



INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES



Bayesian Data Analysis on E-commerce Trends during COVID-19 Pandemic

Luca Rossi, Marco Valeri, Rodolfo Baggio

To Link this Article: <http://dx.doi.org/10.6007/IJARBSS/v12-i5/12970>

DOI:10.6007/IJARBSS/v12-i5/12970

Received: 07 March 2022, **Revised:** 12 April 2022, **Accepted:** 28 April 2022

Published Online: 11 May 2022

In-Text Citation: (Rossi et al., 2022)

To Cite this Article: Rossi, L., Valeri, M., & Baggio, R. (2022). Bayesian Data Analysis on E-commerce Trends during COVID-19 PANDEMIC. *International Journal of Academic Research in Business and Social Sciences*, 12(5), 1187 – 1205.

Copyright: © 2022 The Author(s)

Published by Human Resource Management Academic Research Society (www.hrmars.com)

This article is published under the Creative Commons Attribution (CC BY 4.0) license. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this license may be seen at: <http://creativecommons.org/licences/by/4.0/legalcode>

Vol. 12, No. 5, 2022, Pg. 1187 – 1205

<http://hrmars.com/index.php/pages/detail/IJARBSS>

JOURNAL HOMEPAGE

Full Terms & Conditions of access and use can be found at
<http://hrmars.com/index.php/pages/detail/publication-ethics>



INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES



Bayesian Data Analysis on E-commerce Trends during COVID-19 Pandemic

Luca Rossi, PhD¹, Marco Valeri, PhD², Rodolfo Baggio, PhD³

¹Faculty of Social Sciences, Niccolò Cusano, Rome - Italy, ²Faculty of Economics, Niccolò Cusano, Rome-Italy and Faculty of Social Sciences Taylor's University, Subang Jaya – Malaysia, ³Bocconi University - Milan, Italy

Abstract

The aim of this paper is to examine the marked trend of consumers to make online purchases during the Covid-19 pandemic in Italy, highlighting if consumer habits have changed. Various aspects of human lifestyle and world society have been dramatically modified both for the present and for a long time to come. A crucial role in these changes has been played by the growth of digitalization and the intensified implementation of formerly forecasted trends that the information management literature has been discussing for a long time.

To analyze the acknowledgement of new information as the outcome of the process of consumers' attribution, our work makes use of Bayesian data analysis theorem. The survey was carried out by distributing a questionnaire to 2282 persons (916 women and 1366 men) having an average age of 34 years ($\sigma=10$) and resident in Italy.

The analysis allowed us to ascertain the propensity of consumers towards online purchases during the lockdown (March-May 2020), but above all, to highlight how e-commerce has become a common practice in the population. Furthermore, the responses enabled us to establish whether online traders are upgrading the standard of their shopping websites.

Keywords: COVID-19 Pandemic, E-Commerce Trends, Digitalization, Bayesian Data Analysis, Entrepreneurial Opportunities, Habit Formation

Introduction

The health emergency caused by COVID-19 has forced people in numerous OECD countries to restrict physical contacts. Owing to social distancing, that became essential to avoid virus transmission, and to the rigid limits adopted by said countries, the traditional market, known as brick-and-mortar, has been put almost entirely on hold, at least for the moment (OECD, 2020).

The COVID-19 pandemic has strongly disrupted business operations and consumer activity. While its effect on the digital transformation of organizations has been studied, the impact of COVID-19 on consumers and their consumption behaviour has received relatively little scholarly attention (Kim, 2020; Verma and Gustafsson, 2020; Guthrie et al., 2021).

Industry reports and consumer surveys show that the pandemic has accelerated the trend towards e-commerce observed before the crisis (Kim, 2020). The fear of the pandemic has notably influenced consumer perceptions regarding the economic and environmental

benefits of e-commerce platforms (Tran, 2021). Some authors predict that the marketplace digitalisation and the habits learned during the pandemic may bring about structural changes to consumption as individuals maintain their modified behaviour once the pandemic ends (Kim, 2020; Sheth, 2020), such as the one observed in China in 2002–2003 during the SARS pandemic (Clark, 2018).

Despite a global increase in online purchases since the beginning of the pandemic, uncertainty around the drivers of online purchasing behaviour remains. Further research is needed to understand how online consumption evolves throughout the pandemic and the potential role of electronic commerce in a post-COVID-19 world (Barnes, 2020; O'Leary, 2020; Pejić-Bach, 2020).

This study is an initial effort towards bridging this gap in the literature by exploring how purchasing behaviours evolved before, during, and after a COVID-19 lockdown in Italy. More explicitly, this study intends to examine both the marked trend of consumers to make online purchases during the Covid-19 pandemic in Italy and verify, according with habit formation process, based on the repetition of an action, proposed by various researchers (Beeken et al., 2017; Fleig et al., 2016; Lally et al., 2011; Mullan et al., 2014; White et al., 2017), whether shopping online has become a new habit. In particular Lally et al., in 2010, showed that development of an individual's habits can be depict by an asymptotic curve with a constant increase over time up to a final plateau, achieved at a median of 66 days after the start of testing, sheer length of lockdown in Italy.

To address our research question, we draw on consumer behaviour literature, on emerging COVID-19 research, and on the environmentally-imposed constraints perspective to study the online behaviour of new and existing customers of an online leading French retailer. Our research is exploratory and descriptive in nature, seeking “to provide a ‘picture’ of a phenomenon as it naturally occurs” (Bickman et al., 2009) in a relatively unexplored area (Punch, 2013). We use the extant literature to structure our analysis and use a “pattern matching” procedure to compare empirically based patterns to predicted patterns of behaviour (Yin, 2009).

Our paper contributes to both literature and practice. Firstly, the paper studies how and why consumer behaviour has evolved during the ongoing COVID-19 pandemic, providing timely insights for marketers and e-tailers in a major Western society. To the best of the authors' knowledge, this is the first paper to explore and explain the evolution of online consumer purchasing behaviour during the pandemic. Secondly, the paper studies the changes in consumer behaviour using a theoretical framework based on research into resource scarcity, choice restriction, social comparison, and environmental uncertainty. We believe that this multi-perspective approach best addresses the complexity of consumer reactions and actions throughout the pandemic.

The paper is organized as follows. The first section provides a literature review of consumer behaviour during periods of crisis and presents the theoretical framework that is used to guide our research. The research methods used in data collection and measure are then discussed, followed by a presentation of results. The paper concludes with a discussion and conclusions.

Literature Review

This past decade there has been a growing scholarly interest in the influence of constrained and stressful situations on consumer behaviour. With the outbreak of the COVID-19 pandemic, we have observed extreme differences in the way countries have approached and

sometimes have successfully reduced the spread of the virus. Information management research is the key to elaborating new scenarios and functions in order to facilitate the tracing, monitor and control of infectious contacts, for example by means of the Internet of Things (IoT), detecting sensors and portable devices.

Despite the increasingly important role of electronic commerce throughout the crises, such as the SARS outbreak (Forster and Tang, 2005), terrorist attacks (Predmore et al., 2007), economic recession (Sarmiento et al., 2019) and the COVID-19 pandemic (e.g. Watanabe and Omori, 2020), few studies have examined how online consumer's purchasing behaviour evolves during these periods of restriction.

During pandemic periods, online purchases have enjoyed a very great surge in popularity, because both regular customers and newcomers have strived to make purchases in any possible way. According to ACI Worldwide (2020), world e-commerce sales increased by 207% in the single month of April 2020. Loyal online consumers are now very numerous in many countries. Since then, many organizations have shifted to e-commerce to keep a revenue flowing, whereas the prevailing e-commerce suppliers such as Amazon, technology stores and online groceries have flourished. A number of market failures occurred but only apparently, as when we assisted to an uncontrolled and exponential rise in prices due to the increase of sales of sanitizing items such as hand gel, disposable gloves and facemasks. The likely post Covid-19 scenario suggests that social distancing will have to be observed for a long time to come. Therefore, technology will maintain and even reinforce its key role in the way consumers will make their purchases. Information management research is currently analyzing whether consumers' attitude towards e-commerce shown during the pandemic period can be considered a lasting one. That is to say: are online sales going to remain the first choice over mainstream retail?

From China's experience, we have learned that after the lockdown period e-commerce has dramatically increased (Stewart, 2020). Once the current crisis is over, it is expected that consumers will be more willing to accept advanced technological innovation in their consumption habits. For example, virtual reality is a terrific tool that plays a key role in creating interactions with consumers and that is able to engage them in potential sales. As said before, the fast shift to digitalization brought about by lockdown has led to several considerable advantages, but at the same time it has brought up old issues that information management researchers are very well aware of.

Recent studies underscore consumer resilience during such times (Hamilton et al., 2019). This study focuses on the work in resource scarcity, choice restriction, social comparison, and environmental uncertainty to describe the effects of financial constraints on consumer behaviour. After the initial reaction to a situation created by a new constraint, consumers devise coping strategies to work within it.

Other frameworks have also been used to explain consumer responses to the COVID-19 pandemic, most notably the Stimuli-Organism-Response (SOR) framework. The SOR model states that stimuli influence a consumer's emotional state (organism) and subsequent actions (response), such as online purchasing behaviours (Mehrabian and Russell, 1974). This framework has been widely and successfully used in extant retail (Vieira, 2013) and e-commerce literature to explain how consumers react to environmental stimuli such as web atmospheric cues (Eroglu et al., 2001; Richard, 2005). More recently, Laato et al. (2020) used the SOR framework to study how exposure to online information sources in the early stages of the pandemic (stimuli) influenced a consumer's level of cyberchondria and his or her intention to make unusual purchases. The authors found that "when the data collection

period for the present study ended, consumers quickly adapted to the new normal of COVID-19” and called for more longitudinal studies to record how behaviour evolves.

In this paper we will use the RCA model to explore how online consumption specifically evolved during the COVID-19 pandemic (Kirk and Rifkin, 2020). According to this model, the authors argue that there are 3 stages of response to a constraint during COVID-19:

1. Reaction Purchasing Behaviour

The consumers may react to a pandemic by hoarding goods perceived as scarce and essential. In some cases, they may reject behavioural mandates such as social distancing and mask-wearing. This behaviour is a reaction to the perceived threat of the pandemic and an attempt to regain control of lost freedoms. According to Sheth (2020), hoarding was the first immediate effect of the COVID-19 pandemic on consumption and consumer’s behaviour. During the pandemic, consumers stockpiled essential products such as “toilet paper, bread, water, meat, disinfecting and cleaning products” (Sheth, 2020). Such unusual purchasing behaviour is a common reaction to the uncertainty of future product availability, and it has been observed across the globe during the COVID-19 crisis (Islam et al., 2021). Given the likelihood of further waves of COVID-19 and future pandemics, there have been calls to identify and explain the types of products hoarded by consumers (Kirk and Rifkin, 2020). During the SARS pandemic, for example, there was notably a “dramatic rise” in orders for cleaning products, such as bleach from Hong Kong's leading online retailer (Forster and Tang, 2005). During a health crisis, consumers may consider disinfectants and sanitizers as essential purchases to allay health concerns. Purchases of products to limit the health threat of a pandemic may be higher during the reacting period of the crisis

2. Coping Purchasing Behaviour

Over time, consumers begin to cope by adopting new behaviour and exerting control in other areas. Coping behaviour includes maintaining social connectedness by sheltering in place with friends or family, using video and chat software, adopting domestic animals, engaging in do-it-yourself activities to overcome product shortages, and modifying their perception of brands.

After a period of time, consumers adjust their thinking and decision making to attenuate and cope with the constraint (Hamilton et al., 2019). Coping can either be problem-focused or emotion-focused (Lazarus and Folkman, 1984).

Problem- focused coping involves actions that directly address the problem and actions that allow the individual to adapt to the situation to make life less stressful. The ongoing nature of the COVID-19 crisis has led consumers to reevaluate their spending priorities.

Emotion-focused coping activities are directed towards the individual's own feelings and emotions and they often seek to take one's mind away from the problem. Examples include turning to religion, therapy or distracting oneself (Carver et al., 1989). Consumers may purchase emotion-focused products during the coping phase that allow them to focus on themselves, such as personal care and well-being goods.

Another coping strategy is to seek out social connectedness “not only with other humans, but also with other living beings” (Kirk and Rifkin, 2020). A large number of American households according to reports adopted a pet during the COVID-19 lockdown (Phillips, 2020) and more and more engaged in DIY pet grooming.² A number of pet shops in France also reported giving away guinea pigs and mice (Grassaud, 2020) and an increase in sales of fish and chickens (Diouris, 2020). As supermarkets were often closed during lockdown periods,

pet owners turned increasingly to online merchants for pet care supplies and veterinary products.

3. Adaptive Purchasing Behaviour

Long-term adaptations include changes in consumption habits such as more home-based experiences, increased online purchasing, and retail experiences that facilitate social distancing. Coping strategies deployed to deal with stressful life circumstances often include changes in consumption activities and behaviour (Mathur et al., 2003; Mathur et al., 1999).

Stressful events such as terrorist attacks, natural disasters, and pandemics also produce in long-term behavioural shifts and changes in consumption lifestyles “to adapt to new life circumstances” (Mathur et al., 2003). The COVID-19 pandemic, lockdown, and social distancing measures have disrupted buying and shopping practices and led consumers to experiment with new channels and learn new habits (Arora et al., 2020).

Consumers may discover that online shopping and home delivery is practical, cheaper, reassuring and allows them to overcome the stress imposed by new sanitary rules and regulations in retail outlets. Following the confinement period, customers may be concerned about contamination and adapt their behaviour accordingly (Hazée and Van Vaerenbergh, 2020), such as continuing to shop online.

A final possible behavioural change brought by the pandemic may be the recruitment of previously reticent online consumers. Kim (2020) uses innovation diffusion theory to argue that the pandemic has incited “late adopters” to buy online for the first time. Late adopters learn to shop online during the pandemic, and the convenience and safety of online shopping may help them overcome their skepticism and motivate them to continue shopping online after the pandemic ends. Late adopters of online purchasing are typically older consumers (Liu et al., 2019).

Research Methodology

Bayesian data analysis is becoming more and more popular in the 21st century. It is a potentially useful framework for investigating the acceptance of new information as a result of the consumer's attribution process (Kruschke, 2014; McElreath, 2018). There are many advantages of Bayesian data analysis, such as its ability to work with missing data and to combine prior information with data in a natural and principled way. Furthermore, Bayesian methods offer high flexibility through hierarchical modelling and estimate the parameters of an underlying distribution based on the observed values of interest.

The Bayesian analysis consists of various steps. First of all, in the computation of a prior distribution which can be based on an evaluation of the relative likelihoods of the parameters or on the results of non-Bayesian observations. It is good practice to take as prior distribution a uniform distribution over the appropriate range of values (Gelman et al., 1995). The analysis carries on with the data collection to obtain the observed distribution necessary to calculate the likelihood of the observed distribution as a function of parameter values. The posterior probability, considering Bayes theorem, is defined by multiplying the likelihood function by the prior distribution and normalizing the results. The distribution mode is then the estimation of the parameter involved.

In this paper we proposed the use of Kruschke's model (2011), to quantify the predictive adequacy of two competing hypotheses: the null hypothesis is an invariance and the alternative hypothesis relaxes the restriction imposed by the null hypothesis and reflects the intuition that the effect is likely to be small. In the specific the model is a particular Bayesian

approach for the comparison of data derived from two different groups/considerations. The method gives a clear distributional information about the means and standard deviations of each group allowing to highlight every possible difference of means, of standard deviations, and all possible effect sizes among the two groups.

Data Analysis

The key research questions this study aims to answer are:

- a) have consumers' ways of shopping changed during lockdown?
- b) have consumer's habits changed due to lockdown?
- c) have companies improved the quality of an e-commerce site?

To answer these questions, a questionnaire was administered to 2282 individuals (916 females and 1366 males, all Italian residents) with an average age of 34 years ($\sigma=10$). The questionnaire, included 32 questions divided into three different sections and administered in December 2020. The questionnaire, was built using the Google questionnaire platform and diffused we using the social platforms: Twitter, Facebook, WhatsApp and Instagram.

The answers helped us determine the change in the individual's shopping habits and verify, through the perception of consumers, whether companies are improving the quality of their e-commerce facilities.

The first section focuses on the various socio-demographic features of the individuals (gender, age, residence, kind of work, type of product bought online) which could help us to identify, through a descriptive analysis, trends among consumers.

The second section, composed by 3 questions ("How often did you shop online before march 2020?", "How often did you shop during the lockdown (March - May 2020)?" and "How often are you shopping during this time?"), focuses on how individuals interacted with online purchases and to understand whether consumer's habits changed due to lockdown, which is crucial research question for our study. For this purpose, considering Kruschke's model, we should have, first of all, computed, the posterior probabilities ($p(x_i|A_j)$), for each period under test (pre lockdown (A_1), lockdown (A_2) and post lockdown(A_3)) applying Bayesian Theorem to the data obtained:

$$p(x_i|A_j) = \frac{p(A_j|x_i) * p(x_i)}{p(A_j)} \quad \forall i = 1 \text{ to } 4 \text{ and } \forall j = 1 \text{ to } 3$$

- $X = \{x_1; x_2; x_3; x_4\}$ is the space of possible outcomes of the questionnaire (no; a bit; quite; a lot);
- $p(x_i)$ is the marginal probability;
- A_j is the event that consumer makes online shopping during the period considered;
- $p(A_j|x_i)$ is the conditional probability: the likelihood of event x_i occurring given that A is true;
- $P(A_j)$ is the prior probability.

$P(A_j)$ is defined as the integral, over the space, of the multiplication between the conditional probability and the marginal probability:

$$P(A_j) = \int p(A_j|X) * p(X)dX \quad \forall j = 1 \text{ to } 3$$

and this implies that Bayesian analysis is possible only for mathematical forms that could be analytically integrated or analytically approximated. To avoid this problem, in this paper we used Markov chain Monte Carlo (MCMC) (Bradley, 1995) method that approximates the posterior probability by a very large representative random sample of parameter values drawn from the posterior distribution, obtained through questionnaire, without needing to compute the difficult integral for $P(A_j)$. From the large sample, we determined the distributional information necessary for Kruschke's analysis.

According to Kruschke's model we cross-compared the several fits using reaction time (RT) and adaptation level and 95% HDI (highest density interval).

Reaction time or adaptation level is widely used in psychology to measure the propensity of a sample to react to external stimuli (Cho et al., 2002; Jones et al., 2013; Zhang et al., 2014) and thus gives us an absolute measure of how consumers interacted with online commerce during the relevant period.

Classical statistical approaches such as ANOVA on sample means, are inappropriate for reaction time analysis being generally a causal variable (Whelan, 2008). Various studies highlighted reaction time distribution can generally be assumed to be composed of random variables identically and independently distributed and, with a good approximation, be similar to ex-Gaussian distribution (Luce, 1986; Balota et al., 1999). The ex-Gaussian is defined as the sum of two independent causal variables: the Gaussian with mean μ and variance σ^2 and the exponential of rate λ .

In 1993 Ratcliff, furthermore, showed that mean can be assumed as a measure of central tendency for the reaction time distribution. In this work, the reaction time value is, therefore, assessed as mean value of the distribution of posterior probabilities computed ($x = p(x_i|A)$) that is assumed to be similar to an ex-Gaussian distribution ($f(x; \mu, \sigma, \lambda)$):

$$RT = \int_{-\infty}^{+\infty} x * \frac{\lambda}{2} * e^{\frac{\lambda}{2}(2\mu + \lambda\sigma^2 - 2x)} * \text{erfc}\left(\frac{\mu + \lambda\sigma^2 - x}{\sqrt{2}\sigma}\right) dx.$$

The HDI (Kruschke, 2015) defines an interval that spans the 95% of distribution, such that points inside the interval have higher credibility than any points outside the interval. In a symmetric distribution, the central element of interval is zero. Following this consideration, we applied 95% HDI to distributions of differences among groups to verify whether the completion times of the periods are different.

In the third part of questionnaire, we take a quick look at the companies, checking whether, according to respondents, companies are improving the quality of their e-commerce sites. At this aim we incorporated in the questionnaire, questions concerning technical improvements of e-commerce sites that consumers have noted in this period.

Results

Descriptive statistics

The socio-demographics of a person were obtained by incorporating variables such as *gender, age, residence, kind of work, type of product bought online* (Tab. 1).

Tab. 1: Distribution of data for categorical variables

Categorical Variables	Category	Percentage (%)
Gender	Male	59.9
	Female	40.1
Nationality	Italian	98.7
	Foreign	1.3
Italian residence	North	31.1
	Center	28.7
	South	27.3
	Isles	12.9
Age	< 24	22.8
	25-34	38.2
	35-44	21.2
	45-54	14.4
	55-64	3.1
	>65	0.3
Buy online before pandemic	No	2.2
	A bit	43.7
	Quite	31.4
	A lot	22.7
Buy online during lockdown (March-May 2020)	No	0.4
	A bit	22.8
	Quite	47.9
	A lot	28.9
Buy online after lockdown	No	3.1
	A bit	26.6
	Quite	45.8
	A lot	24.5
Occupation	public or private	27.2
	employee	22.5
	student	18.2
	worker	7.4
	freelancer	6.4
	manager	5.3
	military	4.3
	education	7.5
	unemployed	1.2
	other	
Online purchases before pandemic	Electronics	70.2
	Clothes	59.1
	Footwear	31.4
	Travel	25.3
	Cosmetics	21.5
	Personal care	12.9
	Pharmaceuticals	9.6
	Food	8.2
	Household cleaning	7.9

	Books	4.1
	Toys	0.1
	Other	4.3
Online purchases during lockdown (March-May 2020)	Electronics	64.1
	Clothes	55.1
	Footwear	29.9
	Travel	5.6
	Cosmetics	22.7
	Personal care	21.6
	Pharmaceuticals	14.2
	Food	19.1
	Household cleaning	16.6
	Books	3
	Toys	0.1
	Other	4.1
Online purchases after lockdown	Electronics	64
	Clothes	58.5
	Footwear	33.5
	Travel	9.5
	Cosmetics	21.2
	Personal care	16.9
	Pharmaceuticals	11.9
	Food	12.5
	Household cleaning	13
	Books	3
	Toys	0.2
	Other	2.5
E-commerce site to shop	Amazon	92.4
	Zalando	32.1
	Ebay	25.3
	Local business sites	14.2
	Sephora	6.8
	Yoox	5.7
	VeraLab	2.0
	Altro	4.5

Source: Author's Elaboration

The data distribution table, inserted in this subsection, enabled us to obtain a general understanding of the background of respondents:

- Only 2.2% of respondents never made online purchases and this does not seem to be related to the age group ($\chi^2(1) = 5.675$, , $p < 0.001$, C.L. =99%) or the type of job ($\chi^2(1) = 6.064$, , $p < 0.001$, C.L. =99%);
- Italians mainly buy electronic devices online. The trend remained constant in the three periods considered (before, during and after the lockdown). The outcome is consistent with previous studies (Arora et al., 2020; Forster and Tang, 2005): an individual during a crisis tends to maintain some semblance of normality and the online shopping is obviously a useful instrument in this contest.

- The block of tourism and transport linked to the lockdown was also felt on the overall online purchases for the sector. In fact, before the lockdown, 25% of respondents said they had purchased a trip online. Instead, only 9% after the lockdown continued to buy travel online.
- During the lockdown there was a significant increase in food purchases, going from 8% in March to 19% during the lockdown and then decreasing to 12% in the following months. The finding is in accord with recent studies (Islam et al., 2021; Sheth, 2020) regarding the purchasing behavior of an individual during a period of uncertainty: to buy essential products such as toilet paper, bread, water and meat.
- According with Carver et al (1989), also in Italy, during the lockdown, there was a significant increase in household cleaning products, going from 7.9% in March to 16.6% during the lockdown and then decreasing to 13% in the following months and in personal care, going from 12.9% in March to 21.6% during the lockdown and then decreasing to 16.9% in the following months.
- 90% of respondents use the Amazon e-commerce site to shop.

Inferential statistics

The following section focuses on the framework created to determine how consumer habits have changed increasing online purchases. For this purpose, the following questions were formulated:

- How often did you shop online before march 2020?
- How often did you shop during the lockdown (March - May 2020)?
- How often are you shopping during this time?

Through the Bayesian analysis we investigated the changes in the three considered periods. The data were already split into the three conditions described (pre-lockdown, lockdown and post-lockdown) for each question posed, so we only needed to specify the prior probabilities. The selection was based on the consideration that respondents had no constraints on the answer to choose, so we assumed a uniform distribution. The analysis was conducted using the BEST package of the R programming environment, available at the link <https://cran.r-project.org/web/packages/BEST/index.html> Through the function BESTmcmc we fitted the Bayesian model for each period using Markov Chain Monte Carlo (MCMC) diagnostics¹ and model fit (Cowles and Bradley, 1996). The output highlighted that the convergence diagnostic Rhat (Brooks-Gelman-Rubin scale reduction factor) was practically one for all parameters (a small auto-correlation) and the effective sample sizes were of the order of samples taken and Monte Carlo standard errors were relatively small. This implied a good quality of the distributions.

For our purposes, we proceeded by cross-comparing the several fits obtained (Fig 1, Fig. 2 and Tab. 2). The outputs highlight the reaction times of three clusters, the histograms of distributions of differences (the horizontal black line denotes the 95% HDI interval and the vertical blue line marks the mean difference) and the 95% HDI for the difference between groups respectively.

¹ MCMC diagnostics are tools that can be used to check whether the quality of a sample generated with an MCMC algorithm is sufficient to provide an accurate approximation of the target distribution.

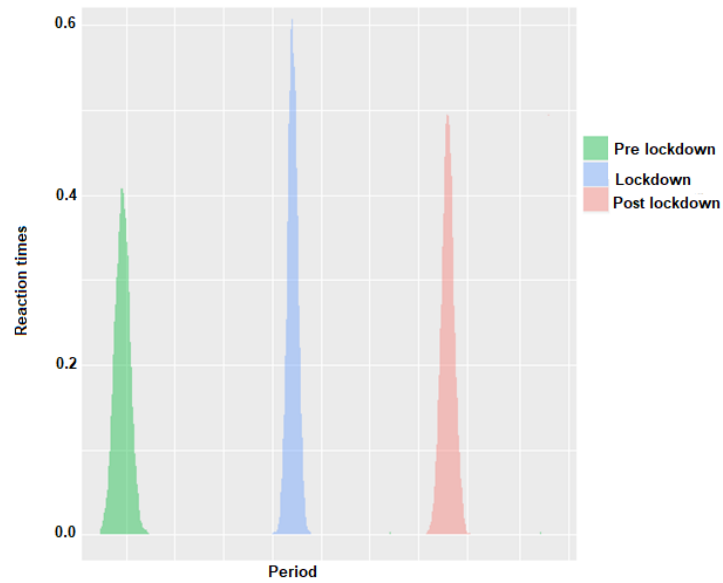


Fig. 1: Reaction times
 Source: Author's elaboration

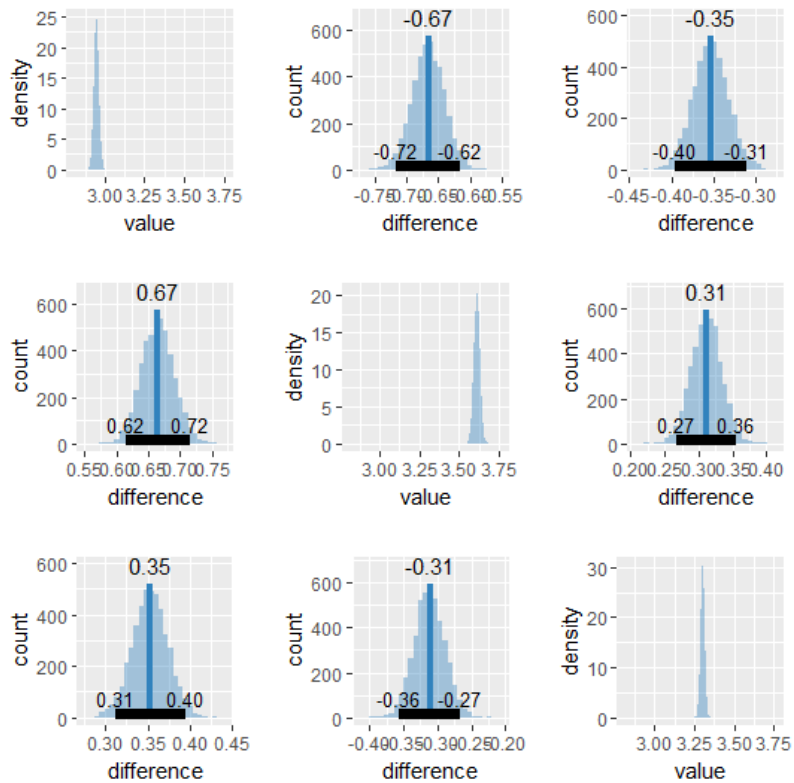


Fig. 2: Differences in average completion times for the three periods. Row and column 1 represent Pre-lockdown task, row and column 2 the Lockdown task and row and column 3 the Post-lockdown task.

Source: Author's elaboration

Tab. 2: Cross-comparing several fits

Reaction time or adaptation level	95% HDI
Pre_lockdown < Lockdown: 1.00 +/- 0.00000	[-0.72, -0.62]
Pre_lockdown < Post_lockdown: 1.00 +/- 0.00000	[-0.36, -0.27]
Lockdown > Post_lockdown: 1.00 +/- 0.00000	[0.31, 0.40]

Source: Author's elaboration

Based on the output we maintained that:

- 95% HDI intervals in all cases exclude 0 and that means the task completion times are different.
- the Lockdown group's expected reaction times are faster than the others, this implies a greater attitude of the consumer to buy online during that period.
- the Post lockdown group's expected reaction times are lower than Lockdown group's and are faster than Pre lockdown group's, this implies a substantial decrease in the attitude to buy online compared to the lockdown period.

The finding is in accord with various studies (Lally ,2010; Mathur, 2003) highlighting that stressful life circumstances often include changes in consumption activities and behaviors and that a change, whether repeated over time, can become a habit. In other words, the results, imply the pandemic brought people closer to ecommerce becoming a habit.

Descriptive Statistics

The following section focused on the framework created to determine, via consumer sensation, whether companies are improving the quality of their e-commerce sites. This information was obtained by incorporating questions concerning technical improvements of e-commerce sites.

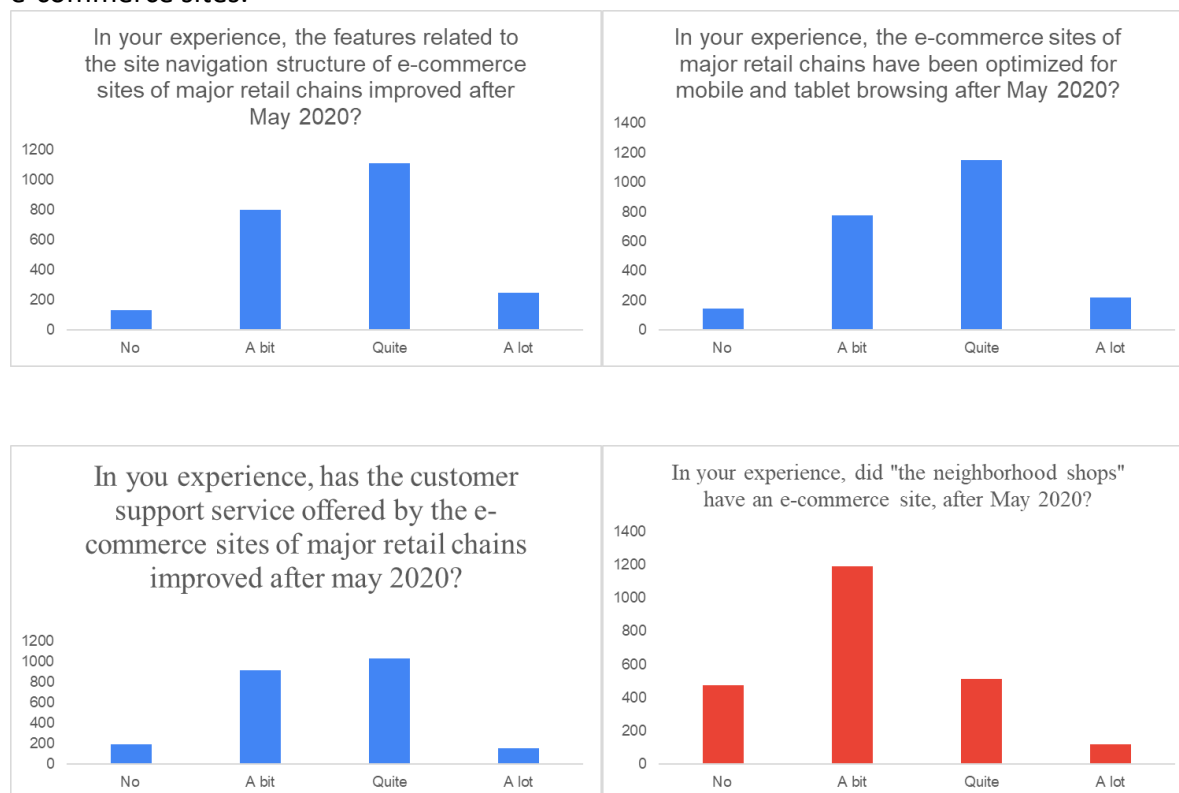


Fig. 3: Answers regarding technical improvements of e-commerce sites

Source: Author's elaboration

The responses of consumers showed that the big brands are working to improve the technical characteristics of their e-commerce site. The neighborhood shops do not yet seem to want to push into this market even if various reports, such as Retail report 2020 published on 22 October by Adyen, showed that the only solution for physical stores to remain competitive is to move quickly towards omni-channel sales strategies, meaning to combine traditional sales with online ones.

Discussion

The aim of this work was to analyze the marked trend of Western societies (Italian consumers) to make online purchases during the Covid-19 pandemic and verify whether individual's habits changed and how this mode of purchase has now become a habit among consumers even after the lockdown.

Data show, according with Mathur et al (2003), that also Italians, due to pandemic, are a population that makes online purchases normally by now, only 2,2% of interviewees never made online purchases. The finding is also in accord with Forster and Tang (2005), consumers turned to online shopping to maintain some semblance of normally during the crisis.

Statistics highlighted also that, due to the pandemic covid-19, the type of products purchased online changed. Italians, as is customary in many other countries, mainly buy electronic devices online and this trend remained constant in the three periods taken as a reference (before, during and after the lockdown). This can be due to the decisions made, for example, by many companies to carry out activities using remote connections. A sector that has had a large collapse in online sales was tourism, affected by the decisions made by the official institutions to stop or greatly restrict the movements of people. Data showed in the third period a decrease of 16% in comparison with the pre-lockdown period.

In the food sector, on the other hand, there was a large increase in online sales during the lockdown with a decrease after, but still exhibiting an increase of 12% in the third survey period with respect to a pre-lockdown situation. According with Islam et al (2021) such unusual purchasing behavior was a common reaction to the uncertainty of future product availability. During the lockdown, consumers bought essential products such as "toilet paper, bread, water and meat (Sheth, 2020).

Our analysis reflects the evidence of Carver et al (1989): during a problematic period, an individual tends to focus on himself, such as personal care and well-being goods. In Italy, during the lockdown, there was a significant increase in household cleaning products, going from 7.9% in March to 16.6% during the lockdown and then decreasing to 13% in the following months and in personal care, going from 12.9% in March to 21.6% during the lockdown and then decreasing to 16.9% in the following months.

Another important aspect analyzed in this paper was to verify whether shopping online has become a new habit. Various researchers (Beeken et al., 2017; Fleig et al., 2016; Mullan et al., 2014; White et al., 2017) and in particular Lally et al (2010), showed that development of an individual's habits can be depict by an asymptotic curve with a constant increase over time up to a final plateau, achieved at a median of 66 days after the start of testing, sheer length of lockdown in Italy. The Bayesian analysis allowed us to verify whether the propensity to online purchases, as a result of covid-19 pandemic, has had changes. The results highlighted that, during the lockdown, many approached e-commerce. More significant are the data related to the post-lockdown period. The analysis showed a decline compared to the previous period but also that the propensity to shop online remained higher than the pre-lockdown period (Tab.1). This means that this practice, which lasted for a relatively long

period (a few months), has become an established habit among consumers that somehow have become more likely to avail themselves of the possibilities provided by e-commerce.

What is happening has been well understood by the major brands? The answers of the interviewees (Fig. 3), in fact, showed that they are improving the quality of their e-commerce sites making them more and more user-friendly. Same thing cannot be confirmed for neighborhood shops or small activities. The survey highlighted how they do not yet seem to want to enter this market in a more resolute way, disappointing the suggestions of various reports, such as Retail report 2020 published on 22 October by Adyen, showing instead that the only solution for physical stores to remain competitive is to combine traditional sales with online ones.

Conclusion and Limitations

In this paper we have reviewed and deliberate on disparagingly Italy's COVID-19 outbreak. We were interested in relating the coronavirus with the spread of e-commerce in Italy, and generally speaking we believe that our findings should hold for similar European or Western societies. The statistics confirmed that, also in Italy, during the lockdown, many consumers, for various reasons, approached e-commerce, as happened in many other countries. The data analysis highlighted, that during lockdown, consumers mainly bought electronic devices, but there was a large increase in online sales for food, personal care and well-being goods. A sector that has had a large collapse, also in online sales, was obviously tourism due to the decisions made by the official institutions to stop or greatly restrict the movements of people.

Importantly, the data obtained through Bayesian approach. The analysis showed that even in the months following the lockdown the propensity to shop online remained higher than the pre-lockdown period (Tab. 1). This means that this practice, which lasted for a relatively long period (a few months), has become a consolidated habit among consumers who somehow have a greater propensity to take advantage of the possibilities offered by e-commerce. The finding is especially important for traders to sustain the right adjustment of the business.

Another important aspect considered is how brands are facing this radical change. The responses of consumers, at least during this period, showed that the big brands are working to improve the technical characteristics of their e-commerce site unlike the neighborhood shops that do not yet seem to want to push into this market.

This work is the starting point for future studies that will focus on the commercial strategies implemented by the various brands and within the different product categories – corroborating the results in other Western or Eastern contexts.

References

- Arora, N., Pflumm, S., Rodriguez, L., Robinson, K., Bhargava, S., Charm, T., Tormo, S. (2020). Survey: US Consumer Sentiment during the Coronavirus Crisis. <https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/survey-us-consumer-sentiment-during-the-coronavirus-crisis>.
- Balota, D. A., and Spieler, D. H. (1999), "Word frequency, repetition, and lexicality effects in word recognition tasks: Beyond measures of central tendency", *Journal of Experimental Psychology: General*, Vol. 128, pp. 32–55.
- Barnes, S. J. (2016), Understanding virtual reality in marketing: Nature, implications and potential. SSRN Available online: <https://doi.org/10.2139/ssrn.2909100> [Accessed 12th June 2020].

- Barnes, S. J., Pressey, A. D., and Scornavacca, E. (2019), "Mobile ubiquity: Understanding the impact of cognitive absorption on smartphone addiction", *Computers in Human Behavior*, Vol. 90, pp. 246–258.
- Barnes, S. J. (2020). Information management research and practice in the post-COVID-19 world. *Int. J. Inf. Manag.* 55, 102175.
- Baruch, Y. (2000), "Teleworking: Benefits and pitfalls as perceived by professionals and managers", *New Technology, Work and Employment*, Vol. 15, No. 1, pp. 34–49.
- Beaunoyer, E., Dupéré, B., and Guitton, M. J. (2020), "COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies", *Computers in Human Behavior*, 111, 106424.
- Beeken, R. J., Leurent, B., Vickerstaff, V., Wilson, R., Croker, H., Morris, S., and Wardle, J. (2017). "A brief intervention for weight control based on habit-formation theory delivered through primary care: Results from a randomised controlled trial", *International Journal of Obesity*, Vol. 41(2), 246–254
- Bhatti, A., Akram, H., Basit, H. M., Khan, A. U., Naqvi, R. S. M., and Bilal, M. (2020), "E-commerce trends during COVID-19 Pandemic", *International Journal of Future Generation Communication and Networking*, Vol. 13, No. 2, pp.1449-1452.
- Bickman, L., Rog, D. J., Hedrick, T. E. (2009). Applied research design: a practical approach. In: *Handbook of Applied Social Research Methods*, 2, pp. 3–43.
- Bradley, P., and Siddhartha, C. (1995), "Bayesian Model Choice Via Markov Chain Monte Carlo Methods", *Journal of the Royal Statistical Society: Series B (Methodological)*, Vol. 57, No. 3, pp. 473-488.
- Carver, C. S., Scheier, M. F., Weintraub, J. K. (1989). Assessing coping strategies: a theoretically based approach. *J. Pers. Soc. Psychol.* 56 (2), 267.
- Cho, R., Nystrom, L., Brown, E., Jones, A., Braver, T., Holmes, P., and Cohen, J. D. (2002), "Mechanisms underlying dependencies of performance on stimulus history in a two-alternative forced-choice task", *Cognitive, Affective and Behavioral Neuroscience*, Vol. 2, pp. 283-299.
- Clark, D. (2018). *Alibaba: the House that Jack Ma Built*. HarperCollins Publishers.
- Cowles, M. K., and Carlin, B. P. (1996), "Markov Chain Monte Carlo Convergence Diagnostics: A Comparative Review", *Journal of the American Statistical Association*, Vol. 91, No. 434, pp. 883-904.
- Daniels, K., Lamond, D., and Standen, P. (2002), "Teleworking: Frameworks for organizational research", *Journal of Management Studies*, Vol. 38, No. 8, pp. 1151–1185.
- Diouris, P. L. (2020). Coronavirus. Au Mans, les animaleries s'adaptent à la crise. Le Maine libre. <https://www.ouest-france.fr/sante/virus/coronavirus/coronavirus-au-mans-les-animaleries-s-adaptent-a-la-crise-c952219c-70f6-11ea-90c0-16d087144972>.
- Eroglu, S. A., Machleit, K. A., Davis, L. M. (2001). Atmospheric qualities of online retailing: a conceptual model and implications. *J. Bus. Res.* 54 (2), 177–184.
- Fleig, L., McAllister, M. M., Chen, P., Iverson, J., Milne, K., McKay, H. A., and Ashe, M. C. (2016). "Health behavior change theory meets falls prevention: Feasibility of a habit-based balance and strength exercise intervention for older adults", *Psychology of Sport and Exercise*, Vol. 22, 114–122.
- Forster, P. W., Tang, Y. (2005). The role of online shopping and fulfillment in the Hong Kong SARS crisis. In: *Paper Presented at the Proceedings of the 38th Annual Hawaii International Conference on System Sciences*.

- Gaur, S. S., Herjanto, H., Makkar, M. (2014). Review of emotions research in marketing, 2002–2013. *J. Retailing Consum. Serv.* 21 (6), 917–923
- Gelman, A., Carlin, J., Stern, H., and Rubin, D. (1995), *Bayesian Data Analysis*. Boca Raton, FL: Chapman & Hall.
- Goldsmith, K., Griskevicius, V., Hamilton, R. (2020). Scarcity and consumer decision making: is scarcity a mindset, a threat, a reference point, or a journey? *J. Assoc. Consum. Res.* 5 (4), 358–364.
- Grassaud, F. (2020). Que se passe-t-il au rayon animalerie `a l'heure du Coronavirus? , *France 3 Auvergne Rhone-Alpes*, 24 March 2020. <https://france3-regions.francetvinfo.fr/auvergne-rhone-alpes/ain/bourg-bresse/que-se-passe-t-il-au-rayon-animalerie-heure-du-coronavirus-1805518.html>.
- Guthrie, C., Fosso-Wamba, F., Arnaud, J. B. (2021). Online consumer resilience during a pandemic: An exploratory study of e-commerce behavior before, during and after a COVID-19 lockdown. *Journal of Retailing and Consumer Services*, 61. <https://doi.org/10.1016/j.jretconser.2021.102570>.
- Hamilton, R. W., Mittal, C., Shah, A., Thompson, D. V., Griskevicius, V. (2019). How financial constraints influence consumer behaviour: an integrative framework. *J. Consum. Psychol.* 29 (2), 285–305.
- Islam, T., Pitafi, A. H., Arya, V., Wang, Y., Akhtar, N., Mubarik, S., Xiaobei, L. (2021). Panic buying in the COVID-19 pandemic: a multi-country examination. *J. Retailing Consum. Serv.* 59, 102357.
- Jones, M., Curran, T., Mozer, M. C., and Wilder, M. H. (2013), “Sequential effects in response time reveal learning mechanisms and event representations”, *Psychological Review*, Vol. 120, No. 3, pp. 628–666.
- Kim, R. Y. (2020). The impact of COVID-19 on consumers: preparing for digital sales. *IEEE Eng. Manag. Rev.* 1, 1.
- Kirk, C. P., Rifkin, L. S. (2020). I'll trade you diamonds for toilet paper: consumer reacting, coping and adapting behaviours in the COVID-19 pandemic. *J. Bus. Res.* 117, 124–131.
- Kruschke J. K. (2013), “Bayesian Estimation Supersedes the t Test”, *Journal of Experimental Psychology*, Vol. 142, No. 2, pp. 573–603.
- Kruschke J. K. (2014), *Doing Bayesian Data Analysis: A Tutorial With R. JAGS, and Stan. 2nd edition. Academic Press.*
- Kruschke, H. K. (2015). *Doing Bayesian Data Analysis (Second Edition)*, Academic Press
- Kruschke, J. K. (2011), “Bayesian assessment of null values via parameter estimation and model comparison”, *Perspectives on Psychological Science*, Vol. 6, No. 3, pp. 299–312.
- Laato, S., Islam, A. N., Farooq, A., Dhir, A. (2020). Unusual purchasing behaviour during the early stages of the COVID-19 pandemic: the stimulus-organism-response approach. *J. Retailing Consum. Serv.* 57, 102224.
- Lai, Y., and Burchell, B. (2008), “Distributed work: Communication in an officeless firm”, *New Technology, Work and Employment*, Vol. 23, No. 1–2, pp. 61–76.
- Lally, P., Van Jaarsveld, C., Potts, H., and Wardle, J. (2010). “How are habits formed: Modelling habit formation in the real world”, *European Journal of Social Psychology*, Vol. 40, pp. 998–1009 <https://doi.org/10.1002/ejsp.674>
- Lally, P., Wardle, J., and Gardner, B. (2011). “Experiences of habit formation: A qualitative study. *Psychology*”, *Health & Medicine*, Vol. 16(4), 484–489.
- Lazarus, R. S., Folkman, S. (1984). *Stress, Appraisal, and Coping*. Springer publishing company.

- Lerner, J. S., Li, Y., Valdesolo, P., Kassam, K. S. (2015). Emotion and decision making. *Annu. Rev. Psychol.* 66 (1), 799–823.
- Liu, D., Liu, A., Tu, W. (2019). The acceptance behaviour of new media entertainment among older adults: living arrangement as a mediator. *Int. J. Aging Hum. Dev.* 91 (3), 274–298.
- Liu, D., Liu, A., Tu, W. (2019). The acceptance behaviour of new media entertainment among older adults: living arrangement as a mediator. *Int. J. Aging Hum. Dev.* 91 (3), 274–298.
- Luce, R. D. (1986), *Response times: Their role in inferring elementary mental organization.* New York: Oxford University Press.
- Mathur, A., Moschis, G. P., Euehun, L. (2003). Life events and brand preference changes. *J. Consum. Behav.* 3 (2), 129–141.
- Mathur, A., Moschis, G. P., Lee, E. (1999). Stress and consumer behaviour: coping strategies of older adults. *J. Market. Pract. Appl. Market Sci.* 5 (6–7), 233–247.
- McElreath R. (2018), *Statistical Rethinking: A Bayesian Course With Examples in R and Stan.* CRC Press.
- Mehrabian, A., Russell, J. A. (1974). *An Approach to Environmental Psychology.* The MIT Press, Cambridge, MA, US.
- Mullan, B., Allom, V., Fayn, K., and Johnston, I. (2014). “Building habit strength: A pilot intervention designed to improve food-safety behaviour”. *Food Research International*, Vol. 66, 274–278.
- Naeem, M. (2021). Do social media platforms develop consumer panic buying during the fear of Covid-19 pandemic. *J. Retailing Consum. Serv.* 58, 102226.
- O’Leary, D. E. (2020). Evolving information systems and technology research issues for COVID-19 and other pandemics. *J. Organ. Comput. Electron. Commer.* 30 (1), 1–8.
- Pejić-Bach, M. (2020). Editorial: electronic commerce in the time of covid-19 - perspectives and challenges. *J. Theor. Appl. Electron. Commer. Res.* 16 (1), 1.
- Phillips, M. M. (2020). *Wall St. J.* <https://www.wsj.com/articles/coronavirus-makes-us-u-pset-puppies-are-coming-to-the-rescue-11586530110>.
- Carolyn, P. E., Rovenpor, J., Alfred, M. R., Radin, T. (2007). Shopping in an age of terrorism: consumers weigh the risks associated with online versus in-store purchases. *Compet. Rev.: Int. Bus. J.* 17 (3), 170–180.
- Prentice, C., Chen, J., Stantic, B. (2020). Timed intervention in COVID-19 and panic buying. *J. Retailing Consum. Serv.* 57, 102203.
- Punch, K. F. (2013). *Introduction to Social Research: Quantitative and Qualitative Approaches.* Sage.
- Reiter, B. (2013). *The Epistemology and Methodology of Exploratory Social Science Research: Crossing Popper with Marcuse. The Dialectics of Citizenship: Exploring Privilege, Exclusion, and Racialization.* MSU Press, East Lansing, pp. 1–22.
- Richard, M.-O. (2005). Modeling the impact of internet atmospherics on surfer behaviour. *J. Bus. Res.* 58 (12), 1632–1642.
- Sarmento, M., Marques, S., Galan - Ladero, M. (2019). Consumption dynamics during recession and recovery: a learning journey. *J. Retailing Consum. Serv.* 50, 226–234.
- Sheth, J. (2020). Impact of Covid-19 on consumer behaviour: will the old habits return or die? *J. Bus. Res.* 117, 280–283.
- Stewart, R. (2020), *Stores may be reopening, but brands shouldn’t put e-commerce back on the simmer.* *The Drum* Available online: <https://www.thedrum.com/news/2020/06/11/stores-may-be-reopening-brands-shouldn-t-put-e-commerce-back-the-simmer> [Accessed 12th June 2020].

- Tran, L. T. T. (2021). Managing the effectiveness of e-commerce platforms in a pandemic. *J. Retailing Consum. Serv.* 58, 102287.
- Verma, S., Gustafsson, A. (2020). Investigating the emerging COVID-19 research trends in the field of business and management: a bibliometric analysis approach. *J. Bus. Res.* 118, 253–261.
- Vieira, V. A. (2013). Stimuli–organism–response framework: a meta-analytic review in the store environment. *J. Bus. Res.* 66 (9), 1420–1426.
- Watanabe, T., Omori, Y. (2020). Online consumption during the covid-19 crisis: evidence from Japan. *Covid Econ.* 32, 208–241.
- Whelan, R. (2008), Effective Analysis of Reaction Time Data. *The Psychological record.* 10.1007/BF03395630.
- White, I., Smith, L., Aggio, D., Shankar, S., Begum, S., Matei, R., and Jefferis, B. J. (2017). “On Your Feet to Earn Your Seat: Pilot RCT of a theory-based sedentary behavior reduction intervention for older adults”, *Pilot and Feasibility Studies*, Vol. 3(1), 23.
- Yin, R. K. (2009). *Case Study Research and Applications: Design and Methods*. Sage publications.
- Zhang, S., Huang, H. C., and Yu, A. J. (2014), “Sequential effects: A Bayesian analysis of prior bias on reaction time and behavioral choice”, *Proceedings of the Annual Meeting of the Cognitive Science Society*, Vol. 36.