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**Ready meals in the UK: An analysis based on their  
nutritional and sustainable claims**

by Montserrat Costa-Font, Wisdom Dogbe, and Cesar  
Revoredo-Giha

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## Ready meals in the UK: An analysis based on their nutritional and sustainable claims

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### ABSTRACT

Ready meals have been tagged unhealthy and unsustainable due to their high content of energy, sugar, fats and salts, and CO<sub>2</sub>-equivalent emissions. However, no known study has analyzed the performance of supermarket-based ready meals in terms of their nutritional and sustainable claims in the UK. In that context, first, we analyzed the trends in ready meals launched in the UK by claims position and retailer/manufacturer. Second, we performed a hedonic regression to estimate the impact of positioning claims on the prices of ready meals launched from 1998 - 2019. Third, we performed a case study on a major ready meal retailer by analyzing the nutritional and carbon footprint of ready meals offered for sale using trend graphs, descriptive statistics, chi-square tests, and analysis of variance (ANOVA). Global New Products Database (GNPD) about positioning claims and retailer's data on nutritional composition and carbon footprint were merged and used in both analyses. Microwaveable, environmentally friendly package, no additives or preservatives, recycling, and vegetarian claims dominate in the UK ready meals market. Sustainable claims became important in the ready meals market after the year 2014. The top three producers of ready meals are Wal-Mart, Tesco, and Marks and Spencer. Whilst new products were launched from 1996 to 2003, new variety/range extension of ready meals now dominate the market. Vegetable-based ready meals are the cheapest source of energy, most environmentally friendly but with a lower source of protein than meat and fish-based ready meals. Finally, ready meals with animal ethical claims and habitat/resource ethical claims are more expensive.

**Keywords:** Ready-to-eat meals, Sustainability, Carbon footprint, Analysis of Variance, United Kingdom.

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## **Ready meals in the UK: An analysis based on their nutritional and sustainable claims**

### **1. INTRODUCTION**

Ready meals are complete meals requiring few or no extra ingredients, prepared by external procedures and designed to fully and speedily replace the main course of a homemade main meal (Costa et al., 2001; Mahon et al., 2006). They are the second most consumed food after sandwiches with a penetration of 90%; 9 out of 10 households buy ready meals (Wall, 2013). On average, about 18.75 kg of chilled and frozen ready meals per capita per year was consumed in 2019 (Statista, 2020). This makes the ready meals market in the UK an important segment to study as it has implications for sustainable dietary goals.

There is scant literature on ready meals, nevertheless, they suggest that ready meals fall short of the attributes of sustainable diets because of their: (1) high content of energy, sugar, fats, and salt (Food Standard Agency, 2009); (2) high environmental footprint (Rivera et al., 2014); and (3) result in a decrease in family mealtimes and foods prepared at home (Jabs & Devine, 2006). Short (2003) concluded that achieving a sustainable diet is a challenge considering the upward trend in the numbers and frequency of adults consuming supermarket-based ready meals in the UK. This conclusion overrides the economic argument that ready meals are less expensive (per 100 g) compared to making equivalent meals from recipes at home (Howard et al., 2012).

Despite the backlash on the consumption of ready meals, no study has been conducted exploring the evolution of ready meals by their claims positioning (especially sustainable and health) as well as their nutritional composition and environmental footprint. Studies that attempted this line of research were incomplete. For instance, Howard et al. (2012), Remnant & Adams (2015), and Kanzler et al. (2015) explored only the nutritional composition of ready meals in the UK. Only Rivera et al. (2014) attempted to study and compare the environmental footprint of ready meals and home-cooked meals in the UK. The scarcity of studies on the sustainable dimensions of ready meals could be attributed to data limitations on both nutrient composition and environmental footprint.

To the best of the authors' knowledge, no empirical studies have tried to analyze the evolution of ready meals by their claims positioning and estimate the contribution of these claims to their



prices. In addition, no known study has estimated both the nutritional composition and the carbon footprint of ready meals together. Specifically, we seek to analyze the trends in ready meals launched in the UK by claims position and retailer/manufacturer. Second, we performed a hedonic regression to assess how sustainable, health and nutrition, safety, demographic and convenience claims affect the affordability of ready meals launched from 1998 - 2019. Third, we performed a case study on a major ready meal retailer by analyzing the nutritional and carbon footprint of ready meals offered for sale using trend graphs, descriptive statistics, chi-square tests, and analysis of variance (ANOVA).

Such a study is important to understand how a supplier of ready meals reacts to the current demand for sustainable and healthy ready meals and how these claims affect the prices of ready meals. In addition, results can inform consumer choices on the health and environmental implications of different types of ready meals.

The rest of the paper will be organized as follows: Section II provides brief literature on the consumption of ready meals across the UK. Section III discusses the data and methods used to achieve our objectives. Section IV describes the results obtained from our analysis. Section V discusses the implications of our results. Finally, section VI provides a summary and some concluding remarks.

## **2. AN OVERVIEW OF THE CONSUMPTION OF READY MEALS IN THE UK**

The UK is one of the biggest consumers of ready-to-eat meals in Europe followed by Germany and France (Statista, 2020). About 62.5% of households in Great Britain consume ready meals (Bardsley, 2000). In addition, a computerized assisted web interview by Kanter Worldpanel from 2013 to 2018 revealed that about 42 percent of the Britons 15 years and older consume ready-made meals once a week.

Figure 1 shows the average consumption per person per week of ready meals from 1974 to 2018 in the UK<sup>3</sup>. The figure shows three categories of ready meals: meat-based ready meals, fish-based ready meals, and vegetable-based ready meals. Between 1974 and 1991, fish-based ready meals were the most consumed. The consumption of vegetable and fish-based ready

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<sup>3</sup> Strictly speaking, the data refer to purchases of ready meals and not consumption; however, despite their differences, since waste is not addressed in this paper, they will be considered that the former is a good approximation of the latter.



meals was overturned by meat-based ready meals from 1999. In the year 2018, the average consumption of meat-based, fish-based, and vegetable-based ready meals were 90.8 grams, 54.2 grams, 71.9, respectively. In summary, in 2018, the total average consumption per person per week was 216.9 grams.

**Paste Figure 1 here**

Figure 2 shows the average price (unit value<sup>4</sup>) of ready meals consumed in the UK from 1974 to 2018. The average price has seen a steady increase over the period under consideration. Between 2001 and 2018 average price of fish-based ready meals was relatively high compared to the rest. However, the total average price of ready meals is lower than the average price of fish-based meals. In 2018, the average price per gram of meat-based, fish-based, and vegetable-based ready meals were 0.59 pence, 0.69 pence, and 0.49 pence, respectively. Those figures suggest that fish-based ready meals are more expensive compared to meat-based, and vegetable-based ready meals.

**Paste Figure 2 here**

Despite the increasing trends in the per capita consumption and price of ready meals, there is significant variation across different regions in the UK. Generally, consumption and expenditure do not follow the same pattern. Figure 3 shows the per capita consumption and expenditure on fish-based ready meals across different regions. The blue bars show that Wales is the biggest consumer of fish-based ready meals whilst Northern Ireland is the least. The per capita expenditure on ready meals is highest in Eastern England and lowest in Northern Ireland, probably due to low demand.

Figure 3 also shows the average consumption of meat-based ready meals across different regions in the UK. The North East of England is the biggest consumer of meat-based ready meals whilst London consumes least. In terms of expenditure, per capita expenditure in London is the lowest whilst Eastern England has the highest.

Eastern England is the biggest consumer of vegetable-based ready meals whilst West Midlands consumes the least (see Figure 3). West Midlands also recorded the lowest per capita expenditure on vegetable-based ready meals, while London has the highest.

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<sup>4</sup> Unit value is the total expenditure divided total quantity which ignores the quality variation across the types of ready meals.



### **Paste Figure 3 here**

In summary, the figures show that the importance of ready meals in the food market cannot be overemphasized (Olsen et al., 2010). The distribution of consumption varies across different regions in the same country. Economically, ready meals are cheaper compared to home-cooked meals which typically cost more (Drewnowski, 2017). In addition, the consumption of ready meals allows consumers to save time – convenience (Kanzler et al., 2015).

## **3. METHODS**

### **3.1 Data**

The study relied on data obtained from the Global New Product Database (GNPD) which contains information on food products launched by major retail supermarkets and manufacturers between 1996 and 2019. Each product contains information on the date it was first launched, product category, the producing company, positioning claims, prices, package size, the brand, product description, storage type, etc. The database also contains nutritional information such as total energy, fat, saturated fat, carbohydrate, sugar, protein, fiber. However, there was no data on the greenhouse gas emission content of the food products. As a result, we performed a case study using a major retailer's CO<sub>2</sub>-eq emission data for the carbon footprint analysis.

Table 1 shows that ready meals with an average pack size of 440 grams are sold at 2.74 pounds. Among the convenience claims category, microwaveable is the most important claim positioning representing about 70 percent of total ready meals launched. Among the demographic category, vegetarian ready meals are the most important representing 18 percent of ready meals launched. For health and nutrition claims, ready meals low or containing no fat or transfat were the most important. Two percent of the ready meals were labeled GMO-free and considered as important for safety. Among the sustainable claim, ready meals with environmentally friendly package or recyclable package represented about 69 per cent of the ready meals. In summary, 88 percent of ready meals had convenience claims, 85 per cent had sustainable claims, 70 per cent had health and nutrition claims, 40 per cent had demographic



claims, and 33 per cent had safety claims. According to launch type, 46 per cent of ready meals were a new variety/range extension, 30 per cent were new products, 9 per cent had new packaging, 7 per cent had new formulation and 6.9 per cent were relaunched. Majority of ready meals representing 67 per cent were sold as chilled, 22 per cent were sold as frozen whilst 10 per cent were sold as shelf-stable.

**Paste Table 1 here**

### **3.2 Analyses**

#### *3.2.1 Trends in ready meals launched in the UK*

The analyses for this study were in three parts; the first part involved analyzing the GNP database for trends in ready meals launched between 1998 and 2019. First, we analyzed the total number of products launched between 1996 – 2019. Second, we analyzed trends in the number of ready meals launched by the top five manufacturers in the UK ready meal market. Third, we estimated the percentage of products launched by the top 23 retailers in the market. Finally, we analyzed the trends in ready meals by claims positioning and claims category across the years and for different retailers/manufacturers.

#### *3.2.2 Hedonic pricing model*

The last part of the analysis involved estimating the impact of the positioning claims on the prices that suppliers offer for sale using a hedonic pricing model. The general form of the hedonic model from Rosen (1974) is represented as:

$$P_{it} = f(c_1, \dots, c_n)$$

where  $P_{it}$  is the price of the ready meal  $i$  at time  $t$ , and  $c_1, \dots, c_n$  is attributes that determine the price of the ready meal. The function allows for the estimation of the value of each attribute. The attributes are measured by dummy variables, and the price variables are specified in logarithms to allow for interpreting the coefficients of the independent variables in percent. We also introduced time dummies into the model to capture the variation in prices due to the date the product was launched.

The model used in the analysis was specified as:



$$\begin{aligned}
\ln P_{it} = & \emptyset + \alpha_i \text{Quantity} + \sum_{m=1}^5 \beta_m \text{Convenienc}_m + \sum_{l=1}^5 \theta_l \text{Demographic}_l \\
& + \sum_{n=1}^6 \mu_n \text{Health}_n + \sum_{s=1}^1 \pi_s \text{Safety}_s + \sum_{z=1}^5 \rho_z \text{Sustainable}_z + \sum_{x=2}^5 \sigma_x \text{Claims}_x \\
& + \sum_{r=2}^{20} \varphi_r \text{Year}_r + \sum_{c=2}^5 \omega_c \text{Launch}_c + \sum_{v=2}^3 \gamma_v \text{Storage}_v + \varepsilon_i
\end{aligned}$$

Where  $\ln P_{it}$  is the logarithm of Price  $i$  at time  $t$ ,  $\emptyset$  is the constant term; and  $i, m, l, n, s, z, x, r, c,$  and  $v$  are the index for quantity, convenience category, demographic category, health category, safety category, sustainable category, claims category, sustainable category, launch type category, and storage category; the error term is  $\varepsilon_i$ . A summary of the data used for the hedonic pricing model is presented in Table 1.

### 3.2.3 Nutritional composition and environmental footprint

For the second part of the analysis, the estimation was conducted at the group level for a major retailer in the UK. At the most aggregated level, we compared the nutritional and environmental implications of plant/vegetable-, fish/seafood- and meat-based ready meals. At the least aggregated level, we compared the nutritional content and environmental footprint of ready meals composed of beef-, chicken-, lamb-, fish-, and plant only.

After a thorough search of the top leading supermarkets in the UK - *Aldi, Wal-Mart (Asda), Cooperative Food, Iceland, Lidl, Marks & Spencer, Morrisons, Sainsbury's, Tesco,* and *Waitrose* - only Tesco had data on both nutritional content and greenhouse gas emission of ready meals sold in their supermarkets. Therefore, Tesco hypermarket was selected as the unit of analysis. A total of about 1,486 unique products were launched by Tesco between 1996 and 2019.

A total of 652 unique ready/prepared meals were launched by Tesco between 1996 and 2019. However, not all 652 ready meals are currently being sold and had data on both nutrient composition and greenhouse gas emission. Fifty ready meals (comprised of shelf-stable, chilled and frozen) currently being sold and containing data on nutrient composition and greenhouse gas emission were considered for the final analysis. Ready meals were grouped as described above.



The cost, package size, nutritional content per euro, and kg of CO<sub>2</sub>-eq emission were described using means and graphs. An analysis of variance (ANOVA) and chi-square test was conducted to compare the means between groups. Mean nutritional content per 100 grams as compared to current UK guidance on front of pack nutrition, ‘traffic light’, labeling – this indicates ranges for red/high, amber/medium, and green/low content of fat, saturated fat, sugar, and salt (Department of Health, 2013).

## **4. RESULTS AND DISCUSSION**

### **4.1 Trends in ready meals launched in the UK**

Figure 4 shows the trends in the number of ready meals launched in the UK from 1996 to 2019. The number of ready meals launched was lowest in 1996 and highest in 2015. They are composed of new formulation, new products, new packaging, new variety/range extension, or relaunched. The graph also shows cyclical trends in the number of ready meals launched. For instance, the number of ready meals launched decline sharply after 2005 and started to increase after 2009. Also, the number of ready meals launched declined after 2013 and rose sharply in 2015. The lower number of ready meals launched from 2007 to 2010 could be attributed to the global financial crisis which might have affected research and development and also consumer demand (Archibugi et al., 2013).

**Paste Figure 4 here**

Figure 5 shows the number of products launched each year by the top 5 companies and the remaining companies are summed as the rest of the companies. These companies launched products each year. Between 1996 and 2001, Marks and Spencer was the leader in terms of the number of products launched. However, the number of products launched in 2002 decreased giving an advantage to Wal-Mart to launch the highest number of ready meals in 2002. Also, between 2008 and 2012, Tesco launched the highest number of ready meals, but this was overturned by Wal-Mart from 2013 to 2019. Except in 1996, the number of products launch by the rest of the companies is larger than the number launched by each of the top five companies.

**Paste Figure 5 here**

Figure 6 shows the top 23 companies and the number of products launched from 1996 to 2019. Wal-Mart is the company that launched the largest number of ready meals (13.83 per cent) whilst Coca-Cola company launched the lowest number of ready meals (5.74 per cent). In descending order, the top five companies in terms of the share of ready meals launch from 1996



to 2019 are Wal-Mart, Marks & Spencer, Tesco, Sainsbury's, and John Lewis Partnership. These companies are important in the ready meal markets because they launched at least one type of ready meal each year.

**Paste Figure 6 here**

Figure 7 present the percentages of the claims position for the ready meals launched from 1996 to 2019. These represent 90 per cent of claims positions that were made for the products launched. Microwaveable products represent the largest number of products launched (22.1 per cent) whilst GMO-free ready meals represent the lowest number of products that were launched (0.80 per cent). From the figure, the top 10 claims position representing 74 per cent of the total claims are microwaveable, ethical - environmentally friendly package, no additives/preservatives, ethical – recycling, vegetarian, low/no/reduced fat, low/no/reduced transfat, premium, ease of use and ethical – animal.

**Paste Figure 7 here**

Figure 8 puts the 82 different claims positionings into 5 main categories: convenience, demographic, health and nutrition, safety, and sustainability. The trend line shows that ready meals with convenience claims were the most launched from 1998 to 2014 followed by health and nutrition. However, after 2014, products with sustainable claims were the most launched. It is important to add that between 1996 and 2008, products with sustainable claims were the least launched. The growth in the number of products with sustainable claims is confirmed by Nunes et al. (2020).

**Paste Figure 8 here**

Figure 9 shows the number of products in each claim category launched by the top 6 retailers in the UK. In Wal-Mart (Asda), products with sustainable claims form a major share of the total number of ready meals launched from 1996 to 2019. However, ready meals with claims targeted at specific demographic segments form the lowest share of ready meals launched within the period under study. In Tesco and Sainsbury's, ready meals with convenience claims formed the largest share of the total number of ready meals launched between 1996 and 2019 whilst ready meals with safety claims formed the lowest share of products launched. In Marks and Spencer, John Lewis, and Morrisons, the largest share of ready meals launched from 1996 to 2019 had sustainable claims whilst the lowest share of ready meals had safety claims. Figure 6, therefore, shows that the priority of manufacturers of ready meals differs across the different



claims categories. In five out of the six manufacturers, ready meals with safety claims are not considered important. However, in four out of the six retailers, sustainable claims are considered very important when new products are being launched or relaunched. The results show the importance of ready meals with sustainable and ethical claims across the top retailers in the UK (see The Poultry Site, 2019).

#### **Paste Figure 9 here**

Figure 10 shows the number of products launched and the launch type from 1996 to 2019. New products of ready meals dominated the market from 1996 to 2002. However, after 2002, a new variety/range of extensions of the same products dominated the market. In 2019, a new variety/range of extension was the major characteristic under which the majority of the products were launched whilst ready meals with new formulation formed the lowest share of ready meals launched.

#### **Paste Figure 10 here**

### **4.2 Hedonic pricing model**

Table 5 shows the regression results from a semi-log hedonic pricing model. The model consist of the total package size, claims positions, launch type, and the year dummies when the ready meal products were launched. The impact of total package size on the price of ready meals was found to be positive, suggesting that larger package sizes attract higher prices.

#### *Sustainable claims*

All the sustainable claims included in the model were significant; products with animal ethical claims and habitat/resource ethical claims were found to appreciate the prices of ready meals by 14 and 25 per cent, respectively. This result seems to support studies suggesting that consumers are willing to pay higher prices for sustainable products (Grunert et al., 2014). However, products with environmentally friendly package, recycling claims, and environmentally friendly products lower the prices of ready meals. For instance, ready meals in recycling packages have prices 12 per cent lower.

#### *Health and nutrition claims*

In terms of health and nutrition claims, the prices of gluten free, low/no/reduced trans fat and low/no/reduced fat ready meals are 7 per cent, 10 per cent, and 6 per cent lower, respectively. This may be because low-fat and transfat ready meals are high in plant-based products.



However, the prices of ready meals containing low/No/Reduced Allergen and suitable for slimming are 28 per cent and 7 per cent higher than those without these claims.

#### *Safety and convenience claims*

In terms of safety, our hedonic price model shows that ready meals labeled as GMO-free are 8 per cent more expensive than GMO-containing ready meals. For convenience, ready meals labeled as ease of use are 15 per cent more expensive than those without such labels. Products that save time/speed are 10 per cent cheaper whilst premium-ready meals are 26 per cent more expensive. Microwaveable ready meals are 13 per cent cheaper.

#### *Demographic claims*

Ready meals that are labeled economy, suitable for children between 5 – 12 years, and vegetarian were found to be 53 per cent, 26 per cent, 14 per cent less expensive, respectively than ready meals without such claims. However, ready meals with social media claims were found to be 17 per cent more expensive than those without. Ready meals with vegan claims did not have any significant impact on the price consumers pay, whilst ready meals with on-the-go claims are 18 per cent more expensive.

#### *Launch type*

We compared the prices of ready meals that were relaunched to those launched as a new product, new formulation, new packaging, and new variety/range extension. Only ready meals launched as new products and new variety/range extension had a significant impact on the price consumers paid. Specifically, ready meals launched as new products were 10 per cent more expensive than when ready meals were relaunched. Similarly, ready meals that were new variety/range extension are 6 per cent more expensive than those that were relaunched.

#### *Storage*

The prices of ready meals were also analyzed by storage type. There were three main storage types: frozen ready meals, shelf-stable ready meals, and chilled ready meals. Chilled ready meals were used as the reference category, the results suggest that frozen ready meals and shelf-stable ready meals were 33 and 50 per cent more expensive than chilled ready meals.

We also included a dummy indicated the country where the product was produced; ready meals manufactured in the UK were found to be 8 per cent more expensive. Twenty time dummies were included in our hedonic pricing model. Except for 2016 and 2017, all time dummies were



significant. The time dummy for the year 2018 was the only significant and positive dummy. For instance, the time dummy for 2018 suggests that ready meals launched in 2018 were 7 per cent more expensive than ready meals launched in 2019. However, since ready meals launched between 1998 and 2015 had negative price coefficients, the implications are that ready meals launched between these years are less expensive than those launched in 2019. The possible explanation could be inflation and the inclusion of new attributes to new products launched each year.

### **4.3 The nutritional and environmental footprint of ready meals**

Table 2 summarises the mean cost, pack size, CO<sub>2</sub>-eq emission, and nutritional content per 100 grams of meals and how they vary by composition and protein source. On average, a meal supplying 125.82 kcal generates a CO<sub>2</sub>-eq emission of 781.6 grams and cost about 2.74 pounds in the UK. All variables, except pack size, energy, total fat, saturated fats, and sugars variables, showed significant differences across the three main meal groups. Fish-based ready meals are the most expensive compared to meat and plant-based meals. Even though plant-based ready meals provide the least number of calories (116 kcal), they contain the highest amount of total fat (5.17) and saturated fats (2.38). Evidence support that meat-based ready meals have the most impact on climate (1.02 kilograms of CO<sub>2</sub>-eq emission) compared with fish- (405 grams) and plant-based (236.67 grams) meals.

Table 2 shows significant variations across ready meals based on the source of protein. There were significant differences in the cost of meals based on their protein sources; beef and lamb ready meals were the most expensive whilst plant-based ready meals were the least expensive. There was no significant difference in the package sizes. In terms of emission, beef-based meals have the highest carbon footprint (1772.5 grams) compared to vegetable/plant-based foods (236.67 grams). Lamb-based ready meals supplied the lowest level of calories and had the lowest amount of total fats and saturated fats. In terms of protein, beef-based ready meals had the highest amount (8.47 grams) whilst vegetable-based foods had the lowest amount (2.06).

#### **Paste Table 2 here**

The relative nutritional content per 100 grams of food is displayed in Figure 6. The colors in Figure 6 reflect current UK guidance on front-of-pack “traffic light” nutrition labeling. Green, amber and red colors suggest low, medium, and high content of the nutrients per 100 grams of food, respectively. Overall, ready meals were rated medium for total fats and salts. Lamb-based



ready meals were rated low in saturated fats. Pork-based ready meals contain the highest amount of sugars and salt. Contrary to Howard et al. (2012) and Remnant and Adam (2015) ready meals were found to be medium in salts and total fats, independent of the composition and the protein source. Except for lamb-based ready meals, all types of ready meals were medium in saturated fats. The implication is that when consumed in large quantities consumers may expose themselves to fat and salt-related diseases like obesity and hypertension.

**Paste Figure 6 here**

#### **4.3.1 Nutritional content per pound**

Overall, a ready meal containing 248.27 kcal cost 1pound<sup>5</sup> (see Table 3). Apart from fiber and protein, there were no significant differences in the three main ready meal groups. Comparing the three main meal types, meat-based ready meals are the cheapest source of protein. Whilst vegan or plant-based ready meals are the cheapest source of energy; fish-based ready meals are the most expensive source of energy.

Except for salt, there were significant differences across all ready meals based on the protein source. Vegan or plant-type ready meals are the cheapest source of energy (304.91 kcal per euro), followed by chicken (274.17 kcal) and pork (224.51 kcal). Lamb-based ready meals were found to be the most expensive source of energy. Vegetable-based ready meals were found to be the cheapest source of total fat, saturated fats, and carbohydrate whilst lamb-based ready meals are the most expensive source of total fats, saturated fats, and carbohydrates.

**Paste Table 3 here**

#### **4.3.2 Nutritional content per kg of emission**

Table 4 presents the estimated average nutrient per kg of CO<sub>2</sub>-equivalent emission. Overall, every 280.51 kcal of ready meals consumed generates 1 kg of CO<sub>2</sub>-equivalent emission. In addition, consuming a ready meal that contains 31.43 grams of carbohydrate, 11.27 grams of protein and 11.22 grams of fats amounts to producing 1 kg of CO<sub>2</sub>-eq emission.

Table 4 shows that there are significant differences across the three main groups of ready meals. Notably, vegetable-based ready meals provide the most efficient source of energy. This is because it provides the highest source of energy (490.44 kcal) energy for every 1 kg of

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<sup>5</sup> Prices used in the analysis are based on 2020 figures obtained from Tesco online shopping.



emission. However, fish-based ready meals are the most efficient source of protein supply with an average of 18.33 g of protein per kg of CO<sub>2</sub>-eq emission.

Considering the source of protein, there were also significant differences across the 6 types of ready meals considered here. Beef-based ready meals were found to be the most inefficient source of energy compared to all other types. It generates the lowest amount of calories per kg of CO<sub>2</sub>-eq emission (112.91/kg). Comparatively, vegan/plant-based ready meals are the most efficient source of energy-producing 490.44 kcal of energy per 1 kg of emission. Fish-based ready meals were found to be the most efficient source of protein as they provide about 18 grams of protein per kg of CO<sub>2</sub>-eq emission. Moreover, from the climate perspective vegan ready meals are the most efficient source of carbohydrates. In summary, vegetable-based ready meals are the most efficient source of energy considering that it has the least environmental impact and the highest source of energy at the same emission rate. Switching from animal-based ready meals to plant-based ready meals presents the most sustainable option for ready meals consumers.

**Paste Table 4 here**

**Paste Table 4 here**

## **5. Conclusion**

This study attempt to bring to highlight the trends in positioning claims of ready meals launched in the UK. Also, we estimated how these positioning claims affect the affordability of ready meals. We concluded with a case study on the nutritional and carbon footprint of ready meals sold by a top retailer in the UK.

Our study shows that different ready meal attributes have value over which manufacturers rely on to maximize their market margins. Results from the study suggest that the following positioning claims: microwaveable, environmentally friendly package, no additives or preservatives, recycling, and vegetarian dominate in the UK ready meals market. Sustainable claims became important in the ready meals market after the year 2014. The top three launchers of ready meals are Wal-Mart, Tesco, and Marks and Spencer. Whilst new products were launched from 1996 to 2003, new variety/range extension of ready meals now dominate the market.

Various attributes are influential in determining the prices of ready meals. Environmental claims such as animal ethical claims and sustainable habitat/resource ethical claims increase





the prices of ready meals. On the other hand, products with recycling package claims are cheaper. Health and nutrition claims such as slimming and no/reduced allergen imply higher prices for ready meals whilst no/reduced fat or transfat claims tend to lower prices of ready meals. On average both environmental and health and nutrition claims imply higher prices for new ready meals launched.

In general, ready meals were rated amber for fat and have a medium impact on the environment. Specifically, plant-based ready meals are the cheapest source of energy, most environmentally friendly but lowest source of protein. Meat-based ready meals are the cheapest source of protein yet environmentally unfriendly.

Over the years producers have modified their ready meals to comply with the demand for more sustainable products. We recommend that consumers take advantage of these products to reduce the production of less sustainable ready meals. Also, manufacturers should increase advertisement on ready meals with sustainable claims to improve their performance after they are launched. Ready meals producers should consider improving the nutritional content (from amber to green) of ready meals to comply with current UK regulations.

Despite the significant implications of our results, the study faced some limitations. There is limited data on GHGe of ready meals. The data used for the analysis are few as such generalization of the result should be done with caution. Moreover, the GHGe depends on the production intensity and efficiency which is likely to change over time. Future studies should consider the comparison of the nutritional and emission content of ready meals sold across different UK segments.

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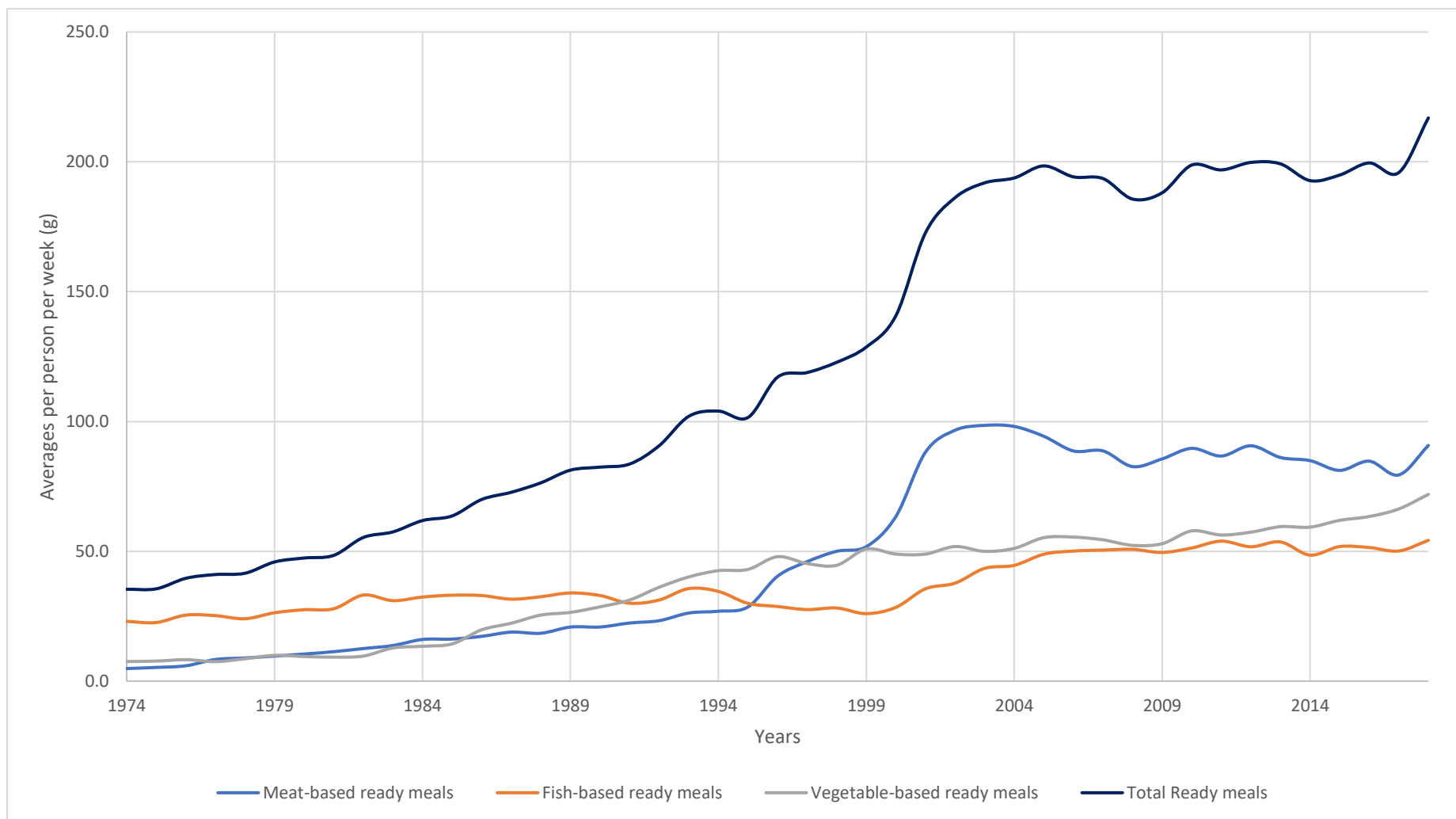
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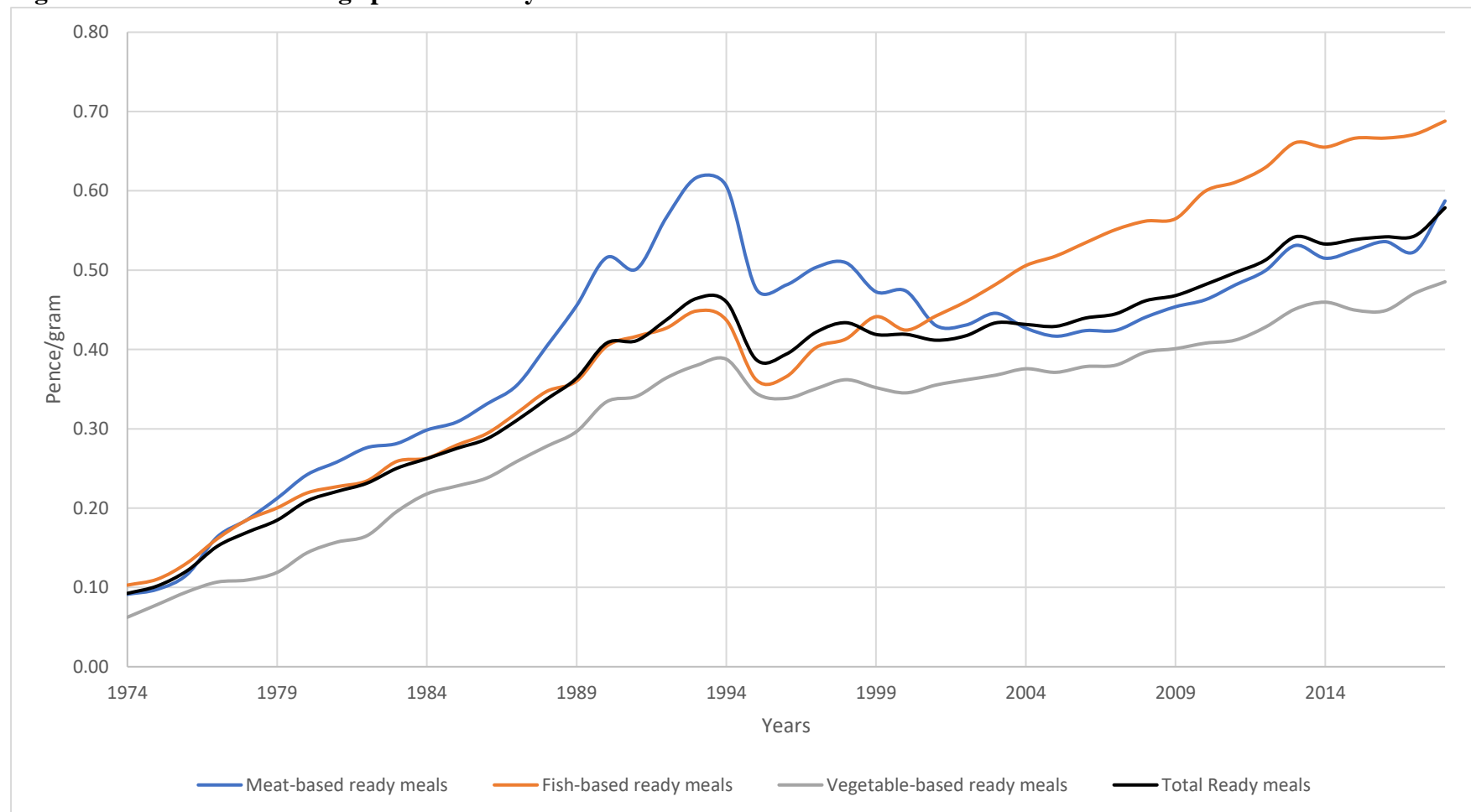
**Figure 1 Trends in the average weekly consumption of ready meals in the UK**



Source: Own elaboration based on DEFRA data

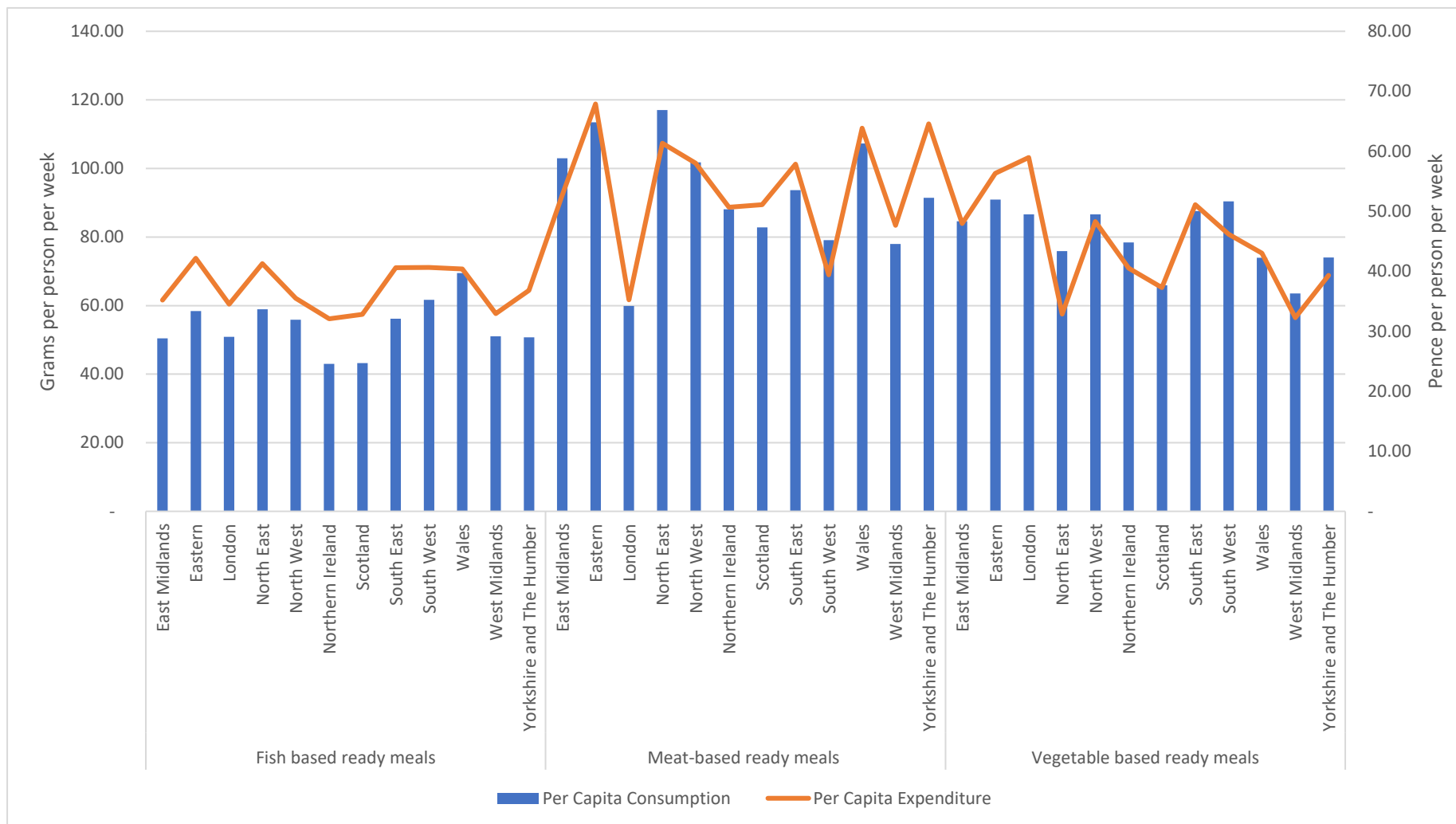


**Figure 2 Trends in the average price<sup>6</sup> of ready meals in the UK**



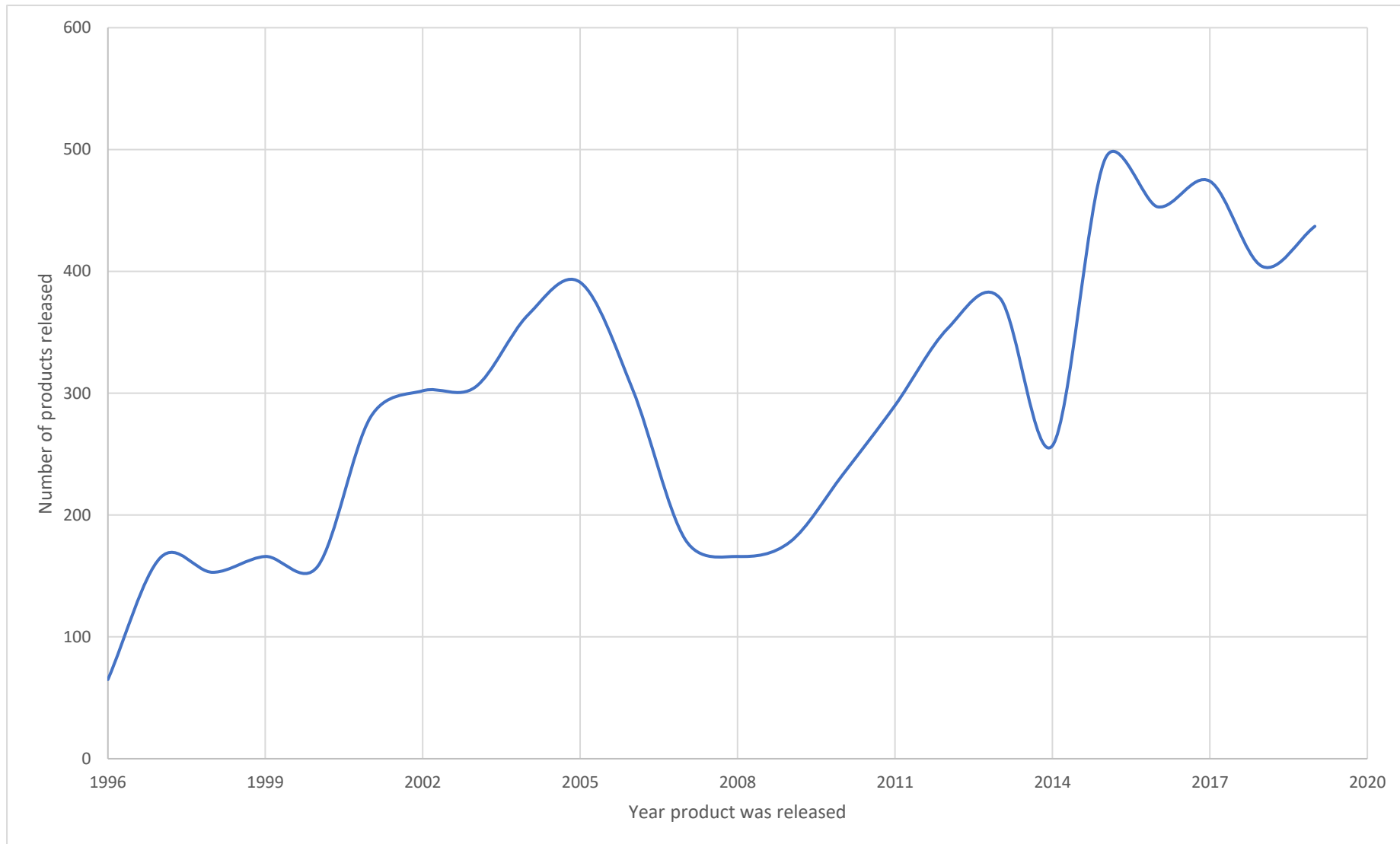
**Source: Own elaboration based on DEFRA data**

<sup>6</sup> These are unit values computed as total expenditure per person per week over the total quantity per person per week. This is for demonstrational purpose and ignores quality variation among the different groups of ready meals.



**Figure 3 Comparison of per capita consumption and expenditure on of fish-based, meat-based, and plant-based ready meals across different regions the UK**

Source: Own elaboration based on DEFRA data



**Figure 4. Number of ready meals launched between 1996 and 2019**

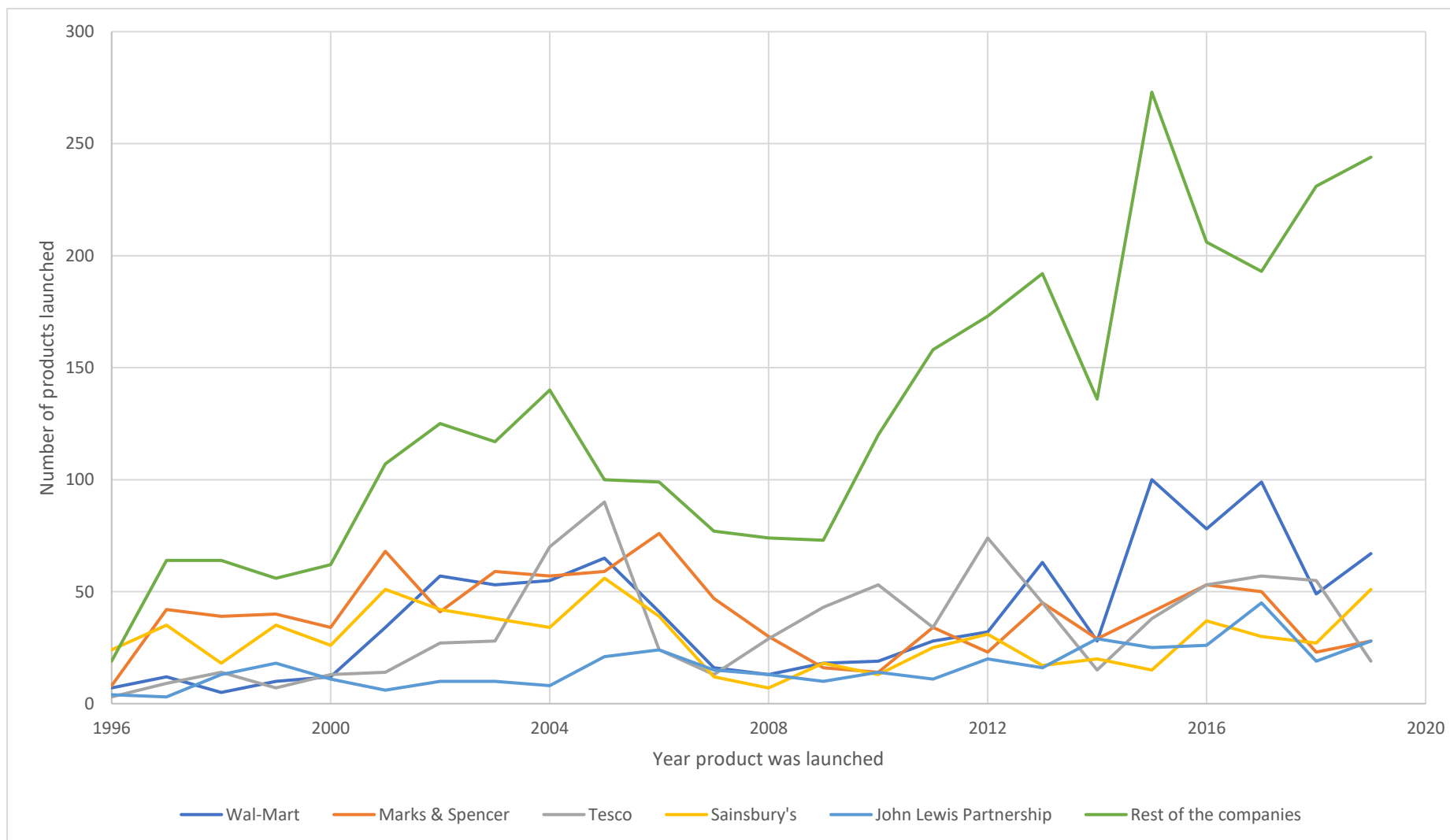
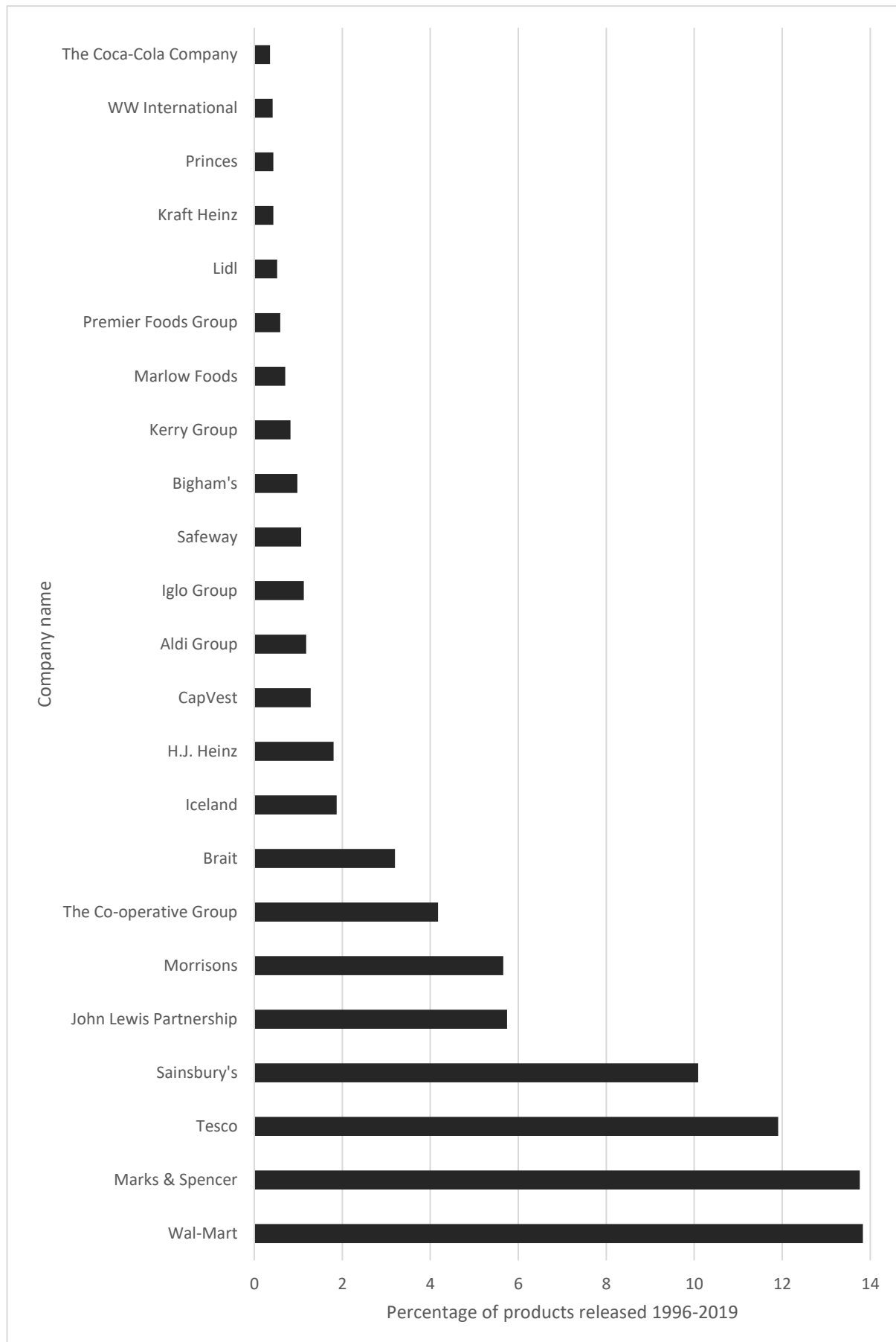
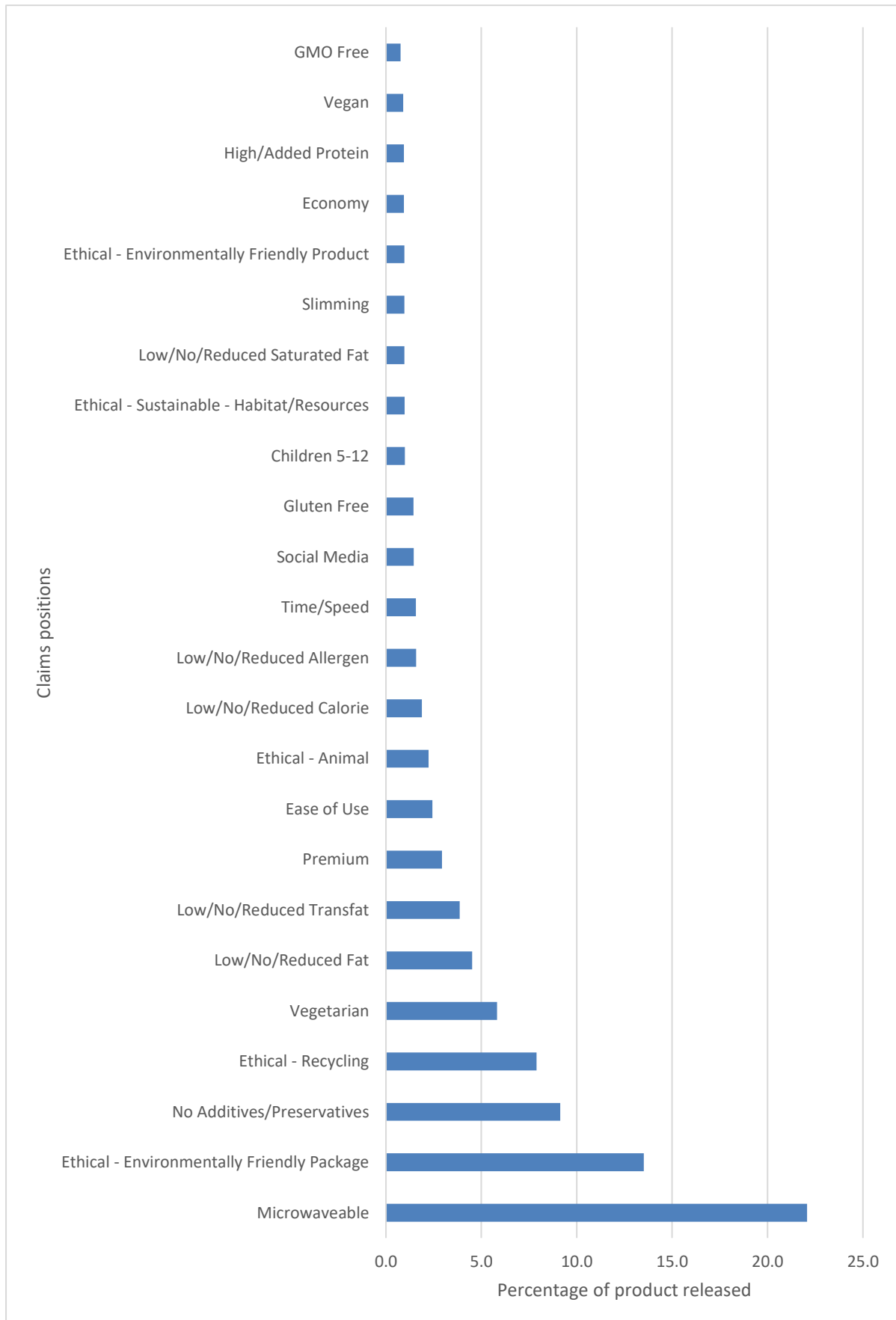


Figure 5. Number of ready meals launch by top retailers of ready meals in the UK from 1996 and 2019





**Figure 6. Percentage of ready meals launched by the top 23 manufacturers and retailers in the UK**



**Figure 7. percentage of ready meals launched by claims positioning**

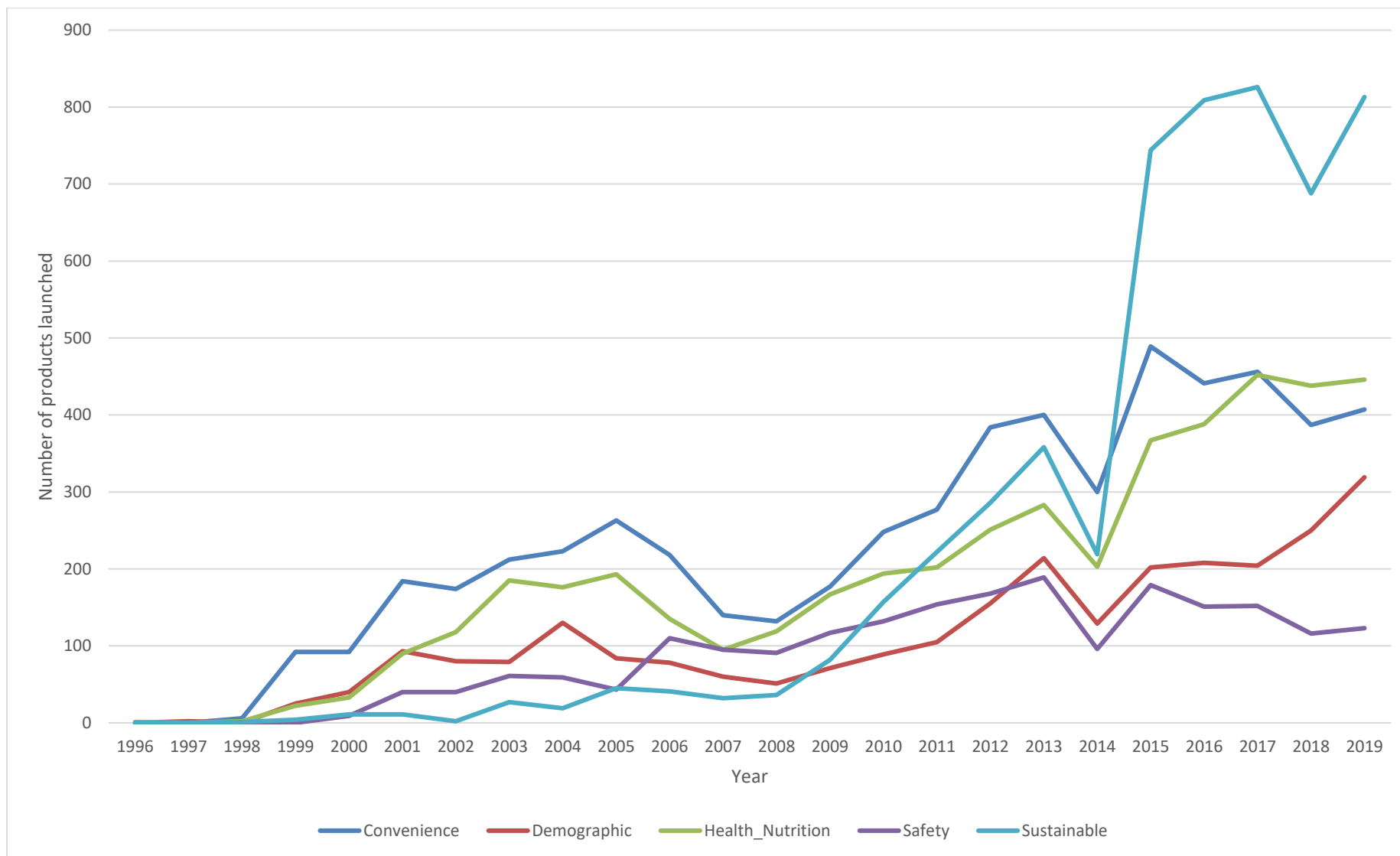


Figure 8. Number of ready meals released by claims category from 1996 to 2019

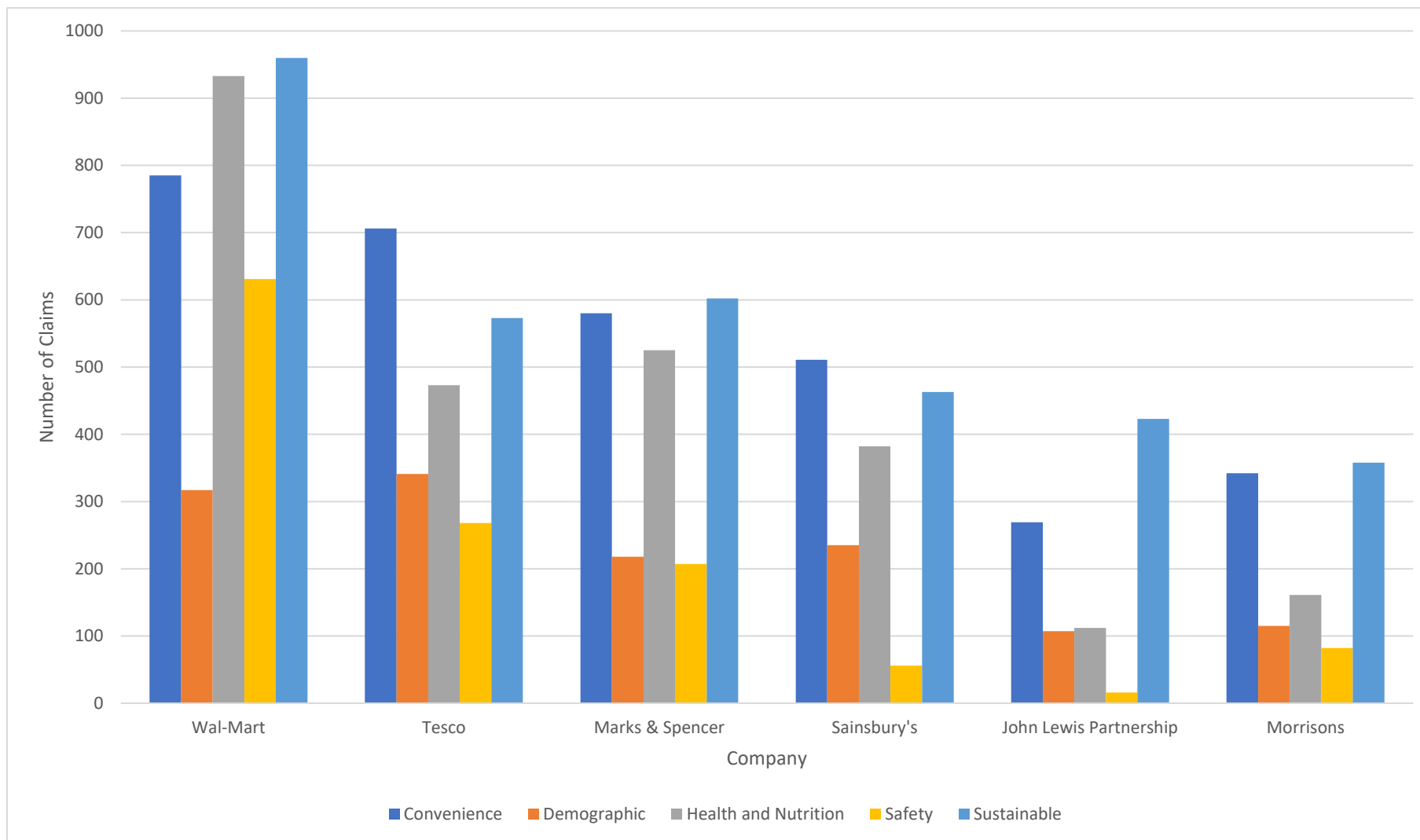


Figure 9. number of ready meals launched by claims category for the top retailers in the UK

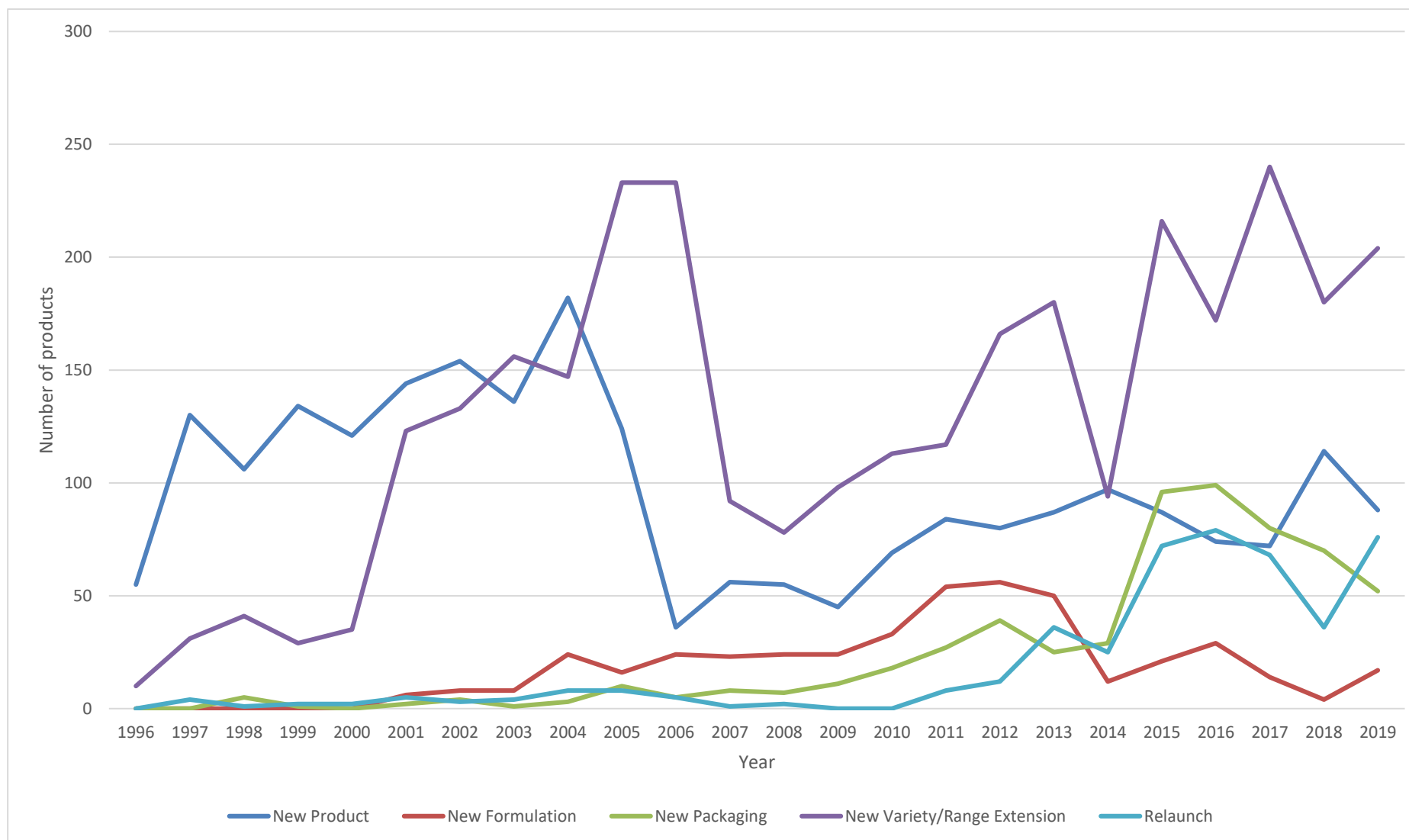


Figure 10. Trends in the number of ready meals by launch type

**Table 1. Descriptive Statistics**

<b>Feature</b>	<b>Description</b>	<b>Average</b>	<b>Std. Dev.</b>
Total Pack Size	(ml/g)	440.77	214.10
Price	£	2.74	1.52
<b>Convenience claim</b>			
Ease of Use	1 if labelled as ease of use, 0 otherwise	7.42%	0.26
Economy	1 if labelled as economy, 0 otherwise	3.00%	0.17
Microwaveable	1 if microwaveable, 0 otherwise	70.57%	0.46
On-the-Go	1 if labelled as on-the-go, 0 otherwise	0.75%	0.09
Time/Speed	1 if labelled as time/speed, 0 otherwise	4.83%	0.21
<b>Demographic Claim</b>			
Children 5-12	1 if suitable for children 5-12, 0 otherwise	3.00%	0.17
Premium	1 if labelled as premium, 0 otherwise	9.06%	0.29
Social Media	1 if labelled as social media, 0 otherwise	4.66%	0.21
Vegan	1 if suitable for vegans, 0 otherwise	2.83%	0.17
Vegetarian	1 if suitable for vegetarians, 0 otherwise	18.30%	0.39
<b>Health and nutrition claim</b>			
Gluten Free	1 if labelled as gluten free, 0 otherwise	4.51%	0.21
Low/No/Reduced Allergen	1 if labelled as Low/No/Reduced Allergen, 0 otherwise	4.91%	0.22
Low/No/Reduced Fat	1 if labelled as Low/No/Reduced Fat, 0 otherwise	14.24%	0.35
Low/No/Reduced Transfat	1 if labelled as low/no/reduced transfat, 0 otherwise	12.40%	0.33
Slimming	1 if labelled as slimming, 0 otherwise	3.13%	0.17
<b>Safety claim</b>			
GMO Free	1 if labelled as GMO free, 0 otherwise	2.31%	0.15
<b>Sustainable claim</b>			
Ethical - Animal	1 labelled as ethical-animal, 0 otherwise	7.06%	0.26
Ethical - Environmentally Friendly Package	1 if Ethical - Environmentally Friendly Package, other otherwise	44.03%	0.50
Ethical - Environmentally Friendly Product	1 if Ethical - Environmentally Friendly Product, 0 otherwise	3.08%	0.17
Ethical - Recycling	1 if Ethical – Recycling, Otherwise	25.77%	0.44
Ethical - Sustainable - Habitat/Resources	1 if Ethical - Sustainable - Habitat/Resources, 0 otherwise	3.10%	0.17
<b>Claim Category</b>			
Convenience	1 if labelled as convenience, 0 otherwise	88.26%	0.66
Demographic	1 if labelled as demographic, 0 otherwise	40.59%	0.65
Health and nutrition	1 if labelled as health and nutrition, 0 otherwise	70.55%	1.22
Safety	1 labelled as safety, 0 otherwise	32.71%	0.51
Sustainable	1 if labelled as sustainable, 0 otherwise	85.66%	1.01

**Table 1. Descriptive Statistics cont'd**

<b>Feature</b>	<b>Description</b>	<b>Average</b>	<b>Std. Dev.</b>
<b>Year</b>			
1998	1 if year 1998, 0 otherwise	1.97%	0.14
1999	1 if year 1999, 0 otherwise	2.20%	0.15
2000	1 if year 2000, 0 otherwise	1.77%	0.13
2001	1 if year 2001, 0 otherwise	3.89%	0.19
2002	1 if year 2002, 0 otherwise	4.25%	0.20
2003	1 if year 2003, 0 otherwise	4.43%	0.21
2004	1 if year 2004, 0 otherwise	5.11%	0.22
2005	1 if year 2005, 0 otherwise	5.56%	0.23
2006	1 if year 2006, 0 otherwise	4.27%	0.20
2007	1 if year 2007, 0 otherwise	2.20%	0.15
2008	1 if year 2008, 0 otherwise	2.09%	0.14
2009	1 if year 2009, 0 otherwise	2.78%	0.16
2010	1 if year 2010, 0 otherwise	3.63%	0.19
2011	1 if year 2011, 0 otherwise	4.42%	0.21
2012	1 if year 2012, 0 otherwise	5.62%	0.23
2013	1 if year 2013, 0 otherwise	6.02%	0.24
2014	1 if year 2014, 0 otherwise	3.92%	0.19
2015	1 if year 2015, 0 otherwise	7.84%	0.27
2016	1 if year 2016, 0 otherwise	7.23%	0.26
2017	1 if year 2017, 0 otherwise	7.47%	0.26
2018	1 if year 2018, 0 otherwise	6.42%	0.25
2019	1 if year 2019, 0 otherwise	6.94%	0.25
<b>Launch type</b>			
New Product	1 if new product, 0 otherwise	30.12%	0.46
New Formulation	1 if contains new formulation, 0 otherwise	7.03%	0.26
New Packaging	1 if has new packaging, 0 otherwise	9.12%	0.29
New Variety/Range Extension	1 if new variety/range extension, 0 otherwise	46.80%	0.50
Relaunch	1 if relaunch, 0 otherwise	6.92%	0.25
<b>Storage mode</b>			
Frozen	1 if frozen, 0 otherwise	22.83%	0.42
Shelf stable	1 if shelf stable, 0 otherwise	10.13%	0.30
Chilled	1 if chilled, 0 otherwise	66.67%	0.47

**Table 2. Ready meals: Average cost, pack size, CO<sub>2</sub>-eq emission and nutrient composition per 100 grams**

Composition	Cost	Pack Size	CO <sub>2</sub> -eq (grams)	Energy (kcal)	Fats (g)	Saturated Fat (g)	Carbohydrate (g)	Sugars (g)	Fibre (g)	Protein (g)	Salt (g)
All Meals	2.74 (0.20)	465.10 (23.74)	781.60 (184.80)	125.82 (4.96)	4.93 (0.39)	2.00 (0.21)	13.35 (0.80)	2.25 (0.15)	1.75 (0.13)	6.14 (0.42)	0.48 (0.02)
Fish Meals	3.13 (0.83)	446.25 (87.40)	405.00 (27.84)	113.75 (12.50)	4.80 (1.01)	2.25 (0.71)	9.63 (1.00)	1.43 (0.19)	1.20 (0.14)	7.38 (0.48)	0.50 (0.14)
Meat Meals	3.07 (0.25)	486.76 (31.03)	1,018.24 (262.96)	130.68 (5.56)	4.86 (0.48)	1.83 (0.21)	13.45 (0.94)	2.51 (0.18)	1.74 (0.15)	7.44 (0.37)	0.51 (0.02)
Vegan/Plant Meals	1.68 (0.15)	410.00 (34.26)	236.67 (18.60)	116.08 (12.66)	5.17 (0.86)	2.38 (0.60)	14.32 (1.94)	1.79 (0.29)	1.98 (0.31)	2.06 (0.24)	0.38 (0.03)
<b>Chi-square test<sup>4</sup></b>	<b>24.50</b> <b>&lt;0.01</b>	<b>2.80</b> <b>&gt;0.1</b>	<b>33.00</b> <b>&lt;0.01</b>	<b>2.30</b> <b>&gt;0.1</b>	<b>0.10</b> <b>&gt;0.1</b>	<b>0.97</b> <b>&gt;0.1</b>	<b>9.46</b> <b>&lt;0.01</b>	<b>17.35</b> <b>&lt;0.01</b>	<b>9.98</b> <b>&lt;0.01</b>	<b>201.70</b> <b>&lt;0.01</b>	<b>11.50</b> <b>&lt;0.01</b>
Fish	3.13 (0.83)	446.25 (87.40)	405.00 (27.84)	113.75 (12.50)	4.80 (1.01)	2.25 (0.71)	9.63 (1.00)	1.43 (0.19)	1.20 (0.14)	7.38 (0.48)	0.50 (0.14)
Beef	3.25 (0.52)	484.58 (46.97)	1,772.50 (707.75)	125.67 (9.64)	4.69 (0.54)	2.01 (0.21)	13.50 (1.25)	1.86 (0.20)	1.27 (0.19)	6.76 (0.65)	0.49 (0.04)
Chicken	2.96 (0.39)	508.33 (60.43)	556.00 (24.78)	141.16 (7.82)	5.22 (0.81)	1.78 (0.37)	13.99 (1.79)	3.08 (0.27)	2.18 (0.24)	8.47 (0.48)	0.53 (0.03)
Lamb	3.25 (0.25)	440.00 (13.54)	922.50 (87.79)	104.40 (8.98)	3.08 (0.39)	0.85 (0.17)	11.25 (2.16)	2.80 (0.70)	1.65 (0.18)	7.05 (0.88)	0.52 (0.06)
Pork	2.67 (0.44)	450.00 -	440.00 (168.03)	133.33 (25.34)	6.07 (3.04)	2.70 (1.25)	13.50 (2.00)	1.90 (0.38)	1.50 (0.38)	5.50 (1.36)	0.50 (0.10)
Vegan/Plant	1.68 (0.15)	410.00 (34.26)	236.67 (18.60)	116.08 (12.66)	5.17 (0.86)	2.38 (0.60)	14.32 (1.94)	1.79 (0.29)	1.98 (0.31)	2.06 (0.24)	0.38 (0.03)
<b>Chi-square test<sup>5</sup></b>	<b>39.92</b> <b>&lt;0.01</b>	<b>n/a</b>	<b>152.75</b> <b>&lt;0.01</b>	<b>10.77</b> <b>0.056</b>	<b>12.43</b> <b>0.029</b>	<b>24.57</b> <b>&lt;0.01</b>	<b>10.41</b> <b>0.064</b>	<b>27.99</b> <b>&lt;0.01</b>	<b>17.57</b> <b>&lt;0.01</b>	<b>233.32</b> <b>&lt;0.01</b>	<b>12.38</b> <b>0.030</b>

Source: Own elaboration based on GNPD data (standard errors are in the brackets)

<sup>4,5</sup> Test of differences between the means





**Figure 11. Ready meals: Nutrients per 100 grams**



Source: Own elaboration based on DEFRA data

**Table 3. Quantity of nutrient per pound of ready meal types consumed in the UK**

<b>Meal Composition</b>	<b>Energy (kcal/£)</b>	<b>Fats/£</b>	<b>saturates/£</b>	<b>Carbohydrate/£</b>	<b>Sugars/£</b>	<b>Fibre/£</b>	<b>Protein/£</b>	<b>Salt/£</b>
All Meals	248.27 (19.87)	9.25 (0.88)	3.71 (0.40)	28.45 (3.18)	4.47 (0.46)	3.70 (0.51)	10.97 (0.80)	0.98 (0.10)
Fish	194.55 (52.99)	8.02 (2.18)	3.44 (0.87)	17.49 (6.33)	2.65 (1.03)	1.87 (0.18)	12.10 (2.31)	0.85 (0.28)
Meat	234.59 (20.22)	8.46 (1.08)	3.15 (0.41)	25.26 (2.79)	4.59 (0.56)	3.20 (0.43)	12.79 (0.90)	0.98 (0.13)
Vegetable (i.e. potatoes)	304.91 (56.29)	11.87 (1.77)	5.40 (1.06)	41.14 (9.87)	4.71 (0.98)	5.72 (1.64)	5.44 (0.91)	1.02 (0.18)
<b>Chi-square test<sup>4</sup></b>	<b>2.11</b> <b>&gt;0.1</b>	<b>3.03</b> <b>&gt;0.1</b>	<b>3.97</b> <b>&gt;0.1</b>	<b>4.09</b> <b>&gt;0.1</b>	<b>3.00</b> <b>&gt;0.1</b>	<b>13.13</b> <b>&lt;0.01</b>	<b>34.49</b> <b>&lt;0.01</b>	<b>0.26</b> <b>&gt;0.1</b>
Fish	194.55 (52.99)	8.02 (2.18)	3.44 (0.87)	17.49 (6.33)	2.65 (1.03)	1.87 (0.18)	12.10 (2.31)	0.85 (0.28)
Beef	218.17 (33.98)	8.44 (1.86)	3.50 (0.59)	23.00 (3.05)	3.94 (1.34)	2.25 (0.37)	11.51 (1.64)	1.02 (0.33)
Chicken	274.53 (33.98)	9.48 (1.81)	3.16 (0.72)	29.72 (5.48)	5.59 (0.61)	4.30 (0.83)	15.48 (1.24)	1.04 (0.14)
Lamb	141.68 (8.37)	4.16 (0.43)	1.25 (0.38)	15.42 (2.92)	3.81 (0.91)	2.28 (0.31)	9.41 (0.44)	0.72 (0.13)
Pork	224.51 (14.20)	9.21 (3.20)	4.18 (1.26)	25.12 (7.35)	3.29 (0.68)	2.74 (1.01)	9.03 (0.92)	0.84 (0.06)
Vegetable (i.e. potatoes)	304.91 (56.29)	11.87 (1.77)	5.40 (1.06)	41.14 (9.87)	4.71 (0.98)	5.72 (1.64)	5.44 (0.91)	1.02 (0.18)
<b>Chi-square test<sup>5</sup></b>	<b>43.49</b> <b>&lt;0.01</b>	<b>31.97</b> <b>&lt;0.01</b>	<b>24.81</b> <b>&lt;0.01</b>	<b>11.39</b> <b>0.04</b>	<b>9.70</b> <b>0.08</b>	<b>14.30</b> <b>0.01</b>	<b>46.14</b> <b>&lt;0.01</b>	<b>4.00</b> <b>&gt;0.1</b>

Source: Own elaboration based on GNPS data (Standard errors are in bracket)

<sup>4,5</sup> Test of differences between the means

**Table 4. Nutrient content per Kg of ready meals consumed in the UK**

<b>Meal Composition</b>	<b>Energy (kcal/kg CO<sub>2</sub>)</b>	<b>Fats (g/kg CO<sub>2</sub>)</b>	<b>Saturates (g/kg CO<sub>2</sub>)</b>	<b>Carbohydrate (g/kg CO<sub>2</sub>)</b>	<b>Sugars (g/kg CO<sub>2</sub>)</b>	<b>Fibre (g/kg CO<sub>2</sub>)</b>	<b>Protein (g/kg CO<sub>2</sub>)</b>	<b>Salt (g/kg CO<sub>2</sub>eq)</b>
All meals	280.51 (24.27)	11.22 (1.32)	4.75 (0.76)	31.43 (3.56)	5.01 (0.56)	4.30 (0.56)	11.27 (0.81)	1.04 (0.09)
Fish	285.54 (37.16)	11.96 (2.40)	5.46 (1.54)	24.57 (4.30)	3.64 (0.73)	2.94 (0.22)	18.33 (1.09)	1.25 (0.35)
Meat	205.82 (22.24)	7.75 (1.24)	2.93 (0.54)	21.30 (2.81)	3.92 (0.42)	2.85 (0.39)	11.32 (1.03)	0.78 (0.08)
Vegetable	490.44 (34.04)	20.81 (2.70)	9.67 (2.22)	62.42 (7.12)	8.54 (1.64)	8.88 (1.41)	8.77 (1.03)	1.68 (0.20)
	<b>49.01</b>	<b>19.82</b>	<b>10.43</b>	<b>29.09</b>	<b>7.87</b>	<b>17.45</b>	<b>42.97</b>	<b>18.53</b>
<b>Chi-square test<sup>4</sup></b>	<b>&lt;0.01</b>	<b>&lt;0.01</b>	<b>&lt;0.01</b>	<b>&lt;0.01</b>	<b>0.02</b>	<b>&lt;0.01</b>	<b>&lt;0.01</b>	<b>&lt;0.01</b>
Fish	285.54 (37.16)	11.96 (2.40)	5.46 (1.54)	24.57 (4.30)	3.64 (0.73)	2.94 (0.22)	18.33 (1.09)	1.25 (0.35)
Beef	112.91 (13.83)	4.28 (0.65)	1.81 (0.27)	11.84 (1.47)	1.66 (0.23)	1.15 (0.22)	6.22 (0.92)	0.42 (0.05)
Chicken	266.03 (24.91)	9.77 (1.60)	3.34 (0.71)	26.98 (3.99)	5.57 (0.44)	4.03 (0.48)	15.56 (1.06)	0.99 (0.09)
Lamb	116.75 (16.23)	3.34 (0.29)	0.93 (0.19)	12.90 (3.04)	2.93 (0.42)	1.78 (0.03)	7.84 (1.29)	0.57 (0.09)
Pork	395.17 (128.46)	17.46 (9.76)	8.02 (4.07)	41.93 (18.34)	6.08 (2.30)	5.14 (2.46)	15.17 (4.90)	1.49 (0.49)
Vegetable	490.44 (34.04)	20.81 (2.70)	9.67 (2.22)	62.42 (7.12)	8.54 (1.64)	8.88 (1.41)	8.77 (1.03)	1.68 (0.20)
<b>Chi-square test<sup>5</sup></b>	<b>143.95</b> <b>&lt;0.01</b>	<b>70.07</b> <b>&lt;0.01</b>	<b>39.48</b> <b>&lt;0.01</b>	<b>65.11</b> <b>&lt;0.01</b>	<b>79.16</b> <b>&lt;0.01</b>	<b>83.54</b> <b>&lt;0.01</b>	<b>102.18</b> <b>&lt;0.01</b>	<b>68.88</b> <b>&lt;0.01</b>

Source: Own elaboration based on GNPS data (Standard errors are in brackets)



<sup>4,5</sup> Test of differences between the means

**Table 5. Parameter Estimates of the hedonic model**

<b>Groups</b>	<b>Independent variables</b>	<b>Estimate</b>
	(Intercept)	-1.32 *
	pack_size	0.43 *
<b>Sustainable Claims</b>	Ethical - Environmentally Friendly Package	-0.02
	Ethical - Animal	0.13 *
	Ethical - Recycling	-0.13 *
	Ethical - Environmentally Friendly Product	0.00
	Ethical - Sustainable - Habitat/Resources	0.22 *
<b>Health and Nutrition Claims</b>	Gluten Free	-0.07
	Low/No/Reduced Transfat	-0.10 *
	Low/No/Reduced Fat	-0.06 *
	Low/No/Reduced Allergen	0.25 *
	Slimming	0.07 *
	Low/No/Reduced Calorie	0.03
<b>Safety</b>	GMO Free	0.08 *
<b>Convenience Claims</b>	Ease of Use	0.15 *
	Premium	0.23 *
	Time/Speed	0.10 *
	Microwaveable	-0.14 *
<b>Demographic Claims</b>	Vegan	0.05
	Economy	-0.77 *
	Children 5-12	-0.31 *
	Social Media	0.16 *
	On-the-Go	0.17 *
	Vegetarian	-0.15 *
<b>Launch Type (Relaunch as reference year)</b>	New Product	0.10 *
	New Formulation	0.01
	New Packaging	0.01
	New Variety/Range Extension	0.09 *
<b>Storage (Chilled as reference variable)</b>	Frozen	-0.41 *
	Shelf stable	-0.70 *



Table 2. Parameter Estimates of the hedonic model cont'd

<b>Groups</b>	<b>Independent variables</b>	<b>Estimate</b>
<b>Country</b>	Country manufactured	0.08 *
	1998	-0.48 *
	1999	-0.32 *
	2000	-0.30 *
	2001	-0.28 *
<b>Years (2019 as reference year)</b>	2002	-0.32 *
	2003	-0.30 *
	2004	-0.32 *
	2005	-0.36 *
	2006	-0.28 *
	2007	-0.24 *
	2008	-0.18 *
	2009	-0.28 *
	2010	-0.22 *
	2011	-0.22 *
	2012	-0.19 *
	2013	-0.15 *
	2014	-0.10 *
	2015	-0.11 *
	2016	-0.05
	2017	-0.03
	2018	0.06 *

Sample size: 6,179

Multiple R-squared: 0.39

Adjusted R-squared: 0.39

F-statistic: 82.3, p-value: < 0.001