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Are supermarket food prices more or less likely to be discounted the longer they
remain without a sale?

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1. Motivation

Everyone buys food. In both developed and developing countries we increasingly buy our food from supermarkets. Promotional discounting (sales) has an influential role in supermarket price-setting behaviour with around 40% of price variation in UK food retailing being accounted for by them (Lloyd et al., 2009). Sales, which typically last 4 weeks for food products, have been the subject of much recent research (Berck et al 2008, Hosken and Reiffen, 2004, Nakamura and Steinsson, 2008) but little is known about the duration of non-sale prices, what we term 'regular' prices. This study analyses the duration of these regular price spells to investigate whether there are common patterns across product categories, supermarket chains and between branded and own label products. In particular, we address whether sales are more or less likely the longer the regular price prevails, and find that contrary to theories of sales behaviour, the longer the regular price persists, the less likely it will be discounted.

2. The Scanner Dataset

The research uses a high-frequency disaggregate-level scanner dataset (from Nielsen Scantrack) representing a comprehensive panel of weekly UK supermarket prices on over 1,700 products in 15 categories over a 2.5 year (2001-4) period, giving 231,069 individual price observations in total. Three dimensions of the database are particularly interesting: products are evaluated at a highly specific – barcode – level in up to seven of the UK's major food retailers (Tesco, Sainsbury, ASDA, Sainsbury, Somerfield, Kwik Save and Waitrose) and include both branded and own label products. Each time series of prices is identified at the product-supermarket level with a unique product code (UPC). Figure 1 illustrates the prices of one such UPC, 'Gerber Libbys Organic Orange Juice Tetra 1L 4Pack' in Waitrose, which experiences three sales during the sample each of which lasts approximately 4 weeks. As can be seen, the regular price spells last 46 and 52 weeks, suggesting that for this product, sales occur on an annual basis.

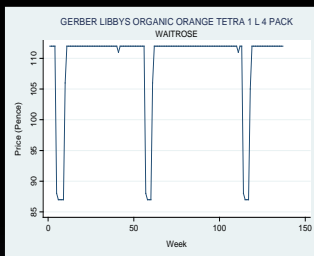


Figure 1: Price observations from a typical UPC

3. Theories of Sales

Varian (1980) develops a model of price setting in which sales occur randomly over time. In contrast, Sobel (1984) and Pesendorfer (2000) consider that the timing of sales is positively related to the price duration of the regular price. Hosken and Reiffen (2007) suggest that a product's durability (shelf-life) is significantly related to sales; Berck et al (2008) find that own-label products are promoted less than brands.

4. The Methodology

Using a statistical approach known as duration (or survival) analysis we analyse the duration of 6,007 regular price spells in 1704 UPCs to identify patterns across product categories, product format (fresh, frozen, ambient etc), supermarket chain and brand status. Although common in biomedical science and engineering, duration analysis has been used little in the analyses of prices (Fougère, 2007).

Using a parametric Maximum Likelihood approach (Jenkins, 2005; Kalbfleisch and Prentice, 2002; and Kiefer, 1988) we create a hypothetical distribution of price duration spells that gives the observed data the greatest probability of occurrence. From this we derive the hazard function, which estimates the probability that a product goes on sale. This is commonly known as the 'hazard', which we can make conditional on both time (the length of time since the last sale) and state-dependent influences (product category, supermarket chain, format and brand status). For every hazard function there is a corresponding survival function showing the probability that regular price spells persist. Plots of these functions portray the relationships in an easily interpretable manner.

5. Empirical Results

The estimated hazard and survivor functions illustrated in Figures 2 and 3 show that:

- The hazard is a non-monotonic curve which rises at first; reaches a peak and then falls as the duration of the regular price spell increases.
- The highest hazard that a sale occurs corresponds to the duration of 2 weeks although the probability of this is small at roughly 4%.
- Because the rate at which sales occur is so small, most products remain at regular prices for long periods of time, as emphasised by the survival function which shows that around 40% of regular price spells last one year.

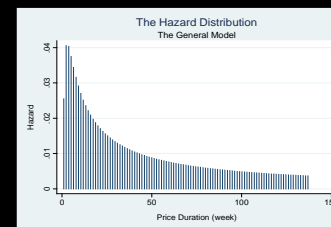


Figure 2: Hazard Rate of Food Prices since Last Sale

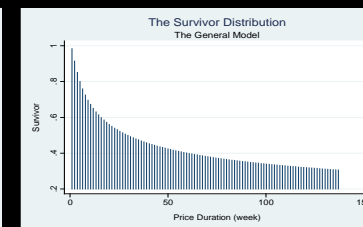


Figure 3: Survival Rate of Regular Food Prices since Last Sale

Results also underline the importance of the retailer on the duration of regular prices (and by implications the use of sales). Whereas most supermarket chain use sales similarly 'Hi-Lo' and everyday low pricing strategies of Sainsbury are clearly apparent

These results are also robust across product categories, formats (fresh, frozen, tinned etc) and brand status, and to a lesser extent by supermarket. Although the shape of the hazard function is remarkably similar there is statistically significant variation in the height (probability) of each hazard function on the graph which suggests:

- Regular price spells last longer for durable foods (tinned and ambient products) than perishable ('fresh', frozen) foods (Figure 3).
- Branded products are promoted more often than own-label products

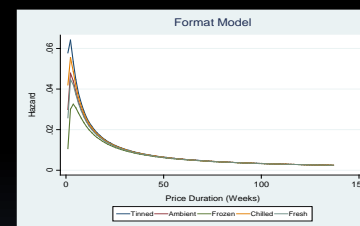


Figure 4: Sales Behaviour across Durability

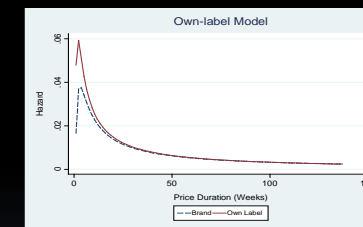


Figure 5: Sales Behaviour by Brand status

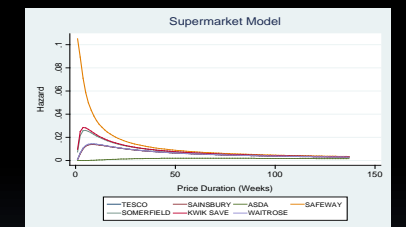


Figure 6: Sales Behaviour across Supermarkets

Results (see Figure 6) also underline the importance of the retailer on the duration of regular prices (and by implications the use of sales). Whereas most supermarket chain use sales similarly 'Hi-Lo' and everyday low pricing strategies of Sainsbury are clearly apparent.

6. Conclusion

In this paper, the preliminary results of a duration analysis of regular (non-sale) pricing is reported. While we all have an interest in knowing when the next sale will happen, understanding sales behaviour in a modern supermarket is an essential aspect of supermarket pricing. Contrary to received economic theory we find that the longer a regular price remains, the less likely it is that the product will be promoted. This finding is robust to product category, format and brand status, although less so by retailer, where clear differences in sales strategy are apparent. The study is on-going and aims to offer some explanation for the patterns that have been discovered.

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