The impact of the COVID-19 pandemic on grocery shopper behaviour: Analysis of shopper behaviour change using store transaction data

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Abstract
The systemic shock of coronavirus (COVID-19) and its impact on the global economy has been unprecedented with grocery shopper behaviour changing dramatically through various stages of the pandemic. COVID-19 has caused unusual market conditions, with significant changes to grocery shopper behaviour that need to be understood to allow for appreciation of shopper behaviour change and retail planning implications during future systemic shocks. The aim of this study was therefore to understand grocery-shopping behaviour during COVID-19. Specific objectives were to investigate changes to grocery sale patterns by basket size, composition and category, as well as during specific time periods of the pandemic. The use of transaction data using a range of market basket indicators (e.g., value, size, product mix), revealed profound changes that indicate the challenge shoppers faced navigating a new ‘normal grocery shop’ and the pressure on retailers to analyse consumption changes in order to prioritise demand planning. While the use of this data and analysis approach is an important contribution to consumer behaviour research, our focus was on the bigger patterns observed through the data pertaining to changes in shopper behaviour during systemic shocks. A key contribution of this paper is how the use of transaction data from grocery retail provides a nuanced understanding of how grocery shoppers responded leading up to and during the pandemic. For example, we found that grocery shoppers purchased more than just ‘daily staples’ to stock-up during the pandemic, with increased awareness of health and wellbeing an important aspect.

Keywords: consumer behaviour, COVID-19, shopper behaviour, transaction data

INTRODUCTION

In 2020, the COVID-19 coronavirus swept across the world impacting economies, changing societies and taking lives. As the disease spread, governments reacted to try to attenuate its spread using interventions such as social distancing and lockdowns. These measures led to dramatic changes in shopper behaviour across the grocery retail market such as panic buying, growth in online shopping and greater volumes of certain grocery categories being purchased (Martin-Neuninger & Ruby, 2020). While these broad and seismic shifts in grocery-shopping behaviour have been well documented in a range of literature dealing with hoarding and stockpiling in times of perceived scarcity of supply (Gupta & Gentry, 2019; Yoon et al., 2018), less attention has been given to changes in shopper behaviour in response to global systemic shocks of the pandemic.
shocks such as COVID-19 (e.g., grocery expenditure, frequency of shopping trips, basket size and mix; Martin-Neuninger & Ruby, 2020).

COVID-19 has left grocery shoppers with the challenge of navigating a new ‘normal grocery shop’, while also putting food retailers under pressure to prioritise demand planning. Pantano et al. (2020) call for food producers and retailers to be involved ‘in supporting the economy to cope with emergency-induced changes in demand’ (p. 116). Anecdotal evidence from market reports suggest that COVID-19 has caused unusual market conditions, with significant changes to grocery shopper behaviour that need to be understood to allow for appreciation of shopper behaviour change and retail planning implications during future systemic shocks (Mintel, 2020). Due to recency of this societal shock, limited academic research exists in understanding how shoppers have reacted to the COVID-19 pandemic and the implications for understanding consumer behaviour during systemic shocks. Particularly, time-bound periods of cyclical demand in grocery consumption during pandemics become pertinent, where shopper transaction data from retailers can support academics and other stakeholders in better understanding this phenomenon. While COVID-19 may be viewed as a ‘systematic shock’, this paper purports that it is important to gain a nuanced understand how shoppers responded during the pandemic in terms of their basket size and mix along with category implications. The aim of this study was therefore to understand grocery-shopping behaviour during COVID-19. Specific objectives were to investigate changes to grocery sale patterns by basket size, composition and category, as well as during specific time periods of the pandemic.

The use of transaction data using a range of market basket indicators (e.g., value, size, product mix), revealed profound changes that indicate the challenge shoppers faced navigating a new ‘normal grocery shop’ and the pressure on retailers to analyse consumption changes in order to prioritise demand planning. While the use of this data and analysis approach is an important contribution to consumer behaviour research, our focus was on the bigger patterns observed through the data pertaining to changes in shopper behaviour during systemic shocks. With many consumers experiencing fear and rushing to purchase food staples, consumption trends were radically changed (Zwanka & Buff, 2020). A key contribution of this paper is how the use of transaction data from grocery retail provides a nuanced understanding of how grocery shoppers responded leading up to and during the pandemic. The ability to predict the heterogeneity of shopping trips in retail outlets allows for better planning and better understanding of shoppers involved in different types of shopping trips (Sorensen et al., 2017).

It also allows for a nuanced understanding of these changes, by basket size and composition and category for example. For example, we found that grocery shoppers purchased more than just ‘daily staples’ to stock-up during the pandemic, with increased awareness of health and wellbeing an important aspect. Interestingly, shoppers practical considerations of healthy food benefits reveal that fear is not the only factor in play for grocery shoppers during the pandemic, as previous research has tended to focus on. Future considerations from this study pertaining to systemic shocks, pertain to the importance of understanding how key shopper behaviour indicators such as basket size and composition are important. Further, changes in shopper behaviour are more nuanced than stockpiling staples as previous research has tended to focus on. To illustrate, recent reports reveal how consumers definition of a ‘healthy diet’ is evolving and now incorporates much more than standard nutritional claims such as ‘low fat’, ‘low calorie’ and ‘low salt’ (Mintel, 2020). This has been accentuated by COVID-19, with the consumption of ‘five a day’ being prioritised by consumers since the start of the pandemic. The findings of this study corroborate this, revealing an increase in demand for fruit and vegetables.

2 | THEORETICAL BACKGROUND

Historically, systemic shocks have had a significant impact on consumption patterns, with consumer behaviour changing to respond to socio-economic disruption and concern caused by the shock (Mathur et al., 2003). This has been noted after several events such as earthquakes in places such as New Zealand, terrorism events such as 9/11, tsunamis in Thailand, Indonesia and previous pandemics such as the SARS virus (Larson & Shin, 2018). Despite this, while the impact of event-induced stress has been studied widely, limited research attention has been given to the impact of major global and systemic shocks upon grocery-shopping behaviour. Research suggests that the most common psychological reaction to systemic shocks such as natural disasters is fear, which in turn leads to radical changes in shopping behaviour (Larson & Shin, 2018). The inherent fear factor impacts how consumers experience and respond to their grocery shop during major systemic shocks (Baker et al., 2020). Mathur et al. (2006) studied the relationship between life events experienced by individuals, resultant stress and lifestyle changes and changes in consumption and brand preferences. They found that changes may be viewed as the outcome of adjustments to new life conditions and changes in consumption lifestyles, which reflect consumer efforts to cope with stressful life changes. For example, scarcity has led grocery shoppers to stockpile food products such as staples like pasta and rice (Gupta & Gentry, 2019). As Yangui et al. (2016) found perceptions of low-control and high uncertainty motivated grocery shoppers to stockpile staple food products. Watson and Spence (2007) offer four appraisals that appear capable of implicating specific emotions and their effects on grocery shopper behaviour, namely: outcome desirability that encompasses pleasantness and goal consistency; agency which includes responsibility and controllability, fairness and certainty. Such cognitive food shopper appraisals affect information processing extensiveness.

In the COVID-19 context, it would be expected that fear would significantly influence grocery shopping outcome desirability negatively, with agency diminished due to a lack of control and perceptions of grocery product stockouts. Martin-Neuninger and Ruby (2020) in the context of COVID-19 define stockpiling behaviour in response to a loss of control as ‘panic buying’. They go on to describe this behaviour as ‘a common response at times of fear and uncertainty’, which
can be deemed as either rational (e.g., stockpiling goods in limited supply) or irrational (e.g., stockpiling non-essential products not in limited supply). COVID-19 was a major systemic shock and life event that was generational in nature, where the general populace of countries globally reacted within roughly 2 weeks of being aware of the virus’s presence in their country, to begin a stock-up mentality (Zwanka & Buff, 2020). With many people feeling ‘caught off guard’, following a rush to stock-up on relevant medical products, the buying patterns turned to the stock-up of grocery staples. Nicola et al. (2020) noted that, ‘panic-buying resulted in an increase of £1bn worth of food in the UK homes’.

In turn, grocery retailers have tended to respond by pursuing sourcing strategies to respond quickly to stockpiling in anticipation of supply disruptions (Yoon et al., 2018). The challenge for grocery retailers and for shoppers is that while preparatory shopping may be an imperative task to complete during systemic shocks, issues such as retail crowding and difficulty in completing purchases become unavoidable (Larson & Shin, 2018). Therefore, grocery retailer accessibility and how easy it is to complete food purchases safely and quickly becomes highly relevant to shoppers during major global events. However, a limitation in current knowledge is the lack of research that has studied time-bound transaction data from retailers during the time period of the COVID-19 pandemic. Further, although a significant focus of current sales and market research is centred around ‘shopper missions’ and ‘category management’, relatively little work has looked at the impact of a systemic societal shock in these areas (Sarantopoulos et al., 2016). The implications for our understanding of grocery shopper behaviour during systemic shocks and for retail planning to respond are significant to advancing knowledge in this area of consumer behaviour research.

This paper addresses this knowledge gap by studying the impact of the COVID-19 pandemic on grocery-shopping behaviour using retailer transaction data. Considering changes over time to baskets and categories to allow a more nuanced understanding of how systemic shocks impact shopper behaviour.

### 2.1 | Research questions

This study investigates the behaviour of grocery shoppers leading up to and during the COVID-19 global pandemic, using transaction data from a UK grocery retailer. Stemming from the literature discussion and study aim, the following research questions were posed:

1. Did grocery sale patterns change during the COVID-19 pandemic?
   If so, then:
   a. Did grocery sales per category change?
   b. Did shopper numbers change?
   c. Did basket values change?
   d. Did basket size (number of items) change?
   e. Did basket mix (types of items) change?
2. When did grocery-shopping patterns change during the COVID-19 pandemic?

### 3 | METHODOLOGY

The grocery transaction data were collected from a grocery retailer based in the UK region of Northern Ireland over 10-week period (week 6-15); at two time periods pre-COVID-19 (week 9–15, 2019) and (during COVID-19, week 6–15, 2020). The full timeline with key dates is presented in Table 1. The data were collected as part of a commissioned piece of research by the grocery retailer to understand shifts in shopper demand and enable support for retail planning in response to future shock situations. Sales data were captured across all product categories. All transactions were included within the data reflecting normal purchasing behaviour as opposed to loyalty card data, which only reports the transactions of shoppers signed up to the programme. From a privacy perspective, the data used in this study cannot be matched to any information on an individual buyer. The final dataset included a total of 83,652 baskets over a 2-year period (a mean of 4182 baskets per week across both sample periods). Data were anonymised and the grocery store used for sampling will remain confidential.

#### 3.1 | Data sourcing and cleansing

After consolidation, the information analysed totalled over four million data points. This was equivalent to 10 weeks of transactions in 2019 and the same 10 weeks in 2020 running up to and into pandemic lockdown.

#### 3.2 | Data range

The data for this study were initially extracted from 3 February 2020 (Week 6) to 14 April 2020 (Week 17). Analysis of the data showed

| Week commencing (Week) | Events |
|------------------------|--------|
| 3 February 2020 (6)    | Initial COVID-19 coronavirus cases reported in the UK |
| 10 February 2020 (7)   | UK Government warns of ‘a serious and imminent threat to public health’ |
| 17 February 2020 (8)   | Public Health Agency confirm testing underway in NI but no cases found |
| 24 February 2020 (9)   | First case reported in NL. Google Searches for ‘coronavirus’ in NI increase |
| 2 March 2020 (10)      | First death from coronavirus is confirmed in the UK |
| 9 March 2020 (11)      | Cases in NI reach 45. Events cancelled |
| 16 March 2020 (12)     | First recorded death from coronavirus in NI |
| 23 March 2020 (13)     | UK Government issues UK ‘Stay at Home’ (lockdown) guidance |
| 30 March 2020 (14)     | Cases in NI pass 1000 |
| 6 April 2020 (15)      | Cases in NI pass 1500 |
significant variations in Weeks 16 and 17 between 2019 and 2020. Research indicated these variations were due to the date of Easter which, as the store location used for the sample sees an influx of seasonal visitors, affected the sales data. Therefore, results used for the comparison covered weeks 6–15 for both 2019 and 2020, a timeline of which can be seen in Table 1.

3.3 | Data cleansing

Generally, the data were found to be of a good quality with some minor challenges around unclear coding of product names. A thorough cleansing process was performed to prepare the data for future analysis.

3.4 | Data analysis

Once data were sourced and cleansed, the initial research questions were addressed through the steps described below.

- a. Chronological analysis. Time-based analysis of sales was then carried out and compared to coronavirus awareness (as measured through Google Trends analysis of searches for the topic ‘coronavirus’ at U.K. level).
- b. Analysis of total sales and total basket spend. An initial total sales comparison by year was carried out.
- c. Analysis of category sales. A more detailed analysis of the sales per category was performed.
- d. Basket size per week. The average basket size per week was then calculated from the mean sales across the transactions per week.
- e. Analysis of basket size distribution. The distribution of basket (Transaction) size was initially examined.
- f. Basket analysis: Association rule mining. An important part of the review was understanding the relationship between which items were bought together and how this changed during lockdown.

4 | FINDINGS

Using the final cleansed dataset, which accounted for a total of 370,908 transactions across a 10-week shopping period, each proposed research question was addressed.

4.1 | (RQ 1) Did grocery sales change during the COVID-19 pandemic?

Results compared the average sales between 2019 and 2020 during the studied period. To do so, a t-test was performed obtaining a p-value of .046 and therefore, at a standard significance level of .05, it is possible say that there exists a statistically significant difference in the average sales during the total period or during the pre-lockdown period.

However, year on year results showed a 5.56% increase in total revenue sales during the lockdown period. To see if this increase is statistically significant, we performed the same t-test as before when only considering data from the lockdown period (i.e., week 13 onwards). The p-value obtained was .046 and therefore, at a standard significance level of .05, it is possible say that there exists a statistically significant difference in the average sales between 2019 and 2020 during the lockdown period.

4.2 | (RQ 1.a) Did grocery sales per category change during the COVID-19 pandemic?

Further analysis of the total revenue sales between 2019 and 2020 showed that this overall revenue growth was driven by increases across key product categories. Results revealed that the specific categories which showed substantial growth included: pasta (+509%), cleaning materials (+268%), paper products (+252%), meat (+186%; Figure 1).

We further breakdown the annual sales growth within each category across the two 10-week study periods in 2019 and 2020. Results supported insights from Research Question 1 and revealed that in Week 9 (announcement of the pandemic) sales fell and in Week 13 (lockdown period) sales rose (Table 2).

To further analyse this question, we performed three t-tests on the average sales per category, a first one considering the whole studied period a second one that only considered data from the lockdown period (week 13 onwards) and a third one considering data from the pre-lockdown period (weeks 6–12). It is possible to observe that, at a significance level of .05, there are some key products for which the average sales differ during the whole studied period in different years. However, once the lockdown started, we can also notice a change in this trend, where the average sales of some products show a statistical difference between different years. For example, during the whole lockdown period consumers bought more pasta, pulse/rice, red meat, ready meals, bacon, squash, cakes, chicken, crisps, salad, poultry, hot snacks and sandwiches.

Finally, for some grocery products, we can observe a statistical difference in the average between 2019 and 2020 only during the pre-lockdown period. For example, salads, fruits, dairy, cakes or sugar. Note that several more tests were performed but only relevant products are included (Table 3).

4.3 | (RQ 1.b and 1.c) Did shopper numbers and basket values differ during the COVID-19 pandemic?

Within the data sales fell between week 7 and 9 indicating that it was driven primarily by a decrease in transactions (or basket numbers per day). As the pandemic progressed, shopper numbers stabilised before falling sharply again, once the ‘stay at home’ message was released by
the UK government. The key change later in the pandemic was the fact that average basket size rose dramatically once lockdown was announced. Results showed a significant change in the average of the shopper numbers \( (p = .027) \) between 2019 and 2020. A change which more than compensated for the fall in shopper numbers (Figure 2).

The dramatic increase in basket value seen in the three final weeks of the study (week 12–15), the period under which lockdown conditions were enforced, indicated two distinct transaction trends. The first was a general increase in basket size (number of items per basket) across the measured transaction period. Although the most frequent basket value remained between £1.00 and £3.00 there was a general increase in the frequency of basket sizes above £10. The second notable change was a sharp increase in baskets with a value above £30, rising from 1% of baskets in 2019 to over 7% of transactions in 2020. Results highlighted a significant difference in basket values \( (p = .026) \) between 2019 and 2020 (Figure 3).

Further analysis was made to check if there exist a statistical difference between the average basket size between 2019 and 2020 for the same time period. The result of the t-test performed indicated a significant difference \( (p = .0241) \) between the average basket for both periods.

### 4.4 (RQ 1.d) Did basket size (number of items) differs during the COVID-19 pandemic?

One key driver behind the increase in per basket spend was the growth in items per basket with the average numbers of products in a shop rising from around three to over six once lockdown was implemented (week 13; Figure 4).

Further analysis was made to check if there exist a statistical difference between the average basket size between 2019 and 2020 for the same time period. The result of the t-test performed indicated a significant difference \( (p = .0241) \) between the average basket for both periods.

### 4.5 (RQ 1.e) Did basket mix (items bought together) differs during the COVID-19 pandemic?

To complete the analysis, a review of the various association rules which existed within the baskets was carried out. The output of our analysis uses the form A \( \Rightarrow \) B where A is the antecedent and B the precedent. Essentially it highlights how likely it is that a customer who has bought A will then buy B (with directionality indicated by the \( \Rightarrow \) symbol). It is important to mention here that there is no information about the order in which the products were bought. The analysis calculated the support and confidence of the association—the support being the frequency of the pairing and the confidence indicating the likelihood that B is bought with A. Before a full analysis could begin, the initial association rule mining work across the combined 2019 and 2020 dataset showed a very high volume of rules linked to the Deli counter. Given the aim of this paper, these high-association deli items were then removed to ensure adequate attention could be focused on grocery shopping.
The Association Rules were then determined for both 2019 and 2020. The results were clouded by a high association between lottery products (customers tending to buy two types of scratch card) and customers buying goods with carrier bags. These two groups of associations were then removed to facilitate clarity on grocery purchasing. The comparison of the rules between 2019 and 2020 highlighted several interesting points. As would be expected, the 2019 associations

| Product                      | p-Value whole period | p-Value lockdown | p-Value pre-lockdown |
|------------------------------|----------------------|------------------|----------------------|
| Pasta                        | 0.021                | 0.013            | 0.122                |
| Flour/baking                 | 0.056                | 0.028            | 0.408                |
| Pulses/rice                  | 0.003                | 0.063            | 0.002                |
| Red meat                     | 0.010                | 0                | 0.134                |
| Veg canned                   | 0.037                | 0.002            | 0.534                |
| Meat and fish canned         | 0.070                | 0                | 0.978                |
| Ready meals                  | 0.003                | 0.221            | 0.003                |
| Vegetables                   | 0.054                | 0.016            | 0.778                |
| Salads                       | 0.082                | 0.535            | 0.018                |
| hold hardware                | 0.020                | 0.012            | 0.245                |
| Bacon/sausage                | 0.007                | 0.000            | 0.059                |
| Butters                      | 0.077                | 0.004            | 0.804                |
| Own brand cakes              | 0.026                | 0.005            | 0.166                |
| Chickens                     | 0.026                | 0.146            | 0.075                |
| Bisc countline               | 0.070                | 0.003            | 0.559                |
| Vegetables/rice              | 0.138                | 0.024            | 0.736                |
| Heating fuel                 | 0.039                | 0.390            | 0.049                |
| Potatoes                     | 0.118                | 0.001            | 0.294                |
| Fruit juices                 | 0.648                | 0.216            | 0.006                |
| Cheese                       | 0.106                | 0.031            | 0.478                |
| White bread                  | 0.173                | 0                | 0.975                |
| Cooked meat                  | 0.088                | 0.004            | 0.168                |
| Pet foods                    | 0.020                | 0.007            | 0.294                |
| Poultry                      | 0.603                | 0.074            | 0                    |
| Soft drinks TH VAT           | 0.338                | 0.024            | 0.075                |
| Crisps and snacks            | 0.219                | 0.021            | 0.383                |
| Brown bread                  | 0.566                | 0.026            | 0.831                |
| Ppdk red meat                | 0.298                | 0.014            | 0.126                |
| Pies/Brgs/Rolls              | 0.964                | 0.290            | 0.040                |
| Bisc tea cakes               | 0.416                | 0.276            | 0.007                |
| Ice/D'srts                   | 0.798                | 0.018            | 0.105                |
| Fats                         | 0.193                | 0.537            | 0                    |
| Crisps & snacks              | 0                | 0.007            | 0                    |
| Medicinal Conf               | 0.045                | 0.104            | 0.299                |
| Salad goods                  | 0.035                | 0.072            | 0.198                |
| Hot snacks                   | 0.003                | 0.018            | 0.147                |
| Other cakes                  | 0.026                | 0.166            | 0.123                |
| Frzn-meats                   | 0.007                | 0.523            | 0.007                |
| Sandwich/rolls               | 0.004                | 0.008            | 0.074                |
| BTN NEWSPAPERS               | 0.024                | 0.180            | 0.131                |
| BTN FRENCH OVEN              | 0.017                | 0.133            | 0.067                |
| Stationary                   | 0.016                | 0.105            | 0.026                |
FIGURE 2  Weekly transactions and basket size growth [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE 3  Lockdown basket size distribution (2020 vs. 2019—Weeks 13–15) [Colour figure can be viewed at wileyonlinelibrary.com]
were dominated by relationships which were to be expected within the convenience market. Milk, as the highest value product group appeared in a broad number of associations with links between semi-skimmed milk, milk within promotions and whole milk common in the data set. The remainder of the top associations were dominated by relationships connected with ‘top-up shopping’. Milk, Bread, Newspapers and Confectionary all featured in the dataset. This appears to be consistent with prior expectations in previous research pertaining to small basket sizes (Sorensen et al., 2017; Table 4).

Analysis of the 2020 associations over the same weeks showed a dramatically different set of relationships between product purchases. Overall, a strong rise in sales of fruits, vegetables and meats was evidenced (Table 5).
The increase in addition of fruit and vegetables in baskets is highlighted by the frequency in which they appear together. From almost none of the top-60 associations in 2019 containing this category, 2020 saw a dramatic increase in the number of that contained fruit and vegetables (Table 6).

4.6 | (RQ2) When did shopping patterns change during the COVID-19 pandemic?

To compare sales against societal interest in the coronavirus, the Google Search Trends from the same period were extracted and

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**Table 5** 2020 Association rules (excluding lottery and bags)

| 2020 Rank | LHS                      | RHS                  | Support (%) | Conf. (%) | Count |
|-----------|--------------------------|----------------------|-------------|-----------|-------|
| 1         | Sp Milk 2/£2 (8288)       | Semi Milk            | 3.53        | 74.82     | 1682  |
| 2         | S/Roll 2 For £2 (0)       | OB Sausage Roll      | 1.63        | 98.61     | 778   |
| 3         | Orange and Pink Lady      | Orange               | 1.29        | 89.65     | 615   |
| 4         | Large Orange              | Pink Lady and Large Orange | 0.85    | 66.83     | 405   |
| 5         | OB Fillets                | OB Meats 2 For £7    | 0.75        | 71.69     | 357   |
| 6         | Semi Milk, Whole Milk     | Sp Milk 2/£2 (8288)  | 0.72        | 88.37     | 342   |
| 7         | OB Burgers                | OB 2-4-£5 Meats/Sides| 0.69        | 74.04     | 328   |
| 8         | Pink Lady                 | Pink Lady and Large Orange | 0.55    | 56.83     | 262   |
| 9         | Three Pears               | Pear                 | 0.40        | 94.12     | 192   |
| 10        | Hovis Soft Whit, Sp Milk (8288) | Semi Milk         | 0.39        | 79.15     | 186   |
| 11        | OB Beefy                  | OB 2-4-£5 Meats/Sides| 0.35        | 78.40     | 167   |
| 12        | OB Honey Porkers          | OB 2-4-£5 Meats/Sides| 0.35        | 78.30     | 166   |
| 13        | OB Porkers                | OB 2-4-£5 Meats/Sides| 0.28        | 68.39     | 132   |
| 14        | Banana, Orange and Pink Lady | Orange             | 0.27        | 90.21     | 129   |
| 15        | Banana, Orange            | Orange and Pink Lady | 0.27        | 80.12     | 129   |
| 16        | Orange and Pink Lady, Semi Milk | Orange       | 0.27        | 90.71     | 127   |
| 17        | Orange, Semi Milk         | Orange and Pink Lady | 0.27        | 90.71     | 127   |
| 18        | Banana Bag,Sp Milk 2/£2 (8288) | Semi Milk      | 0.27        | 75.60     | 127   |
| 19        | OB Goujons                | OB Meats 2 For £7   | 0.26        | 73.49     | 122   |
| 20        | Cadbury Egg Promo669      | Cad Creme Egg       | 0.25        | 95.20     | 119   |

*Note: Numbers in parenthesis denote promotions. Abbreviation: OB, own brand products.*

**Table 6** Fruit and vegetables association rules

| LHS                                      | RHS                                      | Support (%) | Conf. (%) | Count |
|------------------------------------------|------------------------------------------|-------------|-----------|-------|
| Clementine and Pink Lady                 | Clementine                               | 1.29        | 89.65     | 615   |
| Large Orange                             | Pink Lady and Large Orange               | 0.85        | 66.83     | 405   |
| Pink Lady                                | Pink Lady and Large Orange               | 0.55        | 56.83     | 262   |
| Three Pears                              | Pear                                     | 0.40        | 94.12     | 192   |
| Banana, Clementine and Small Pink Lady   | Clementine                               | 0.27        | 90.21     | 129   |
| Banana, Clementine                       | Clementine and Pink Lady                 | 0.27        | 90.12     | 129   |
| Clementine, Semi Milk                    | Clementine                               | 0.27        | 90.71     | 127   |
| Clementine, Semi Milk                    | Clementine and Pink Lady                 | 0.27        | 90.71     | 127   |
| Banana Bag, Sp Milk 2/£2 (8288)          | Semi Milk                                | 0.27        | 75.60     | 127   |
| Parsnips                                 | Carrots                                  | 0.21        | 54.89     | 101   |
| Large Orange, Semi Milk                  | Pink Lady and Large Orange               | 0.19        | 69.53     | 89    |
| Pink Lady and Large Orange, Semi Milk    | Large Orange                             | 0.19        | 59.33     | 89    |
| Banana Bag, Clementine and Pink Lady     | Clementine                               | 0.18        | 89.36     | 84    |
| Banana Bag, Clementine                   | Clementine and Pink Lady                 | 0.18        | 88.42     | 84    |
analysed. The data compared the frequency of searches for specific terms indexed so that the day with the highest number of searches is equal to 100. Results from the chronological analysis showed two initial peaks in public searches for coronavirus in Northern Ireland: the 27 February 2020—the date of the first confirmed case of the infection in Northern Ireland and 12 March 2020—the day before the UK Chancellor’s pandemic-related budget. Mapping weekly sales against the average weekly Google search index revealed that grocery sales initially fell as early awareness of the virus grew. This fall was reversed as lockdown was implemented and interest in the coronavirus peaked (Figure 5).

5 | DISCUSSION

This study aimed to understand grocery-shopping behaviour during a specific time period of COVID-19 that included lockdown, accounting for basket and category changes and time impacts using data analysis and association rule mining techniques. The use of transaction data using a range of market basket indicators revealed profound changes to shopper behaviours during COVID-19, emphasising the how major systemic shocks impact people and how they shop. Transaction details were extracted for a 10-week period in 2019 and 2020 spanning week 6 (initial awareness) through to week 15 (lockdown was implemented in week 13 2020). Changes in sales values and volumes were analysed with additional work carried out to review the changes in basket mix (via association rule mining).

5.1 | Changes in grocery shopper behaviour during the COVID-19 pandemic

Baker et al. (2020) found that household spending on grocery retail across the United States sharply increased during the COVID-19 pandemic. While their findings refer to changes in consumer spend generally, little is known about the difference in actual consumer spend, based on basket value and size, during the pandemic. The focus of this study sought to address this by examining grocery sale patterns change during the COVID-19 pandemic? Specifically, the study sought to understand changes to grocery sales per category, shopper numbers and basket value, size and mix. As well as understanding when grocery-shopping patterns changed during the COVID-19 pandemic.

The findings of this research study indicate that grocery shopper behaviour was significantly changed by the advent of the COVID-19 pandemic. While major factors like grocery shop size remained static, an initial top-level analysis of the data immediately showed an increase in grocery sales of +5.5% (vs. the equivalent 10-week period for 2019). This growth is well above the current UK inflation rate of 1.5% (‘Consumer price inflation, UK—Office for National Statistics’, n.d.). The increase in grocery sales appears to have been driven by a larger basket size which more than compensated for a sharp decline in grocery shopper numbers later in the COVID-19 transaction review period. Results of this study showed an increase in the frequency of basket spend above £10 and in basket value above £30. Results also showed that the number of basket items and the size of baskets increased from three to six items. Grocery shoppers displayed a willingness to spend more in store and buy more items in order to meet their needs. While a positive for grocery retailers, there were associated costs with taking appropriate precautions for minimising the spread of COVID-19 in-store and managing surges in shopper numbers while in store.

Regarding when grocery-shopping patterns changed during the COVID-19 pandemic, we identified from the findings variations in grocery shopper numbers and basket size over the time period studied. It was evident that grocery shoppers displayed increasing pandemic awareness (Week 6–7)–where grocery shopper numbers remained initially stable in week 6 of the study period and then began to fall in week 7 as awareness of the pandemic grew and shoppers focused on stockpiling staple food products. Substantial sales growth during week 6 as the initial period of the pandemic shock took hold, included food categories such as pasta, flour and baking goods and stocks and gravy mix. Martin-Neuninger and Ruby (2020) have noted in the context of COVID-19, stockpiling behaviour in response to a perceived loss of control by shoppers at a time of great uncertainty. These findings extend their comments, by detailing specifically which grocery categories were involved during the initial period and the balance in basket sizes and sales growth between categories. It was also evident that following the initial shock experienced, shopper numbers
decreased (Week 7–8) as shoppers appeared to focus on larger shops during store visits. It is also notable that while pasta consolidated its sales growth, the other aforementioned food staples flour and baking products and stocks and gravy mixes fell back.

Perhaps most significantly, was the significant growth in grocery sales from week 12 at the peak, declining but still year on year greatly up through to week 15 of the pandemic time period under study. This is accompanied by a significant growth in basket size. And, interestingly, a significant drop in shopper numbers during week 13 through to week 15. Due to the UK Government recommendations for people to ‘stay at home’. The increase in basket size likely reflects an increase in home deliveries. The basket size increases may also indicate a move from the 2019 ‘impulse’ and ‘top-up’ shops to more substantial ‘main weekly shops’ in 2020 after lockdown was introduced. It is also notable that during this period all product groups, from pasta, cleaning products to flour and baking products experienced significant, albeit tapering, growth. What is particularly interesting is the findings from using the Google Search Trends tool from the same period, is that week 12 was the peak in public searches for coronavirus in Northern Ireland. While this intense public interest in the virus decreased to week 15 in terms of internet searches, the level of interest was still above Google Search results from week 6 until week 12. This suggests a correlation between the anxiety and fear about COVID-19 being experienced by shoppers manifested through intense internet search and the significant growth in grocery sales during the same period. This period during which lockdown conditions were enforced, revealed a general increase in basket size (number of items per basket) and a general increase in the frequency of basket sizes above £10—with sharp increase in baskets with a value above £30, rising from 1% of baskets in 2019 to over 7% of transactions. It would be interesting in future research to consider the relationship between shopper online searches regarding a systemic shock such as a pandemic and changes in their shopping behaviour. Fine-grained and qualitative research could explore deeper the attitudes of shoppers and presence of fear as manifest in their internet searches and how this influences their grocery-shopping behaviour.

5.2 Changes in the basket mix of grocery shoppers during the COVID-19 pandemic

The study also considers the various association rules which existed within the product mix of the baskets analysed (see Tables 5, 6). The study approach, using time-bound transaction data from a retailer during the time period of the COVID-19 pandemic provides a novel means to produce and analyse product mix change from pre-pandemic 2019 to the emergence and development of the pandemic during 2020. In relation to the 2020 associations over the same weeks compared to 2019 pre-pandemic, a dramatically different set of relationships between product purchases was evident. Overall, a strong rise in sales of fruits, vegetables and meats was evidenced in the basket mixes (see Table 6). The increase in addition of fruit and vegetables in baskets is highlighted by the frequency in which they appear together. This increase was from almost none of the top-60 associations in 2019 containing this category, 2020 saw a dramatic increase in the number of that contained fruit and vegetables. This builds upon the findings of Tanusondjaja et al. (2016), who highlight how shopper transaction data enables a deep analysis of what goes into shoppers’ baskets. Their research on cross-category benchmarks shows how such data can allow meaningful deviations to be identified, isolating categories that are more or less intensely co-purchased than expected, guiding decisions regarding store layout and category promotions. Our finding indicates that grocery shoppers purchased more than just ‘daily staples’ to stock-up during the pandemic, with increased awareness of health and wellbeing an important aspect. Significantly, this helps to move our understanding beyond considerations of retailers pursuing sourcing strategies to respond quickly to stockpiling in anticipation of supply disruptions during periods of systemic shocks (Yoon et al., 2018). Shoppers practical considerations of healthy food benefits reveals that fear is not the only factor in play for grocery shoppers during the pandemic, as previous research has tended to focus on (Martin-Neuninger & Ruby, 2020; Nicola et al., 2020; Zwanka & Buff, 2020).

Two points may be made in this respect, which are important to understand in view of obtaining a more nuanced understanding of shopper behaviour changes during future systemic shocks. First, the findings indicate that grocery shoppers purchase these food products for the purposes of ‘meal creation’. Being confined to the home, shoppers were constrained from eating out and with increased time for meal preparation using fresh fruit and vegetables and meat products in the home. This highlights an opportunity for grocery retailers to use menu planning in their stocking on shelves, and as a basis for selling across categories during a pandemic, especially in categories containing items with longer shelf life suited to a reduction of shopping trips, for example, ambient goods, frozen goods and tinned goods. Second, the increased purchase of fruit and vegetables reflects a growing awareness during the pandemic of the importance of health and wellbeing. A trend for healthier food options has been present for some time, with the emergence in the past few years for example of plant-based foods. The rise of plant-based foods has become so significant that many experts do not now classify it as a trend by as a new normal in food consumption. This aligns with a growing trend to eat less meat both for the sake of the environment and for health. Such trends have been accentuated by the emergence of the COVID-19 pandemic. Findings from Mintel show that food consumers are looking to healthier products that boost immune systems and improve their general health and wellbeing (Mintel, 2020). The findings from this study corroborate and add texture to these insights, showing that the pandemic has led to shoppers looking to healthier food products and considering how this relates to basket mix and category management.

6 CONCLUSION

This research set out to examine changes in grocery-shopping behaviour during a time-bound period of the COVID-19 pandemic, in the
run-up to and after the implementation of lockdown. Specifically, how did shopper visit frequency change over the course of virus from initial awareness through to lockdown, how did the societal-shock impact basket size in the convenience market and, finally, did the data suggest any changes to buying patterns such as switching between brands within categories?

Growth was driven by significant basket size increases during lockdown. It is clear from the data that there was a significant change in shopper behaviour—especially as the lockdown was implemented. The research saw a dramatic decrease in shopping trips as lockdown was introduced (reflected in the reduced transactions numbers) as well as a very significant increase in basket size. These factors combined to increase overall sales substantially across the measurement period although it should be noted that a reduction in promotional activity may also be a factor in this change. Anecdotally this increase was driven by a sharp increase in home deliveries where shoppers ordered substantially large baskets, but further analysis would be required to confirm this as the current datasets do not differentiate between purchase types. A chronological examination of the data indicated distinct stages throughout the pandemic impact. Initial awareness where transactions started to fall, a secondary phase where shopper numbers fell substantially as customers moved to supermarkets, a third stage where visits stabilised then a final sharp decrease in shopper numbers as lockdown was implemented. A comparison of the growth and Google search trends during the pandemic indicated a lag between societal interest in the disease and a change in shopping behaviours. Growth occurred across several categories and across grocery products within those categories. Although the study set out to determine whether the ‘shock’ of the impact of the pandemic on society changed the way shoppers purchased various grocery products (such as a move to higher or lower value brands), the variability of availability within the period prevented clear conclusions being drawn.

7 LIMITATIONS

Several limitations in this work are recognised with the most significant likely to be the sample size. As discussed earlier in the paper, the use of a single store poses risks in terms of how representative it is of the market overall. However, as mentioned, the limited dataset allowed for rapid data analysis and assumption validation. More comprehensive datasets on shopping behaviour in the UK tend not to be in the public domain or are delayed or summarised significantly. One important point to note is that anecdotal reports indicate a reduction in promotional activity (especially on multi-buy promotions) during the pandemic period across the retail market (‘COVID-19: A message to our customers from Dave Lewis, Tesco CEO—Tesco PLC’, 2020). Although fewer promotions could drive lower volumes, they could increase basket value—an effect which has not been assessed in this study.

An initial area of future work could examine whether a larger multi-store dataset is available and whether this larger data set could be used to validate the findings in this proof of concept model. This work focused on retail sales, with a comparison to Google searches as a proxy for societal awareness. Future work could also review the addition of multiple other data sources (such as survey data or online shopping information) to broaden the intelligence available for analysis. The impact of product limits could also be an interesting area with further work used to compare stores which limited purchases versus non-limited shops.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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