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THE INFLUENCE OF COVID-19 PANDEMIC ON ONLINE RETAIL PRICES

Abstract. *The coronavirus 2019 (COVID-19) pandemic had a powerful impact on most economic sectors. Chaotic consumer behavior was one of the consequences and it was probably the most prominent in the retail industry, determined by news about restrictive measures such as lockdowns, the closing of stores and restaurants, and other economic activities. This study is designed to assess the hypothesis that the Government-imposed restrictions related to the COVID-19 Pandemic, in its early stages, had a relatively low impact on online retail prices, compared to the current economic turmoil, determined by abnormally high demand in certain sectors. The article analyzes the fluctuation of online retail prices during the Lockdown and High Alert phases in Romania, and for a few weeks after that, comparing the given timeframe to the current situation, more than a year later, when supply chain disruptions in several markets were observed. During the initial period of high uncertainty, although rare cases of price fluctuations as high as 40% were be observed, the overall market was marginally affected by the COVID-19 Pandemic, with some exceptions, such as electrical and electronical devices. Analyzing the retail industry more than a year later, consumer prices during the month of May 2021 rose at the fastest rate in nearly 13 years, and some policymakers are worried that the hyperinflation of the 1970s is just around the corner.*

Our results point to a low degree of correlation between the rise in demand for certain products and COVID-19 related restrictions. The retailer's decision on adjusting their prices for certain products can indicate either a decrease in demand or the retailer's anticipation of such.

This research was based on the prices of a well-established online retailer, which were weekly monitored for a period of 12 weeks.

Keywords*: Economic, Computation, Cybernetics, Studies, Research.*

JEL Classification: C02, C11, C45, C46, C63

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1. Introduction

The COVID-19 Pandemic, caused by the novel coronavirus SARS-CoV-2, has had an unparalleled impact on all economic sectors throughout the world, causing disruptions in the retail market as chaotic consumer behavior and demand forced retailers to adapt to the new normal by adjusting their prices accordingly.

Many local government restrictions on business activities and resident movement were imposed as attempts to limit and monitor the spread of the virus were made. Stay-at-home orders were issued, schools and restaurants were closed, and only essential services like grocery stores were allowed to remain open in many areas.

Adapting to the government-imposed restrictions, consumers started to turn their attention towards online shopping in order to procure their groceries, canned goods, cleaning products, electronics, or other products for their well-being.

Often regarded as an unprecedented situation, the Pandemic led to surges in demand for certain products (i.e. cleaning products, canned goods) in a very short period of time, leading to higher prices, adjusted to the new supply and demand (Jones, 2020).

As such, our work consisted in identifying the product categories where the online retailer adjusted their prices accordingly, to match the most recent government-imposed restrictive measures. Although we gathered and analyzed prices for all product categories present on the website, our research is focused on the most interesting product categories during the early stages of the Pandemic, such as cleaning products, non-perishable goods, or home improvement items, such as electronics.

2. Literature review

In article (Blundell, Griffith, Levell, & O'Connell, 2020), the authors analyzed web-scraped data collected by the United Kingdom's Office for National Statistics (ONS) during the month of March, in order to determine the impact of COVID-19 related panic among buyers. The study concludes that the online prices of several product categories suffered rapid price changes, such as cough and cold medication (+11%), non-perishable goods such as pet food and rice (+1.1%), and others.

These changes could indicate increased profit margins for the retailer as well as an increase in its costs possibly caused by supply chain disruptions. Study (Akter, 2020) conducted from January to May 2020 examines the impact of COVID-19 related "stay-at-home" restrictions on food prices across 31 European countries. The authors state that such restrictive measures could have serious negative effects on food supply caused by supply chain disruptions and demand caused by consumers engaging in panic buying, both these effects combined leading to higher food prices.

According to this article, increased overall food prices were observed, especially in the following categories: meat, fish & seafood, and vegetables. Little

to no change was recorded for other goods, such as bread, cereals, fruits, oils & fats, and others.

The findings in this paper point to a continuous increase of food prices for certain categories, as long as movement restrictions are in place, mainly caused by the above-mentioned reasons: supply chain disruptions and panic buying.

Paper (Patil & Patil, 2020) studies the effect that the pandemic had on consumers' behavior, focusing on periods of lockdowns when restrictions were the most severe. According to the authors, when the lockdown was announced in India, people rushed to buy essential goods, medication, face masks, and sanitizers fearing that the stores will run out of stocks. The article provides evidence that approximately 85% of consumers changed their behavior in a significant manner during the imposed lockdowns, food items being at the top of their shopping preferences.

Among the top reasons for the sudden change of consumer behavior was their perception of the pandemic situation leading to fear and uneasiness and willingness to accumulate stocks of food. Article (Wang, An, Gao, Kiprop, & Geng, 2020) analyzes consumer food stockpiling behavior, including the change of food reserve scale and willingness to pay for fresh food reserves in COVID-19. According to this study, the scale of food reserve extended on average from 3 and a half days to almost 7 and a half days after the pandemic outbreak, possibly caused by a motivation to avoid shortage and subjective risk perception.

The paper also analyzes consumers' willingness to pay increased prices for fresh food reserves during the COVID-19 pandemic, stating that consumers may pay up to 60% more for a package of fresh food reserves. According to the authors, during an emergency such as the current pandemic, food demand increases dramatically in a very short period and governments should be prepared for such situations and adjust the food inventory accordingly, in response to demand shocks during emergencies.

In (Stanciu, Radu, Sapira, Bratoveanu, & Florea, 2020) the authors analyze the shift in Romanian consumers' behavior during the Coronavirus pandemic, as news of lockdowns and restrictive measures were announced. Although Romania had a lower infection level than many Western countries, the imposed restrictions were similar, leading to abnormal buying patterns.

The observed tendencies indicate consumers turned their attention to mainly buying personal care products (+65,6%) and food items (+42%), followed by other product categories such as home attending (+23,4%).

In paper (Coibion, Gorodnichenko, & Weber, 2020), the authors performed a customized survey with more than 10,000 respondents, addressing the issue of consumer spending during the COVID-19 pandemic. The study finds that the average consumer spends 31% less money during COVID-19, mainly caused by unemployment or people's increased uncertainty. Analyzing the breakdown of consumer non-durable spending and comparing it to the pre-crisis situation, the authors observed a significant decrease in spending money for paying debts (such

as mortgages, student and auto loans), transportation, travel, entertainment, and clothing, while medical expenses and food expenses also decreased but by a lesser margin.

3. Methodology

In order to determine the impact that the pandemic has had on the retail industry, we gathered data regarding retail prices for a wide variety of products, as offered by a large Romanian retailer, on their official online shop page. The time period that we concentrated our efforts on is during the month of May, which included two major events:

- May 4th, 2020 - President of Romania announces that the High-Alert phase will not be extended. The new alert phase will start on May 15th
- May 15th, 2020 - The first day of the new Alert phase, a more relaxed version of the High-Alert Phase.

Another important moment identified is June 1st, 2020, when the retailer updated a large number of their prices, a fact that can indicate a monthly price adjustments policy.

The data was usually gathered every Monday, but during the month of May, we decided to use the scraper solution on numerous occasions, given the political dynamic that was happening in Romania at the time.

3.1. General description of the methodology

In order to analyze the data regarding retail prices that we've gathered, we performed several automated tasks so that all the information that we held followed the same structure.. This process, also known as data curation, consisted in the following specific processes:

- Updating the products database with new price data, including:
  - Final price of the product
  - The old price of the product, in case there was an ongoing offer
  - Timestamp
- Perform a check on products that were no longer listed by the retail in their store, according to the new scraper data, and flag them accordingly, including data such as:
  - Last known price of the product
  - Last known timestamp of the product.

By using the said approach, we were able to remove irrelevant products to our analysis, by using a date filter. For example, if we aimed at performing analysis for the month of May, we were able to select only the products for which we have price data for all scraping days. This removed the risk of generating incorrect aggregates for a product category if, for example, one of the products went missing from the retailer's website on the second scraping day and counted towards the

aggregate with a price of 0 lei. We also considered trying a different approach, by setting the last known price of the product to be the actual price, but we eventually disregarded the idea, as we could afford to remove a small chunk of our products database, given our big number of products scraped (2509).

After thorough analysis, we decided to concentrate our efforts on the month of May, where the most important political events, regarding the COVID-19 Pandemic, happened. As such we analyzed price data and fluctuations for approximately 1400 products, divided into categories, such as "Electronics" and subcategories such as "Refrigerators".

3.2. Scraper

For acquiring the data needed, we developed a custom Scraping solution used for gathering the prices from the online retailer's official store. Getting the data directly from the retailer instead of acquiring it through third-party marketplaces, indicates a certain degree of veracity to the price values obtained. This may especially be true during pandemic times, when the urban population relies on online shopping for a range of their needs, including groceries and perishable goods, and so the retailer must update their online prices to reflect their in-store prices more frequently.

The scraper solution is used in conjunction with a custom data analysis tool, which takes the historical prices for a product or a series of products (i.e.: category/subcategory) and outputs valuable information such as relative and absolute price change or the date with the most dramatic price change.

Acquiring the historical prices for a certain product was achieved using a cron-job that was set to run every Monday or when specifically triggered (i.e.: on certain days with important political events). The job consisted in running the scraper solution for getting the data and then storing it in a NoSQL database for persistence. This approach also proved to be of great help when scanning the data for scraping errors and price values inconsistency.

The pagination module for the scraper was also manually implemented by the authors, as can be seen in the code fragments presented below.

Products were scraped in two ways:

1. By parsing the category/subcategory tree structure provided by the retailer
2. By searching for certain important products, such as "flour", "disinfectant" etc.

The scraper uses Axios for getting the HTML of a certain page (such as the search results page or the individual product page) and cheerio for extracting text from the webpage, by using a familiar jQuery-like selector (i.e.: $('#product-price')).

```
const getProductInfoFromHtml = (html) => {
  const $ = cheerio.load(html);
  const details = $(".product.details.product-item-details");

  const name = $("strong.product.name > a", details).text().trim();
  const hyperlink = $("strong.product.name > .product-item-link", details).attr(
    "href"
  );     const finalPriceString: string
  const finalPriceString = $(
    ".price-box.price-final_price span[data-price-type='finalPrice']"
  )
    .text()
    .trim();
  const oldPriceString =
    $(".price-box.price-final_price span[data-price-type='oldPrice']")
      .text()
      .trim() || null;
  const priceStrings = {
    finalPrice: finalPriceString,
    oldPrice: oldPriceString,
  };
  const finalPriceValue = helpers.getPriceValueFromString(finalPriceString);
  const oldPriceValue = helpers.getPriceValueFromString(oldPriceString);
  const priceValues = {
    finalPrice: finalPriceValue,
    oldPrice: oldPriceValue,
  };

  return {
    name,
    hyperlink,
    price: {
      strings: priceStrings,
      values: priceValues,
    },
    created_at: new Date(helpers.timestamp()).toLocaleDateString(),
  };
};
```

Figure 1. For every identified product, the scraper gets the content from the respective HTML as a string.

The scraper takes sale prices into account, storing both retail and discounted prices. A timestamp is also created each time the info of a product is stored in the database.

For the complete scraping solution, contact us at bogdan.posedaru@csie.ase.ro.

4. Research Hypothesis

Our primary goal was to assess the impact of the pandemic-related government measures in the retail industry, as such restrictions have a powerful

psychological impact on the consumer, causing abnormal fluctuations in demand for certain types of products. [0] states that in the USA, sales rose by a very large margin for a series of products in March 2020 compared to March 2019, such as disposable gloves (+670%), bread machines (+652%), non-perishable goods like canned soups (+397%) or rice and dried grains (+386%). The time frame coincides with the early stages of the pandemic, when President Trump signed the Coronavirus Preparedness and Response Supplemental Appropriations Act (March 6th, 2020) or when President Trump declared a national emergency.[20]

However, the psychological factors associated with the early stages of the COVID-19 Pandemic did not have such a powerful impact on the overall markets. By comparing the Consumer Price Index (CPI) for August 2021 and for August 2020, it can be observed that the general rise in consumer prices has begun much later, pointing towards a delayed effect of the Pandemic on the world's economy.

Hypothesis: Government-imposed restrictions related to the COVID-19 Pandemic, in its early stages, had a relatively low impact on online retail prices, compared to the current economic turmoil, determined by abnormally high demand in certain sectors.

5. Statistical Data

A certain degree of impact was observed for every major event that happened during the analyzed period (May 4th - June 1st, 2020):

- May 4th, 2020 - President of Romania announces that starting May 15th, the restrictions will be relaxed
- May 15th, 2020 - The first day of the Alert phase, with relaxed restrictions
- June, 1st 2020 - The first day of the month, with a large market fluctuation, indicating the updating of the retailer's prices policy.

Figure 2. Total Market Value evolution in May 2020.

As can be seen from **Figure 2**, the total market value has suffered a minor depreciation around May 14th, when the High Alert Phase ended, and a severe loss on June 1st, when the retailer updated their prices policy. This could indicate a direct correlation between the retail prices and the political events and restrictive measures in regards to the Pandemic.

Another interesting observed fact is that the market tends to fluctuate more in response to the political events: a very high number of products' prices (191) have been adjusted immediately after the President's announcement that the National Emergency will not be extended, followed by a large number of products (86) on the day that the National Emergency has actually ended. In contrast, on the next scraping day, May 18th, 2020, the prices have been updated for only 14 products.

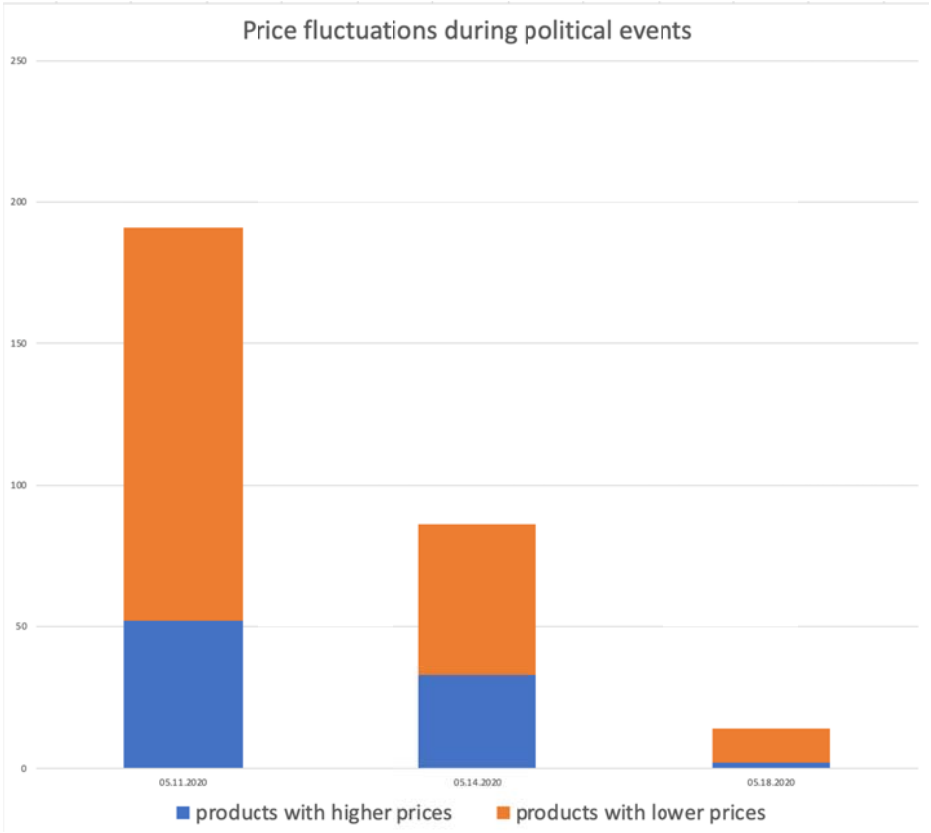

Figure 3. Price fluctuations during political events, May 2020.

Certain product categories such as electronics were sold at lower prices in response to the actual relaxation of restrictions (14-15 May 2020), which indicates a lower demand for said products, as opposed to the abnormally high demand during the early stages of the pandemic. The trend is maintained for June 1st when the whole category market value was 8.64% less than before any of the events happened. One very interesting thing to mention is that besides the moments around the two major events, the prices have been relatively steady, fluctuating by a maximum of 0.36 percentile points.

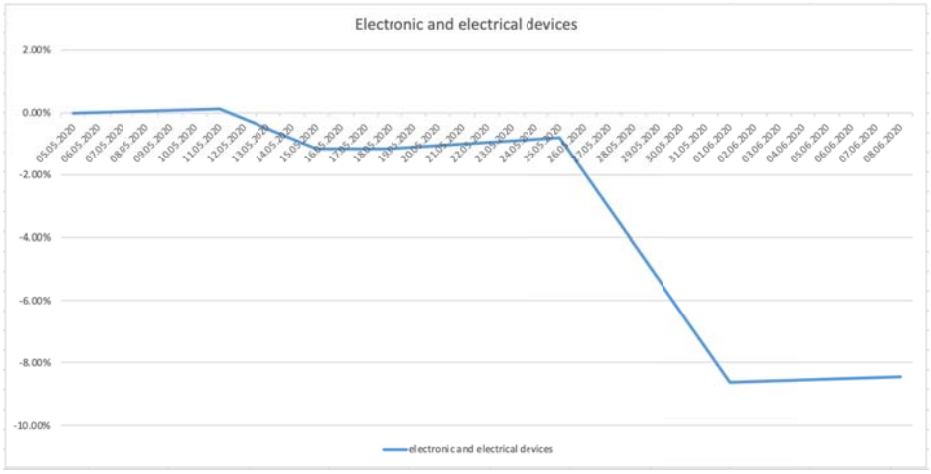

Figure 4. Electronics market evolution in response to the political events.

Another interesting category evolution is for canned goods, including canned meat and canned vegetables in the analysis. The category had a minor fluctuation during the actual relaxation of the restrictions but suffered a great loss when the retailer mass-updated their prices (-4.03%). This could again indicate that during the previous months (when the restrictions were more severe), the demand for canned goods rose unexpectedly and so did the prices, but after the restrictions were lifted, consumers returned to their normal buying behaviors, so the demand lowered by a large margin.

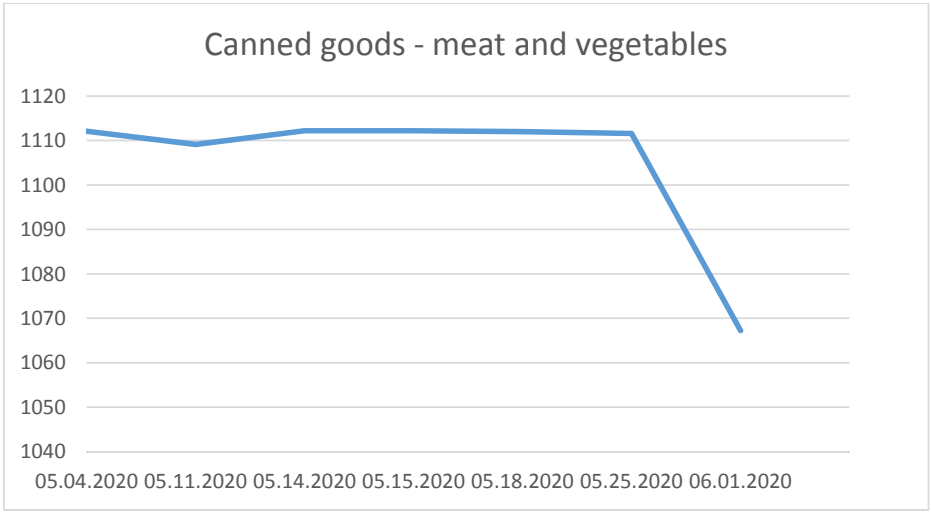

Figure 5. Canned goods market evolution during May 2020.

As was the case for electronic goods, apart from the three major political events, no fluctuation was observed, the total market value for the last scraping day of May (May 28th) being almost the same (-0.05%) as on May 15th, when the alert phase, with moderate restrictions, began.

Perhaps one of the most chaotic product categories during the early stages of the pandemic, home detergents follows the same trend during the month of May: overall, the products were sold at lower prices immediately after the President's announcement and then again on June 1st, so the moments coincide with the political events.

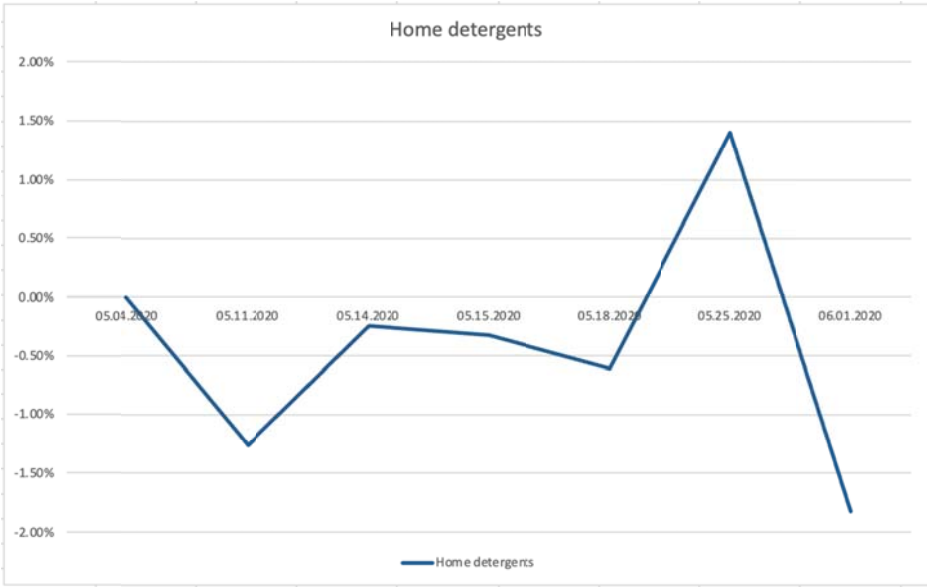

Figure 6. Home detergents market evolution during May 2020.

One interesting trend that was observed in this particular product category was the number of times the products were on sale, with an advertised lower price. This statistic was only possible because we also stored this information during the scraping phase.

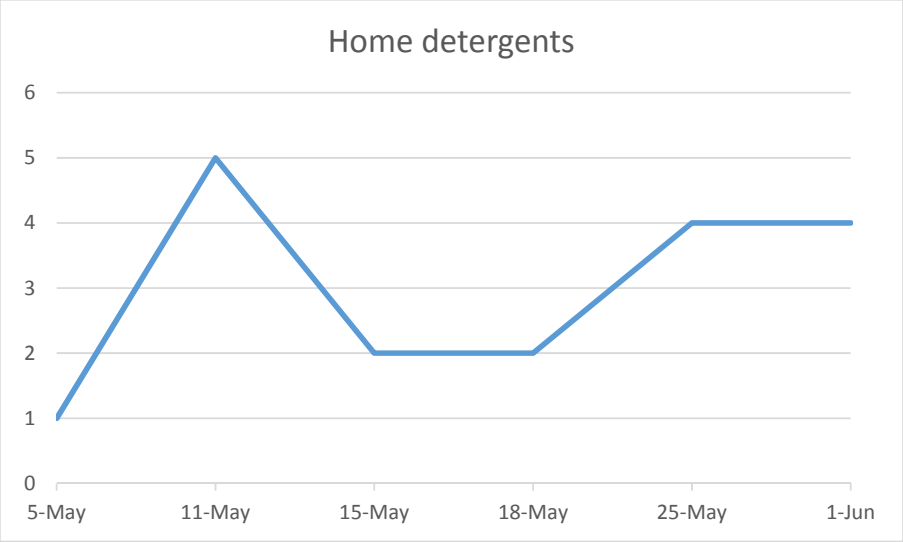

Figure 7. Number of discounted items in home detergents category.

As shown in **Figure 7**, on May 5th, when the first data was obtained, we noticed there was only one product on sale, but immediately after the announcement of relaxation of restrictions, the retailer decided on reducing the price for 5 products, but only temporarily, as the prices got back to normal after the actual beginning of the alert phase.

There were a number of product categories that seemed unimpacted or only slightly impacted by the political events and government-imposed restrictions, such as dairy products.

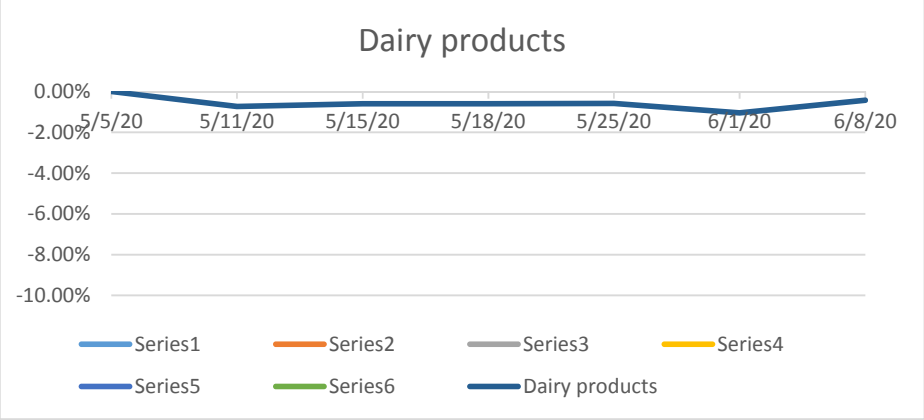

Figure 8. Dairy products category - steady market value despite the political events

Given that demand for dairy products was not as chaotic as for other categories, such as electronics, the steadiness of the market strengthens our idea that the political events and government measures have a variable degree of impact on the retail industry, depending on the product category.

Another perspective is provided by dividing the products into two categories: food and non-food items. The food items section consists of several subcategories, such as dairy products, vegetables, fruits, eggs, groceries, canned goods and sweets, while the non-food items included products from subcategories such as electrical and electronic devices, household items or cleaning products.

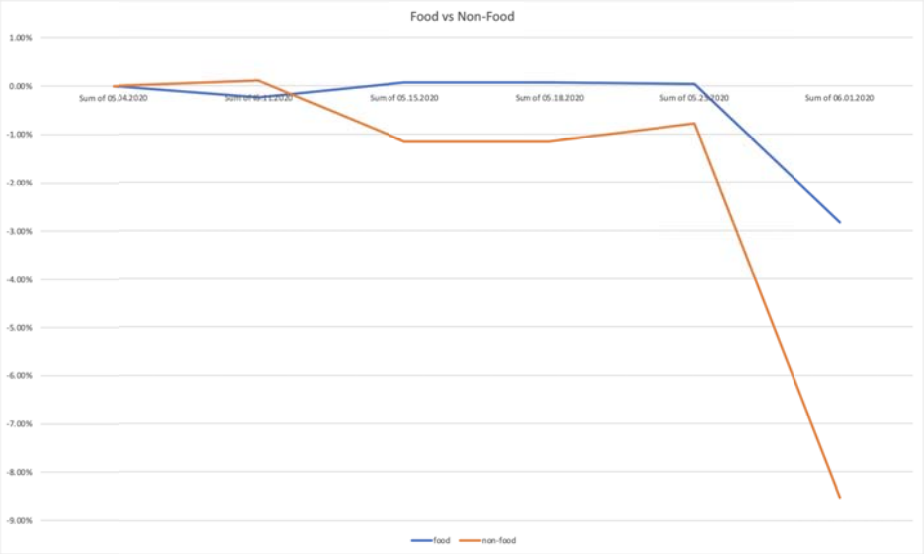

Figure 9. Food and Non-food items market evolution during May 2020.

During the aforementioned political events, food and non-food items reacted in an opposite way: immediately after the announcement, food items market value was 0.24% lower, while non-food items market value was 0.12% higher, but when the actual relaxation began, the trends have inverted: non-food items were sold at lower prices, while food items at higher prices.

Finally, on June 1st, with the retailer's price policy update, both categories' overall market value was much lower (-2.83% for food items and -8.52% for non-food items).

More than a year after the coronavirus outbreak, the world is still struggling with the consequences. Many countries mandated temporary closures of non-essential stores, bars, and venues during the pandemic's peak, as well as prohibiting large public gatherings and urging individuals to work from home if possible. As vaccination rates rise, this is gradually easing.

Even after such a long time since the pandemic outbreak, the markets are still characterized by instability. As such, consumer prices during the month of May 2021 rose at the fastest rate in nearly 13 years , and some policymakers are worried that the hyperinflation of the 1970s is just around the corner.

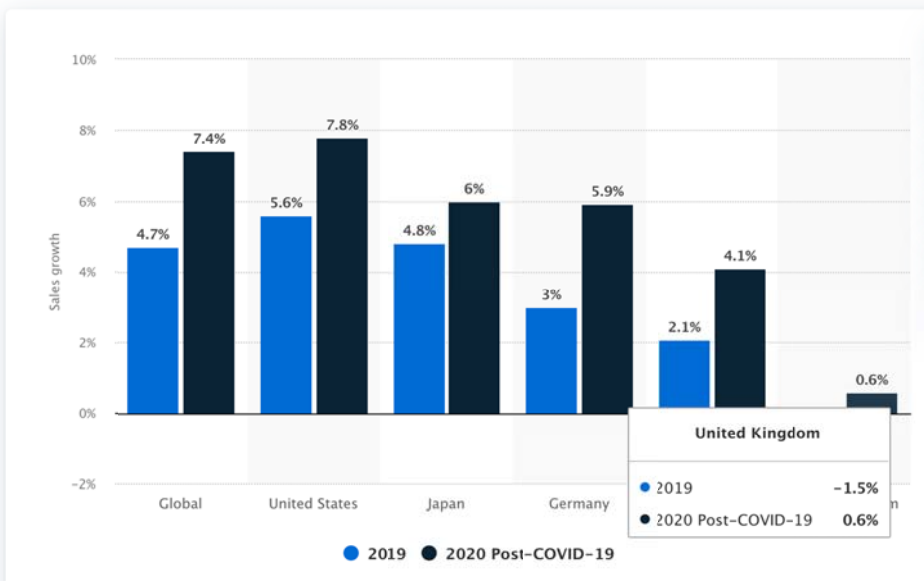

Figure 10. Sales growth in edible groceries worldwide in the pre- and post-COVID-19 period in 2020, by market (Statista.com)

Today's price increases are real: the cost of everything from timber to food to airfares is increasing, and industries are reporting material and labor shortages. However, many, if not all, analysts believe the price hikes are only transitory, owing to the economy's rapid recovery as the virus fades rather than long-term supply concerns.

The majority of price increases in April and May were for high-ticket items like cars, furnishings, and appliances. According to Capital Economics, just three primary categories — used automobiles, new cars and trucks, and furniture — account for more than half of the increase in the price of products since January 2020.

Those increased prices are partly due to timing. Most Americans are ready to spend, owing to federal stimulus packages and tax returns, particularly on major purchases that they had put off during the pandemic.

Yet, in many cases, stocks are low - there aren't enough unsold products to last a year. Last year, factories shut down for months at a time.

Given the current situation, manufacturers are struggling to create and ship everything now that client demand is rapidly increasing.

6. Interpretation of Data

Given the size of the dataset we used for this study, it was critical that we test a variety of approaches to understanding the retail industry by arranging the data in different ways. We were presented with several opportunities for structuring the products into multiple categories because the initial data collection process was designed in a flexible manner, including many meta information about the products such as category and subcategory or whether the product was on sale or not.

By dividing the products into food and non-food items, which included subcategories such as electrical and electronical items or household items, we noticed a significant difference between their prices' evolution.

Regarding food items, price was not significantly affected, indicating an inelastic demand and a lack of shortages, the market presenting no potential for speculation.

In the case of non-food items, online retail prices fluctuated considerably, with the most significant change occurring on June 1, 2020, a date justified by the online retailer's price policy updates. As a result, non-food products had a general price decline of 8.32% (compared to the first observed price, on May 4th 2021), although with substantial differences across subcategories. Prices for detergents and other household commodities exhibited almost no change, indicating inelastic demand and no supply chain disruptions, as shortages affecting the market would have led prices to rise.

Some of the non-food products indicator's components had a big impact on the drastic drop: electronic and electrical devices had a substantial price drop of 8.47 % compared to the first observed prices on May 4th, 2021. This could imply a drop in demand or the retailer's expectation of a drop in demand. In the first example, this might be justified by the fact that the people who are most financially affected by the epidemic make up a large portion of the market for said products. In the second scenario, retailers predicted a drop in demand in the next sales cycle as a result of the pandemic's influence on their most frequent consumers' revenue streams. If this is the case, their interpretation was incorrect, as the epidemic caused substantial supply issues in the months following, resulting in scarcity for complex goods.

On the other hand, without actual sales data, we cannot accurately select one of the two explanations.

7. Conclusions

Our paper examines the evolution of online retail prices in a time of high uncertainty and unpredictability caused by the outbreak of the COVID-19 Pandemic. As a result, starting on May 4th, 2020, we obtained extensive data about products and pricing from Carrefour Online, one of Romania's leading online retailers.

We examined the collected data and attempted to structure and divide the products by a number of features, such as food and non-food items, in order to gain

better insights into the economic condition in the provided timeframe. Because the influence of the Pandemic on retail pricing varied greatly according to the nature of the product and its intended use, this has proven to be a critical step in completing our research.

Structuring the products by category, we were able to identify several aspects of considerable interest. As such, we observed little to no variation in regards to the online retail prices for frequent use goods, such as household items and foodstuffs. This indicates that there was no shortage of supply for said products, no disruptions in their supply chain and no Pandemic-related indirect effects.

Analyzing the electrical and electronic products, a high degree of variance was observed: the online retail prices for products in these categories manifested a downward trend, either based on objective (i.e.: decreased demand) or subjective factors (i.e. anticipation of such decrease), but which of these two we cannot state with certainty, without access to actual sales data.

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