspiration from companies such as Airbnb, Amazon, and Uber that consistently raise the standard for what a best-in-class digital consumer experience looks like. Car dealerships also could integrate features that these companies use, such as dependable service, qualified advisory roles, individualised omnichannel communication, round-the-clock assistance, and pertinent social media marketing.

Consumers have been obtaining the majority of the information they require for purchasing an automobile online or over the phone during COVID-19 (McKinsey and Company, 2021). Hence, it could be expected that consumers will continue to demand to interact with car dealers virtually whenever possible. As a result, dealerships now need to give the virtual and telephone client experience much more priority than they did prior to the emergence of COVID-19. This necessitates spending more time and resources on virtual agent training, website design, and other services using the phone and the Internet.

4 Limitations and future research directions

Since its emergence, COVID-19 has continued to influence the supply side of automobiles, which makes this study highly meaningful to sales managers and salespeople in car dealerships. Although this study employs text-mining analytics to analyse sentiments expressed in consumer online reviews, it certainly has limitations and can be extended in the following directions. First and foremost, even though this study collects consumer online reviews from one of the popular public websites for reviewing car dealerships and salespeople, there are various extraneous factors that could affect the quality of the consumer online reviews. For instance, it has been shown that previous negative consumer online reviews can induce subsequent negative consumer online reviews (e.g., Deng et al., 2021). Additionally, fake or deceptive online reviews have become pervasive due to rapid technological development (Salminen et al., 2022). Because this study collects and analyses consumer online reviews from a public consumer rating site, it remains unknown about the quality, legitimacy, and validity of the collected reviews. Although we perform various readability tests to evaluate the quality of the reviews, we ask sales managers and organisations to use our findings cautiously. As a result, future research can certainly extend this study by utilising different methodologies, such as consumer focus groups.

Undoubtedly, online reviews have become a main source of information for prospective consumers (Le et al., 2022). Prior research, meanwhile, has shed some light on how consumers' characteristics might affect their online reviews. For instance, a consumer's internet experience can influence the consumer's online review intention (Zhu and Zhang, 2010). Additionally, Azimi et al. (2022) find that a consumer's personality traits can lead to systematic online review bias. Even though this study collects more than 28,000 raw consumer online ratings and reviews, another limitation of this study is that it is unable to determine consumer characteristics. Hence, it would be interesting for future research to extend this study by exploring consumers' gender, socio-economic status, family size, brand loyalty, etc.

Since its emergence, COVID-19 has resulted in a significant impact on the automotive industry around the globe (Muhammad et al., 2022). This study, however, only utilises consumer online review data posted in the USA. As such, a third limitation of this study is that it does not consider the effects of macro factors such as societal norms, geopolitics, and public infrastructure on consumers' expectations of the proper sales practices that should be implemented by car dealerships. Given this limitation, findings from this study should be used cautiously. Future research, therefore, is highly encouraged to examine consumer online reviews in various geographic regions.

Even though COVID-19 has created supply chain disruptions and reshaped the interaction between consumers and car dealerships, it cannot be denied that technological advancements have already altered the attitudinal and behavioural patterns of automotive consumers. For instance, the Internet has had a prominent influence on automotive consumers' purchase decisions (Barley, 2015). Similarly, mobile apps have made the communication between car dealerships and consumers more efficient (Woo et al., 2015). Given that technologies have been an important factor in automotive consumers' purchase decisions; it highlights another limitation of this study, which is that it does not account for technological changes in the automotive industry prior to and after COVID-19. Thus, it would be beneficial for future research to incorporate how technologies might be used by car dealership to mitigate the impact of COVID-19 on consumers' automotive purchase decisions.

5   Conclusions

As the automotive industry continues to experience shortages caused by the ripple effect of a semiconductor chip shortage when the COVID-19 pandemic occurred, it becomes important to understand what consumers expect from car dealerships during the so-called shortage economy (Ivanov and Keskin, 2023). In this study, we utilise a text-mining approach to extract consumer sentiments expressed during an automotive purchase. Moreover, we compare whether there are key sentiment shifts prior to and after the COVID-19 pandemic. Furthermore, we conduct an ordered probit regression to examine the effects of consumer sentiments on their ratings of a car dealership. With some limitations, this study offers a theoretical foundation for future researchers interested in exploring consumer behaviours in the context of a shortage economy. Practically, this study provides some crucial recommendations for managers within the automotive industry.

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