

Pet supplies, toddlers and electronics: Long-term changes in three e-commerce product segments during and after the COVID-19 pandemic

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ABSTRACT

This paper examines the impact of the COVID-19 pandemic on e-commerce in Hungary, focusing on three product segments: animals and pet supplies, baby and toddler, and electronics. Using anonymised sales data provided by Barion Payment Inc., a Hungarian startup, the study analyses the relationship between the number of new COVID-19 cases and online sales volumes in these segments from March 2020 to February 2023. The study explores the similarities and differences between the segments, the possible mechanisms through which the increase in cases affected them (such as fear of infection, in-store restrictions, and convenience), and whether the changes were permanent enough for e-retailers to rely on them for business development. The findings suggest that while all three segments experienced increased sales during the pandemic, only the animals and pet supplies segment showed sustained growth due to deeper socio-economic trends, such as increased pet ownership. The paper concludes with recommendations for policymakers and retailers to better prepare for similar situations in the future, including creating crisis scenarios, supporting socially deprived customers, and improving the digital readiness of retailers.

KEYWORDS

COVID-19, long-term impacts, Hungary, e-commerce, animals and pet supplies, baby and toddler, electronics, big data

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1. INTRODUCTION

COVID-19 has dramatically impacted our lives, changed our consumption habits and influenced our need for products and services. Some businesses were adversely affected and had to close; meanwhile, others could adapt to this uncertain, never-before-seen situation. It is widely perceived that the pandemic has basically strengthened e-commerce. This paper examines how e-commerce in Hungary has been affected by the COVID-19 pandemic in three product segments (animals and pet supplies, baby and toddler, and electronics).

During the first pandemic wave, between 11 March and 13 June 2020, Hungary closed its borders and introduced lockdowns, like other countries across Central Europe. During the summer of 2020, the virus was dormant. The second wave started on 28 August 2020 and lasted until 24 January 2021. As the number of affected people was much more than during the first wave, countermeasures had to be introduced: “From midnight 11th November 2020, a curfew is in effect between 8 pm and 5 am which means that everyone must leave the streets by 8 pm and stay at their place of residence or accommodation until 5 am [...] In restaurants only pickup and home delivery services shall be available [...] Shops must close at 7 pm and shall not open before 5 am. Pharmacies and petrol stations may remain open. Rules on mandatory mask wearing and sanctions for not proper use remain in place, meaning that wearing a mask properly is still mandatory in public transportation, shops, restaurants and public offices” (Helpers 2020). The restrictions were only lifted on 21 May 2021 as the number of vaccinated reached 5 million (the population of Hungary is about 9.75 million). Although the third wave (March 2021–June 2021) arrived in Hungary in mid-February 2021, it was only on 4 March that the government ordered the closure of non-essential businesses and primary schools (Kovács 2021). Hungary only used masks to control the fourth (October 2021–January 2022) and fifth (January 2022–April 2022) waves (479/2020, 2020); no curfew decree or other restrictions were in place, and the government even removed these restrictions on 27 March 2022 (Helpers 2021).

Figure 1 shows the daily new cases of these five waves of COVID-19 in Hungary (waves are marked with a dimmed background). After 12 June 2021, hospitals did not have to report the number of new cases and fatalities on weekends, and after 2 May 2022, only weekly reports were required. Hence, a 7-day rolling average is applied to the raw data to smooth out any missing days it may have.

Our research shows the effects of the pandemic on the Hungarian e-commerce sector during and after the waves between March 2020 and February 2023, based on sales data of e-commerce merchants. The data were provided by Barion Payment Inc., a single payment service provider, a Hungarian startup, thus not representative of the population, but provides an analysable picture of the pace of purchases. Three product segments were chosen to demonstrate the relation between e-commerce and COVID-19, which showed the strongest statistical correlation with the number of new cases (for more details, see ‘Materials and methods’ chapter). These segments are “animals and pet supplies”, “baby and toddler” and “electronics” segments.

Although the Hungarian government has not officially declared the end of the pandemic, COVID-19 has no longer been a feature of daily life since 2023. We had the opportunity to examine the pandemic through the lens of Barion data, allowing us to compare the five waves with the subsequent period in terms of e-commerce.

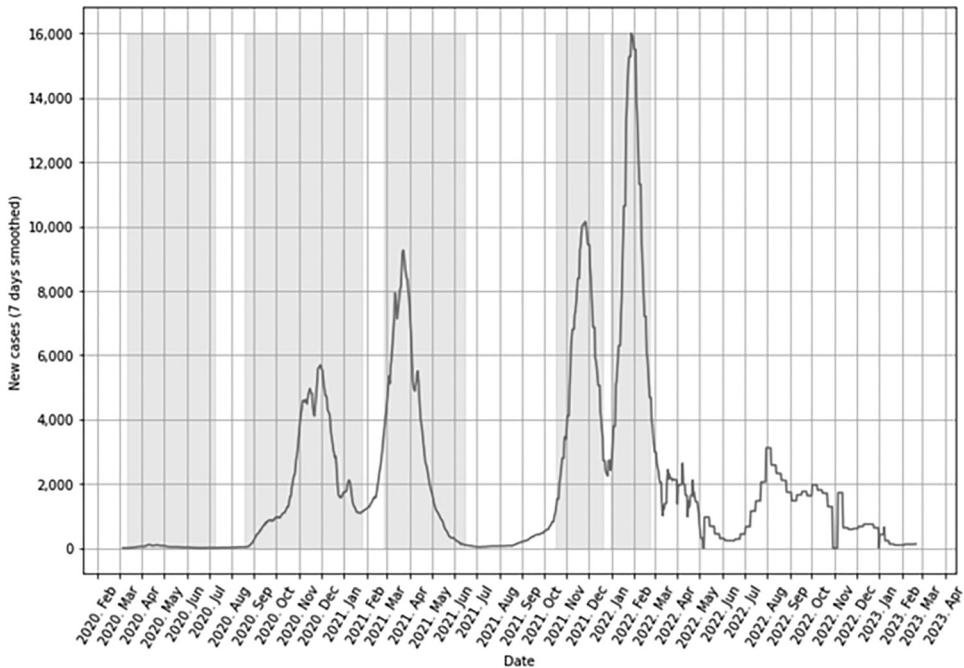


Fig. 1. Daily new cases of COVID-19 during and after the waves in Hungary

Source: [Medicine \(2023\)](#).

The main research questions of the article are:

- What are the similarities and differences between the three examined product segments concerning COVID-19?
- What are the possible mechanisms of action through which the increase in new cases has affected these product segments?
- Were these changes during COVID-19 permanent enough that e-retailers could rely on them in their business development during and after the pandemic?

Why are these questions interesting, or even important, to explore? Firstly, as a layperson, one can assume that e-retailing has emerged stronger from the pandemic. It would be helpful to know whether this is really the case, and if so, what could be the reasons behind it? Secondly, it is worth documenting what happened so that we can learn from it in the event of a possible next pandemic, even if, hopefully, such a pandemic will not occur. But if it does, learning lessons from the 2020–22 pandemic is critical. Thus, such articles can be important, just as the experience of the Spanish flu was relevant at the start of the COVID-19 outbreak to help us think through roughly what we might expect. Thirdly, the results can be used to draw conclusions and suggestions for policymakers and retailers to help them better prepare for similar unexpected situations. Finally, because unfortunately, Barion's data are not openly available, without this article, knowledge of these data would remain inaccessible to the scientific community, e-retailer professionals, or policymakers.

2. LITERATURE REVIEW

E-commerce has grown significantly due to government measures, lockdowns, social distancing and changes in consumer habits caused by COVID-19. An overall shift toward online shopping was observed during the pandemic, as e-commerce partially replaced traditional shopping; people ordered products online that they usually bought in physical stores before the pandemic. However, e-commerce companies encountered several issues, such as prolonged delivery times, controlling movement of employees and consumers, maintaining social distancing, and dealing with lockdowns.

The precise impact of the rising number of new COVID-19 cases on online sales and the nature of the changes it induced remain unclear. However, we can make some assumptions based on the academic literature and our knowledge of the Hungarian e-commerce sector. These suggest three main reasons online shopping may have increased with the rise in new COVID-19 cases: fear, in-store restrictions, and convenience. Some papers mention the specific consumer behaviour changes across regions:

- Fear: people ordered online because they were afraid of being infected or of infecting significant others (e.g. close relatives), so they did not go out in public, including traditional shops, and bought products online instead (Raza – Khan 2021).
- In-store restrictions: people shopped online because in-store restrictions prevented them from shopping in a traditional offline shop as they used to (Shah 2021; Jaller – Dennis 2022).
- Convenience and remote work: people shopped online because it was more convenient for them to do so from home, and during the height of each pandemic wave, government or workplace restrictions forced more people to stay at home (for example, school closures, office restrictions, or telecommuting), hence they ordered products online (Music et al. 2022).

Regarding e-commerce growth patterns and sector impact, Bhatti et al. (2020) claim that consumers worldwide avoided attending brick-and-mortar shops and crowded areas during the lockdowns (Bhatti et al. 2020). Because of social distancing and being able to shop and work from home, the sales volume of e-commerce retailers, such as Walmart, increased by 74% (Bhatti et al. 2020). Meanwhile, the e-commerce providers struggled to maintain the pace with the growth rates (e.g. stock and labour shortages, extended delivery time, etc.; Mansour – Abdullah 2020). People also bought products online to prepare for staying home longer. For example, 25% more electronic products and 21% more food and beverages were ordered during the lockdown in India (Galhotra – Dewan 2020). Although shipping and supply chains have become slower, people continued to make purchases as they had no alternative options (Halim 2022).

After the COVID-19 pandemic, it became clear that the e-commerce sector does not respond uniformly, with different categories being impacted differently by the pandemic's progression. A crucial research question is how demand for various product categories has changed (Kawasaki et al. 2022). While some differences are apparent, such as the significant growth in medical e-commerce and the decline in the travel segment (Tick et al. 2021), it is exciting to examine the evolution of product segments where consumer behaviour is less predictable and changes over time. In this paper, we focused on three such product segments.

There was a noticeable disparity in the capacity for adaptation between large and small or local e-commerce players. Increased demand as a result of the pandemic has had a positive

impact on the economic assessment of larger e-commerce companies. [Abdelrhim and Elsayed \(2020\)](#) found a significant relationship between the returns of shares of the world's largest e-commerce companies (the American Amazon, Chinese Alibaba, Japanese Rakuten, German Zalando and United Kingdom ASOS) and COVID-19 total deaths, total cases, and new cases. A similarly positive relationship was demonstrated between the stock returns of Chinese companies and the number of coronavirus cases (number of additional cases per day and COVID-19 deaths per day) ([Ji – Zhang 2022](#)). In our research, we sought to determine whether e-commerce in individual product segments, represented by a variety of companies rather than major players, could demonstrate a similar significant relationship in a country like Hungary, which is relatively small and less developed in terms of e-commerce.

Nonetheless, the pandemic was a chance, a risk, and a must, mainly for smaller retailers. According to research in Belgium, even though the share of e-commerce increased during the pandemic, local retailers were disadvantaged due to a lack of professionalism. This gap will only get stronger if, as expected, the share of online trade remains high after the pandemic subsidies, unless retailers can learn from the pandemic's challenges and experiences ([Beckers et al. 2021](#)). Another study from Indonesia found that small enterprises faced a decline in revenue due to the non-adoption of e-commerce, which compelled them to adopt e-commerce practices during the pandemic ([Lestari et al. 2021](#)).

A substantial body of literature examining consumer purchasing behaviour during the COVID-19 pandemic has emerged. One study, "Examining Food Purchase Behaviour and Food Values During the COVID-19 Pandemic", supports the increased online grocery shopping. The authors argue that the pandemic has globally reshaped perceptions of "normal," particularly in the context of food purchasing and acquisition. The study is based on a panel survey of 1,370 U.S. households, conducted four times between mid-March and late April 2020. Analysis of the survey data revealed notable shifts in food-related expenditures, including decreased spending on meals consumed not at home and increased reliance on online grocery shopping, indicating a transformation in consumer behaviour and food values over the pandemic ([Ellison et al. 2020](#)).

Further evidence of changing consumer behaviour is provided in the article "Impact of the COVID-19 Pandemic on Online Consumer Purchasing Behaviour." The study highlights the growing influence of consumer awareness and experience on purchasing decisions. Consumers became more accustomed to online environments, so their purchasing behaviour evolved accordingly. The research also emphasises the increasing significance of rapid decision-making when shopping online, suggesting a shift toward more efficient and informed consumer activity ([Gu et al. 2021](#)).

In addition, the study "Analysis and Modelling of Changes in Online Shopping Behaviour Due to the COVID-19 Pandemic: A Florida Case Study" explores the broader behavioural and economic implications of the pandemic. The authors identify store closures and job losses as key drivers of change, noting that while online shopping platforms gained popularity, in-person shopping remained essential for items that require tactile or visual evaluation. The research also addresses disruptions in the transportation and logistics sectors, attributing these partly to the infection of trained personnel. This underscores the sector's dependence on human labour and vulnerability to systemic shocks. Regarding long-term trends, the authors of the Florida case study suggest that the pandemic's impact on the growth of online shopping is likely to be temporary. They predict a rebalancing of consumer preferences, with in-store shopping regaining prominence as conditions normalise post-pandemic ([Adibfar et al. 2022](#)).

To summarise the above results, it may be stated that COVID-19 significantly accelerated global e-commerce growth due to lockdowns, social distancing, and shifting consumer habits, with many shoppers turning to online platforms for products in favour of brick-and-mortar stores. This surge was driven mainly by fear of infection, in-store restrictions, and the convenience of shopping from home, especially amid remote work and school closures. While large e-commerce companies like Amazon and Alibaba benefited from increased demand and rising stock values, smaller and local retailers often struggled due to limited resources. Growth patterns varied across product categories—medical supplies boomed while travel-related goods declined—and some sectors faced supply chain delays and labour shortages. Studies showed a notable increase in online grocery shopping and evolving consumer behaviour as people became more familiar with digital purchasing, though certain goods still required in-person presence. Research suggests that while online shopping expanded rapidly during the pandemic, its dominance may decrease as conditions normalise, with offline shopping gaining prominence.

This paper focuses on discovering a relationship between the pandemic and the sales volumes of different online product segments in Hungary. Only in 2020, the pandemic forced the Hungarian e-commerce to level up, as the total volume of online purchases achieved a 45% annual growth rate (approximately 2.5–3 times higher than the normal annual growth; [GKID 2021](#)) The size of the Hungarian e-retail market in 2020 was HUF 909 billion (about EUR 2.6 billion), excluding services (e.g. accommodation, airline tickets, insurance, etc.). This represented 52.5 million online transactions ([GKID 2021](#)). While in 2015 the share of adults who shopped online in Hungary (47%) was still well below the EU average (62%), in 2020 it was almost the same (70% compared to 72%; [Eurostat 2021](#)). The 23-percentage point increase between 2015 and 2020 was one of the highest among the Member States. Based on this statistic, Hungary ranks among the Eastern European countries with a moderately developed e-commerce market (e.g. Croatia, Slovakia, Lithuania, Latvia, Romania and Bulgaria are less developed, while Slovenia, Poland, Estonia and the Czech Republic are more developed). E-commerce in Central European countries traditionally lags behind Western Europe, but has grown at a higher average rate in recent years than its Western European counterparts ([Paraschiv et al. 2024](#); [Statista 2024](#)).

Our research can be considered novel compared to the existing literature. On the one hand, contrary to the majority of research, it is a retrospective analysis, made not during the pandemic, but after its unofficial end, which is why we can evaluate the entire pandemic period at once. It covers the whole pandemic (in the case of Hungary, between March 2020 and April 2022) and the subsequent period (until February 2023). The analysis is based on a 3-year data series, which provides a complete picture of the course of the pandemic and the relationship between e-commerce. On the other hand, unlike most quantitative research (see, for example [Hasanat et al. 2020](#); [Albliwi – Alsolami 2021](#); [Lestari et al. 2021](#); [Chmielarz et al. 2022](#); [Fakieh – Happonen 2022](#); [Inoue – Hashimoto 2022](#); [Guthrie et al. 2021](#); [Yuan et al. 2021](#)), our research is not based on consumer or retailer survey (opinion or market research), but on automatically collected retailer data. Hence, the data is not biased by inaccuracies arising from recollection and memories. The research also contains data for several product segments, making it possible to identify the differences concerning individual product segments. Finally, the research is not limited to 1–2 major e-commerce companies (see, for example, [Guthrie et al. 2021](#) or [Yuan et al. 2021](#)), yet relies on data from hundreds of smaller companies.

3. MATERIALS AND METHODS

Barion Payment Inc. holds an electronic money issuer licence. Customers can easily and safely pay with Barion Smart Gateway in more than 13,000 online shops in Central and Eastern Europe, mainly in Hungary (Barion 2023). In exchange for lower payment fees, Barion merchants can choose to share the consented data of their customers, which is collected and stored in a data lake. These data can be any kind of customer interest or interaction with the product/service, or willingness to buy a particular product/service in the merchant's webshop. To collect these data, a JavaScript snippet needs to be embedded into the webshop site. Upon the customer's first visit to a website with an embedded Barion snippet, a random unique ID is generated that would identify the customer throughout all the websites they later visit. The ID is stored in a third-party cookie, which expires in 18 months from the last visit to any webpage with these Barion snippets. All the captured sensitive customer-related data is anonymised – according to GDPR – and then saved into a database.

During the data collection phase of this project, the e-commerce retailers of the Hungarian market were categorised according to Google's taxonomy, a list of more than 6,000 subcategories used by Google to help departmentalise products and services in a shopping cart (Google.com 2019). The contents of the shopping carts were fed into a neural network model to classify them according to a taxonomy based on Google's taxonomy but tailored to the Hungarian market. The data were limited to the Hungarian market because there was not enough quality data from webshops in other countries. The model outputs the root category and a subcategory that the product fits best, and the confidence level of this sorting process. (For example: cat food fits the "animals and pet supplies" category). The confidence is a percentage showing the strength of the category prediction. Only those outputs above the 80% confidence threshold are kept, reaching high-quality data.

For each product segment, we used in the analysis only those e-commerce retailers that existed before the beginning of the pandemic and were still operating at the time when the data was collected in 2023. The segments analysed in this paper were systematically selected from Google's established taxonomy. Only those segments were included in the analysis where a minimum threshold of webshops—sufficient to ensure data reliability and maintain competitor anonymity—was met. Hence, we only analysed the data of specific product segments and not the entire e-commerce sector. The preliminary analysis included the sales data of the following selected segments: "animals and pet supplies", "apparel and accessories", "baby and toddler", "electronics", "food and beverages", "health and beauty", "home and garden", and "sporting goods". According to Reacty Digital and eNET joint research on the Hungarian e-commerce sector in 2019 (Reacty Digital - eNET 2020), these product segments were responsible for 53% of e-retail trade turnover altogether in Hungary before the pandemic ("animals and pet supplies": 2%, "apparel and accessories": 9%, "baby and toddler": 3%, "electronics": 20%, "food and beverages": 4%, "health and beauty": 8%, "home and garden": 5%, and "sporting goods": 2%).

The sales volumes of each of the above-described product segments were correlated with the new cases of COVID-19 (statistics obtained from publicly available online sources, Data 2022). Table 1 contains the list of at least medium-strength correlations (between 0.3 and 0.5) of sales volumes of segments with new cases of COVID-19 in Hungary. After the top 5% of the outliers were removed from the input set, the Pearson correlations were calculated for each segment (Statistics 2020).

Table 1. List of at least medium-strength correlations of sales volumes of segments with new cases of COVID-19 in Hungary

Segment	Correlation	p-value
Animals and pet supplies	0.3976	0.0000
Baby & toddler	0.3947	0.0000
Electronics	0.3944	0.0000
Apparel and accessories	0.3326	0.0000
Health and beauty	0.3210	0.0000
Home and garden	0.3066	0.0000

Source: authors.

The higher the COVID-19 new cases were, the more products or services were sold online within these segments. In the top three positions of the list are the “animals and pet supplies”, “baby and toddler” and “electronic” segments. We have concentrated our further research on these three product segments as these showed the strongest correlations. Limiting our research helped us analyse and understand these segments more deeply.

A further limitation of the data collection is that there is no data available before the pandemic, only during and after. Initially, the sales volumes of the pre-COVID era were planned to be compared with the data during the pandemic, but this analysis could not be carried out due to a lack of at least a year of data before COVID. Unfortunately, Barion changed the structure of the data collected at the beginning of 2023, so the subsequent data series are not comparable to the previous data. Hence, the research covers the period between March 2020 and February 2023.

The following chapter shows the sales volume changes over time for the selected product segments. A moving average of 7 days is applied to the values to smooth out the weekly seasonality that the time series may have. The charts were cross-validated and showed trend lines of minimal RMSE (root-mean-square error). However, to comply with Barion policies, the exact number of retailers is not disclosed, but the extent of the changes can be read from the charts.

4. RESEARCH RESULTS OF THE SELECTED E-COMMERCE PRODUCT SEGMENTS

4.1. Animals and pet supplies

The “animals and pet supplies” segment includes live animals and their associated products. In the Hungarian market, it is basically cats, dogs and all other animals and their supplies. [Figure 2](#) shows the general trends of the online sales in the segment. In general, there was an upward trend in the sales volume of the “animals and pet supplies” segment, as [Fig. 2](#) shows, during and after the pandemic. After the end of the 4th COVID wave, the trend line plateaus and increases again after June 2022.

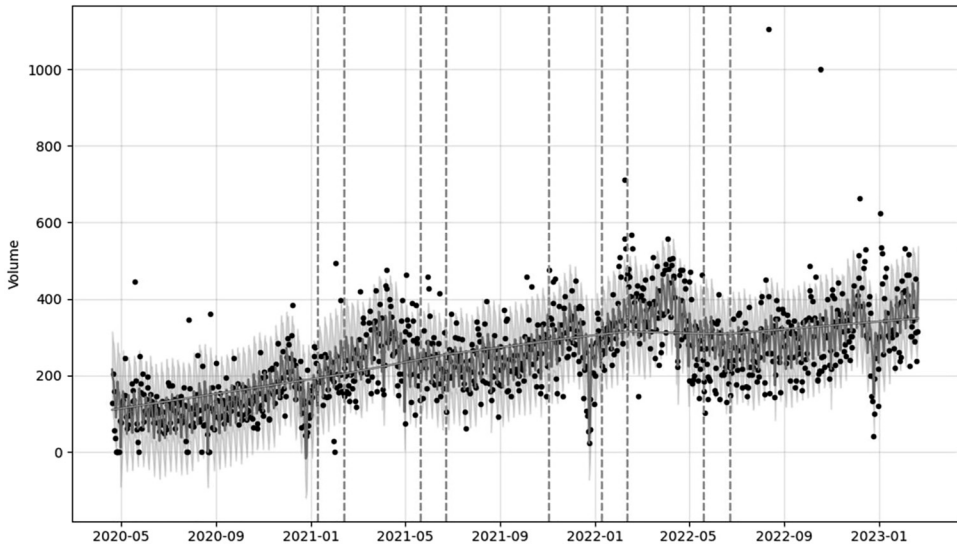


Fig. 2. Sales volume of the “animals and pet supplies” segment between April 2020 and January 2023
 Source: Barion (2023).

The segment also shows strong yearly seasonality (Fig. 3), as most people obtain their pets and pet-related stuff either at the start of the year, during spring or before Christmas. After the curfew was introduced on 14 November 2020, there was an annual peak in sales volume before Christmas. The sales volume in the spring was substantial, as people were probably acquiring their household pets during this time.

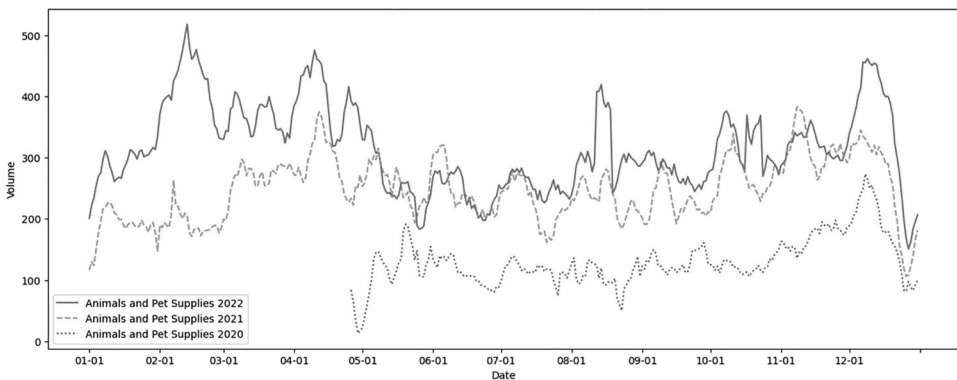


Fig. 3. The yearly seasonality of the “animals and pet supplies” segment calculated from data between April 2020 and January 2023
 Source: Barion (2023).

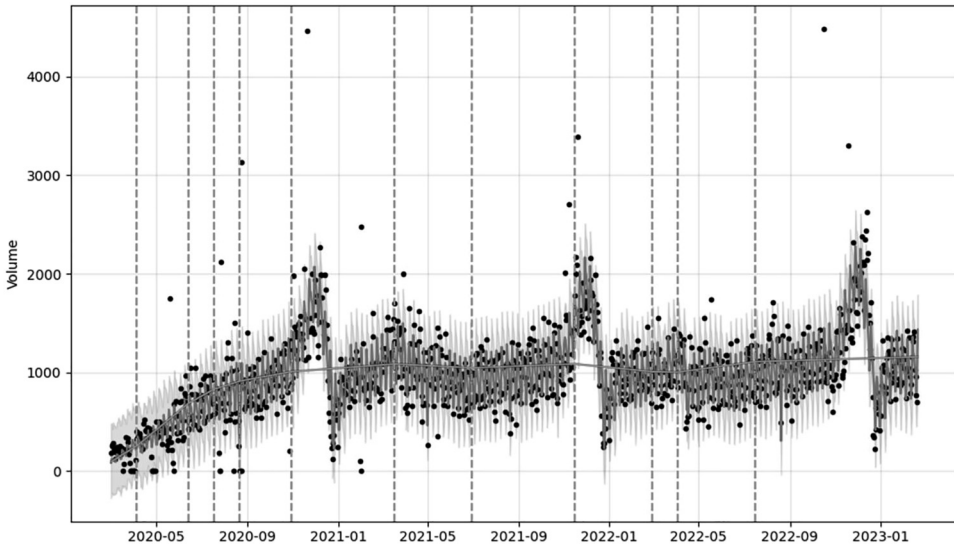


Fig. 4. Sales volume of the “baby and toddler” segment between March 2020 and February 2023
 Source: Barion (2023).

4.2. Baby and toddler

The seasonality of the “baby and toddler” segment charts show that the category has an extreme yearly seasonality, peaking before Christmas and then relapsing in January (Fig. 4). The sales volume shows ascending and descending sections alternating over the three years under review. The annual data in Fig. 5 shows a nearly identical pattern during 2020, 2021 and 2022. Still,

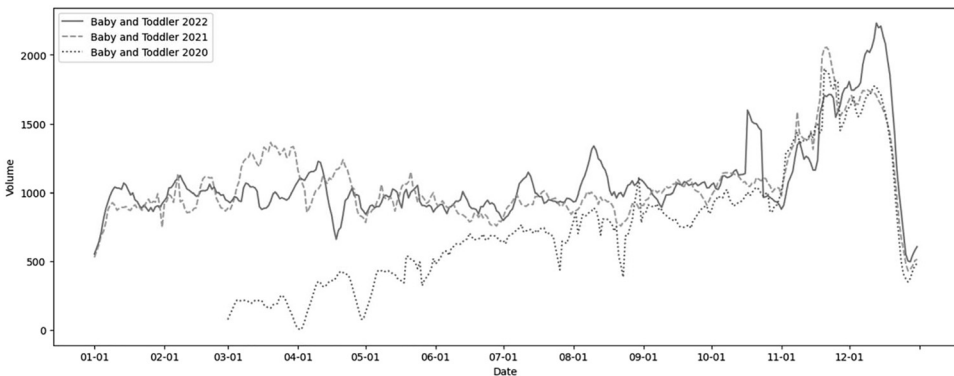


Fig. 5. Trend of the “baby and toddler” segment during the COVID pandemic between March 2020 and January 2023 (sales value over time)
 Source: Barion (2023).

divergences are seen during 2022 compared to the other two years (e.g., April, July–August or October). For 2020, we see differences in June and September.

4.3. Electronics

The sales volume of the shops within the “electronics” (Fig. 6) segment has an upward trend until January 2022, but the Christmas peak was much more solid in 2022. This is interesting because the yearly seasonality shows that most electronic products sold before Christmas and summers are relatively weak. Data shows that electronics could grow significantly during 2021, but could not sustain this growth level at the end of 2022 or in early 2023 (Fig. 7).

5. ANALYSIS AND DISCUSSION

The data indicate that although sales volumes in all three product segments were significantly correlated with the number of new COVID-19 cases, the sales were not uniform across all segments regarding timing and patterns. The patterns of the three product categories differed. The animals and pet supplies segment increased steadily over the three years studied, with occasional stagnation or slight decline. Three small waves were identified for the baby and toddler segment, while electronics formed an M-shape, with relatively large peaks, but with sales showing signs of fading by 2023.

In the three product categories studied, there is no firm evidence of a so-called “habituation” to online shopping (i.e., those otherwise offline shoppers of the product category who once tried online ordering because of the pandemic would have mostly continued to do so). If this had

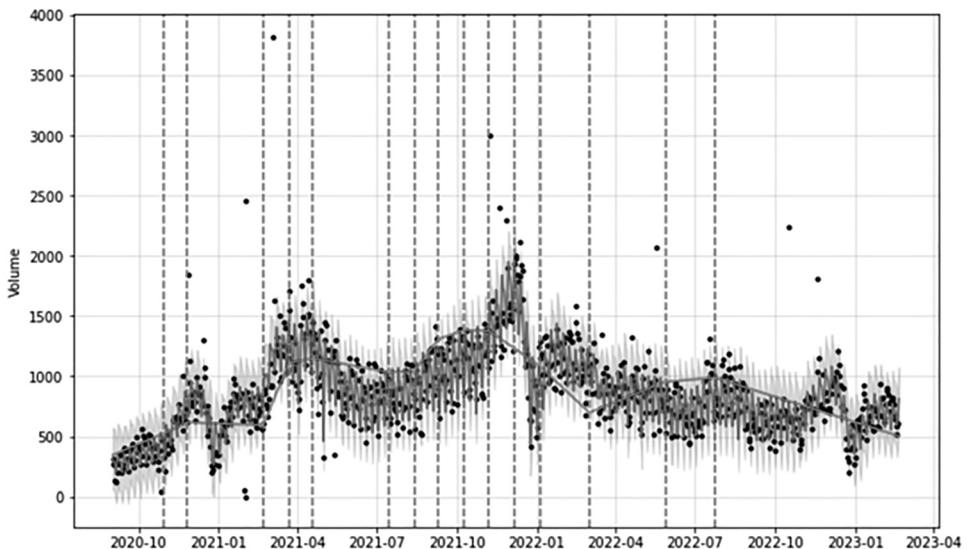


Fig. 6. Sales volume of the “electronics” segment between September 2020 and February 2023

Source: Barion (2023).

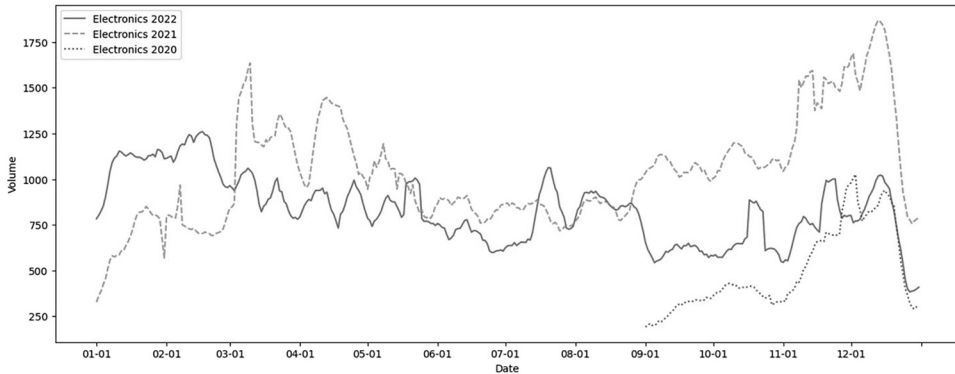


Fig. 7. Trend of the “electronics” segment during the COVID pandemic between September 2020 and January 2023 (sales value over time)

Source: Barion (2023).

been the case, as the number of new cases decreased, people would have stayed with online shopping altogether, and the statistical relationship with the sales data would not have been significant. The research suggests that when the pandemic intensified (case numbers increased) and the fear of infection increased, in-store shopping was restricted, more people were forced to stay at home, online sales volume increased. In contrast, when case numbers decreased, the reverse happened.

In addition to the above, there must have been different reasons behind the variations in sales for the three product categories, which altered the sales patterns. It is essential to highlight why these three product groups showed the strongest correlation with the number of new pandemic cases.

Animals and pet supplies: the sustained increase in demand is presumably linked to the increased number of animals kept. The increase in animal keeping is most probably related to the need to escape curfews and maintain mental health. There was a peak in buying pet products during the lockdown period as dog owners were exempted from curfew in Hungary (Budapest 2020). Also, pets help combat loneliness for isolated people (Rocheleau 2020). This result aligns with a nationally representative survey in Hungary that shows a significant increase in the ratio of dog-keeping households, which rose from approximately one-third¹ to one-half of the Hungarian households during the pandemic (Vetter et al. 2022).

Baby and toddler: this product group typically has young customers who are open to online shopping and are comfortable shopping online, regardless of the pandemic. However, what may have reinforced online shopping as the number of cases rose was fear, especially at the beginning of the pandemic, when it was not known how vulnerable toddlers and pregnant mothers were to the COVID-19 pandemic (Lee et al. 2020; Wastnedge et al. 2020) Meanwhile, a boom in births expected at the pandemic’s beginning has not materialised. In the early stages of the pandemic, there were predictions that there would be a forthcoming baby boom, nine months after the first

¹Estimated number of dogs is 1,403,128 (Vetter et al. 2022).

wave. However, the social distancing and the uncertainties brought about by the pandemic put a pause on having children in many countries (Grantham-Philips 2020). Also, Molly J. Stout et al. mention that societal changes influence reproductive growth and fertility rates. The pandemic resulted in an initial decline in births and an anticipated increase in birth volume in the United States (Stout et al. 2021). In Hungary, according to the Hungarian Central Statistical Office, live births have stagnated around 7,000–8,000 per month since 2016 (Office 2022). As a result, the online demand for baby and toddler products increased during certain waves of the pandemic but remained stable otherwise.

Electronics is undoubtedly the largest of the three product segments studied in terms of volume. Most key Hungarian e-commerce retailers by sales volume sell electronics (for example eMAG-Extreme Digital, Alza.hu, MediaMarkt, Euronics, Aqua, iPon, 220volt; Hasanat et al. 2020). Although these webshops are not in our data sample, this fact shows that this product segment is one of the most important in Hungary. In the case of electronics, the temporary increase in demand because of working from home and e-learning associated with the lockdowns is most evident in the data. Many people have purchased a computer, tablet or smartphone for telecommuting and e-learning and peripherals such as a video camera or microphone (Unnikrishnan – Figliozzi 2020). Hence, the correlation is between the increased number of new COVID-19 cases and the electronics sales: if new cases arise, lockdown is a logical reaction, which leads to the introduction of home schooling and remote work, and both necessitate electronic devices. However, since these devices are typically durable and do not require replacement every 1–2 years, their impact on sales has only been temporary.

During the pandemic, those involved in e-commerce were most concerned about the long-lasting effects of the changes (Kim 2020; Prymon-ryś 2023). Were these changes caused by COVID-19 permanent enough that e-retailers could rely on them in their business development during and even after the pandemic? From the point of view of scalability, supply chain, logistics, etc., the dilemma is what to expect in times of surge demand caused by the pandemic (O’Leary 2020; Ivanov 2021). Could an e-retailer expect the demand to be sustained, the pandemic to be prolonged, and customer behaviour to change permanently after the pandemic? Without knowing this, what investments were rational for a merchant to make? In this respect, the three product categories showed three distinct patterns:

- the growing number of pet owners promises a sustained increase in the market (unless, in the post-pandemic crisis, owners take their former pet to a shelter, but this was not common). The trend data show that, apart from short periods of stagnation, there has been a steady increase over the three years under study.
- Baby and toddler products are heavily dependent on the birth rate. Still, since the boom predicted after the outbreak has not materialised (as described above), the segment is showing the usual patterns as the pandemic subsides.
- In the market for electronics, we see that these products are often much more durable than pet or baby products. Thus, roughly halfway through the pandemic, growth in the product category has stalled, and even the otherwise traditionally strong Christmas period has brought notably weak sales in 2022.

Our research suggests that the rise in the number of new COVID-19 cases during the pandemic has led to an increase in online sales in the three product categories we studied, which were motivated primarily by fear, in-store restrictions, and convenience. However, a

lasting change was only achieved when this was confirmed by deeper socio-economic trends, which was the case for the animal and pet supplies category due to the increased number of pet owners. The baby and toddler, and electronics product segments were less able to benefit from the lasting effects of the COVID-19 pandemic on e-commerce, with the baby boom missed and interest in electronics declining. However, even with these restrictions, the longer-term assumptions are very uncertain. It is not possible to draw long-term conclusions from the 3-year data series.

6. CONCLUSION

The COVID-19 pandemic heavily affected e-commerce retail segments in Hungary. As seen in the results above, the regulations introduced to decelerate the spread of the virus had a massive impact on the e-commerce sector and product segments. Our research showed that the sales volume of Barion's animals and pet supplies, baby and toddler and electronics segments correlated the strongest with the daily new COVID-19 cases. The pandemic boosted the segments that sold something people needed at home in isolation, and those shops that could adapt to this new situation soared.

What is apparent from the data is that COVID-19 has changed the traditional seasonality of e-commerce, and this was evident in two ways in the research: first, in the fact that the evolution of COVID-19 new cases correlated with the sales for the three examined product categories, and second, in the variation in the annual patterns of consumer interest in each product category (between 2020, 2021, and 2022). We can learn from these research results that the whole e-commerce sector cannot be treated uniformly; different product segments behaved differently during the COVID-19 pandemic. The animals and pet supplies, baby and toddler and electronics segments were more sensitive to the pandemic and presumably to government measures and changes in consumer behaviour. However, even with the same level of statistical correlation with new cases of COVID-19, these product segments showed different trend data (patterns) over the period studied (March 2020 to February 2023). These differences partly reflected the course of the pandemic and the various measures against it, partly related to the general seasonality of these online product segments (e.g. people tend to buy electronics at Christmas) and partly echoed more profound socio-economic changes (e.g., an increase in pet owners in Hungarian society).

The research results can also be used to make recommendations for policymakers and firms in the retail sector. It is challenging to prepare for a pandemic, but humanity may face a similar pandemic in the coming decades (Marani et al. 2021). For this reason, it is worth drawing lessons from existing experience. Our recommendations are based on this research and the general knowledge of the Hungarian e-commerce sector. We have identified three recommendations: creating a crisis scenario for similar situations to support the possible faster scaling up of e-commerce, inclusion of most socially deprived customers, and improving the digital readiness of retailers.

Although there was a strong recovery in the commercial sector as the pandemic subsided, some of the effects of the pandemic proved to be long-lasting. One of the key takeaways for the actors involved is to prepare for sudden changes and the period afterwards, and to adapt flexibly. During physical store closures/restrictions, online shopping is significantly boosted, so the

impact of physical store restrictions can be cushioned by e-commerce. This should be anticipated, but measures should also be taken to facilitate the necessary online transition and upscaling, if necessary, as some of these require investment and longer preparation (e.g. expanding warehouse capacity, upgrading machinery, hiring extra staff, etc.) and others require upfront adaptation. It is worthwhile to prepare in advance a policy crisis scenario that sets out the steps to accelerate upscaling (e.g. facilitating the reallocation of shop workers to warehousing, encouraging workers in tourism, e.g. waiters, taxi drivers to participate in e-commerce delivery, etc.).

Those who do not or rarely shop online otherwise and turn to it because of the pandemic (typically the elderly or people living in small settlements) are usually among the higher health-risk groups in a pandemic. According to Eurostat in 2019, 60% of people aged 16–74 years made at least one online purchase in the EU-27 countries, and only 28% of people aged 65–74 years (Eurostat 2020). E-commerce may play a crucial role in the supply of the elderly, which is why it is vital that, on the one hand, they should be able to order online. On the other hand, an infrastructure that serves them should be available (e.g., a high-quality Internet network, nationwide online food retailers, suitable logistics solutions, etc.), currently primarily concentrated in the larger cities. It is also recommended that programs that strengthen digital literacy in these groups be started, and, if necessary, provide the tools and subscriptions at a reasonable price.

Policymakers must support and encourage retailers who do not have an adequate online presence. During COVID-19, traditional trade was in shock, as it was impossible to switch to online overnight. But in the meantime, four years have passed. Hungarian SMEs' digital readiness and maturity have not improved significantly during the pandemic, despite the forced digitalisation, according to Digimeter, which surveys Hungarian SME digitalisation (Digiméter 2022). It is recommended to launch programs that improve the corporate integration of digital technologies in Hungarian businesses, especially retailers, and enable them to introduce omnichannel solutions competitively (Asmare – Zewdie 2022). The share of online commerce within total retail commerce is around 10% in Hungary (GKID 2022). Hence, for most retailers, the online-only mode of operation is not an option. However, the great lesson of the pandemic is that the hybrid (offline and online) mode of operation, multi- or omnichannel sales can mitigate the loss of traffic caused by physical store closures. However, after the pandemic, customers returned to stores, which have continued to play an important role. Based on all of this, it is recommended that retailers open up to hybrid operation, multi- or omnichannel sales.

We know that there are further important questions to be explored in the field. During our research, we also identified several additional possible research questions. It would be helpful to expand the product categories to those that were not examined due to the initial limitation of our research or because of missing data. It could also be fruitful to extend the period of our study. It would be worthwhile to analyse data before the pandemic and compare it with results during and after it. Since the data before the pandemic was not available during the research, and Barion Payment Inc. changed the data structure at the beginning of 2023, we could not analyse data for a longer time. In addition to data from the supply (retailers) side, an examination of demand (consumer) data could modify the results, for example, how consumer habits have changed, what was temporary and what was permanent (e.g. contactless payment, preferred pick-up and delivery methods, trends in purchase frequency, expansion of product categories purchased online, degree and impact of returning to store shopping, etc.). In addition, the differences between customer groups could be compared (gender, age, education, income, type of settlement, etc.). Finally, the impact of additional phenomena – such as the evolution of

the inflationary environment, which likely also influenced seasonality – could also be examined. However, despite these limitations and further research questions, it can be stated that the research still produced interesting and useful results regarding the effects of COVID-19 on e-commerce in Hungary.

Declaration of interest statement: While writing the first version of this article, the first author worked as a data scientist for Barion Payment Inc. and had access to the data of customers' shopping carts using Barion for online payment. However, all the analyses in this paper were performed on anonymised data. Barion has not influenced the preparation of this article, and the content reflects only the authors' views.

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