WHY DO RETAILERS ADVERTISE STORE BRANDS DIFFERENTLY ACROSS PRODUCT CATEGORIES?*

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We provide new evidence on retailers’ pricing and advertising of store brands in the U.K. grocery markets. We analyse a simple Hotelling model in which retailers and manufacturers endogenously advertise their respective brands; we account for the impact of advertising on retailer–manufacturer bargaining and downstream competition. The model predicts that retailers advertise their store brands less when advertising is more rivalrous. We present empirical evidence consistent with this prediction. According to our model, aggregate consumer surplus can be higher with store brands than when they are absent from the market.

I. INTRODUCTION

The large and growing presence of store brands¹ in both the U.K. and the U.S. has led to a debate both about why retailers choose to sell such products and the impact that they have on consumer welfare (see Competition Commission [2006]). The literature has suggested that retailers offer store brands to facilitate retailer–manufacturer bargaining and downstream price discrimination. What has received relatively little attention is the effect of advertising on store brand penetration and how it may explain the large variation in store brand penetration across product categories, along with the implications that this has for welfare.

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¹Also known as private label or own label products.

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Our contribution in this paper is to demonstrate the potential welfare enhancing effects that can arise from the presence of store brand products. In markets in which advertising is rivalrous (it benefits a specific product rather than the entire category), advertising is typically over-provided by the market, because firms do not account for the negative externalities of their advertising on other firms. However, with a store brand the retailer internalises some of the negative externalities from rivalrous advertising, and so spends less on advertising. We show this effect in a simple Hotelling style model that focuses on the endogenous choices of retailers over product advertising and pricing and accounts for the impact these decisions have on retailer–manufacturer bargaining (via wholesale price setting) and downstream competition (via retail price setting). We show that the key predictions of the model are consistent with data. We provide new empirical evidence on the strategic behaviour of grocery retailers using comprehensive data on the U.K. grocery market. Our work brings together insights from existing studies on the effects of advertising on demand and the strategic decisions over store brands. What distinguishes our work from the existing literature is that, while other papers observe that variation in store brand penetration coincides with (and may be explained by) variation in advertising, they do not explain why advertising varies across product categories.

Store brands account for around half of grocery sales in the U.K., and in the U.S. around a quarter of sales and their share is growing. Store brand products sold by the large U.K. retail chains are, in general, equivalent in quality and compete directly with the large national brands. There is considerable variation in store brand penetration across product categories, and this is correlated with retailer advertising expenditure. Grocery retailers spend around £80 million each year advertising specific store brand products, concentrated in a small number of product categories. Several papers have observed that variation in store brand penetration coincides with, and may be explained by, variation in advertising (e.g. Hoch and Banerji [1993]). However, advertising is the result of strategic decisions that are made by retailers and manufacturers, and it is therefore important to understand what drives the differences in advertising, and hence store brand penetration, across categories.

We specify a simple model of the grocery market. We focus on the retailer’s incentives to advertise its store brand, which changes consumers’ perception of the quality of the product, taking into account the impact this has on its relations with consumers and suppliers. Retailer advertising is a topic that we believe has been relatively understudied in the literature on store brand penetration. Many studies of store brands have focused on their role in retailer–manufacturer bargaining (see, inter alia, Mills [1995], Scott Morton and Zettelmeyer [2004], Dubois and Jódar-Rosell [2010], Meza and

\[2\] See PLMA [2016a, 2016b].
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Sudhir [2010], Draganska et al. [2010]), price discrimination (for example, Corts [1998], Soberman and Parker [2004, 2006]) and in creating store loyalty (see Corstjens and Lal [2000], Bonfrer and Chintagunta [2004]) but have placed less emphasis on the role of advertising, and store brand advertising in particular. We allow for the fact that retailer-manufacturer bargaining over wholesale prices can affect retailers’ strategic decisions over its store brand, but we do not think this is the whole story. For example, pasta and rice have similar levels of concentration (the share of total national brand spending constituted by the largest national brand is 53% for pasta and 60% for rice), and therefore similar relative bargaining positions of retailers vis-à-vis manufacturers, but much larger differences in store brand penetration (64% for pasta, 35% for rice). Models that focus only on the bargaining motivation are not well placed to explain this variation. In contrast, variation in advertising patterns is correlated with store brand penetration. For example, the advertising to sales ratio in the rice category is four times as large as the advertising to sales ratio in the pasta category.

In our model, the manufacturer of a national brand profits only from the sales of its own product, and therefore its incentives are straightforward: it wants to advertise to maximise its sales revenue net of the advertising costs. The incentives of the retailer are more complicated, because the retailer profits from sales of its store brand and the national brand. There are situations in which it is more profitable to have a high-end national brand and budget store brand, and use the perceived quality difference to price discriminate between consumers. Alternatively, there are situations in which the retailer finds it optimal to market a quality-equivalent store brand to compete with the national brand. Several papers have documented the correlation between national brand advertising and store brand penetration (e.g. Hoch and Banerji [1993], Dhar and Hoch [1997], Karray and Martín-Herrán [2008, 2009]). We specify a model that highlights the relationship between the respective likelihoods of these situations and how consumers respond to advertising. This points to an important reason behind the joint variation in advertising (including store brand advertising) and store brand penetration across product categories by relating it to basic demand conditions. Our model is also able to explain the variation in store brand penetration across retailer formats by relating it to retailer size and the innate valuations and costs of producing store and national brands.

The model predicts that store brand penetration is lower in product categories in which advertising has a primarily rivalrous effect on consumer demand. In particular, we draw a distinction between (i) rivalrous

3 We see this pattern for other, also similar, product categories. For example, fruit juice and tea have concentration levels of 55% and 57% respectively, but store brand penetrations of 58% and 17% respectively. Bacon and sausages have concentrations of 41%, but store brand penetration of 83% and 61%.

4 In a recent meta-analysis of the determinants of store brand share Sethuraman and Gielens [2014] highlight the absence of work that focuses on store brand advertising.

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advertising, which affects demand for the advertised product at the expense of other products in the market (see, for instance, Friedman [1983], Roberts and Samuelson [1988], Slade [1995], Gasmi et al. [1992]), and (ii) expansionary advertising, which positively affects demand for all products in the market (see, for example, Shapiro [2018], Sahni [2016]). Intuitively, when advertising is rivalrous the national brand manufacturer can more easily make its brand more attractive relative to the store brand. Since the retailer profits from sales of both the store and national brand, it accepts that the national brand will be more attractive and exploits this by charging a higher price for the more popular national brand and reducing the price of its store brand. In equilibrium the market share of the store brand is lower than that of the national brand. In contrast, when the effect of advertising is primarily market expanding, there is a greater incentive for the retailer to advertise: by advertising they can increase the consumers’ valuations of both store and national brands and charge higher retail prices for both, a by-product of which is a higher market share for the store brand.

To investigate this prediction empirically, we need to rank product categories by the strength of the rivalrous effect of advertising. Recent papers in the empirical industrial organization literature have provided estimates of the effect of advertising on demand (for example, Ching et al. [2009], Lewis and Nguyen [2012], Anderson and Simester [2013], Shapiro [2018], Sahni [2016], Sinkinson and Starc [2015], Dubois et al. [2018], Hartmann and Klapper [2017]). Each of these papers focuses usually on one, but at most two or three, markets; they are able to credibly identify the demand effects of advertising by using innovative identification strategies and direct measures of advertising exposure. As these papers illustrate, to do this credibly for one market is a challenge; to do it for the sixty product categories that we study would be an incredibly difficult task. Thus, we take a different approach, constructing two measures of rivalrousness based on insights from the existing literature, and the equilibrium conditions from our model.

In particular, a number of papers show that when advertising is rivalrous (or predatory) it is over-provided by the market; conversely, when it is expansionary, it is under-provided. These include older, theoretical papers (see von der Fehr and Stevik [1998], Bloch and Manceau [1999], Netter [1982] and Buxton et al. [1984]), and newer papers that find this result empirically (e.g., Shapiro [2018], as well as others listed above). This implies that the advertising to sales ratio is higher in markets where advertising is more rivalrous. We show that store brands are less present, have lower market share and are advertised less in markets where the advertising to sales ratio is high. We also use our model directly; we show that under certain conditions, the ratio of the advertising differential between store and national brands to the price differential between the store and national brands is proportional to the rivalrous effect of advertising. We show that this measure of rivalrousness is also negatively correlated with store brand penetration. Finally, we show
that levels of store brand penetration are not correlated with market concentration, measured by the dominance of the national brand in the product category. This leads us to conclude that retailer-manufacturer bargaining motivations do not solely explain store brand penetration, and that at least part of the variation in store brand penetration across categories can be attributed to how consumers respond to advertising.

Our analysis also contributes to the literature that studies both the incentives of firms to advertise and the effect of advertising on, for example, prices and profits (see, for example, Milyo and Waldfogel [1999], Armstrong and Zhou [2011], Haan and Moraga-González [2011], Dubois et al. [2018], Murry [2017]). We use our simple model to show how accounting for the presence of store brands can qualitatively affect welfare calculations. Specifically, we compare the equilibrium values of consumer and producer surplus in our model with two benchmark cases: first, when there is no advertising, and second, where advertising is possible but there is no store brand presence in the category. We show that consumer surplus is higher when a store brand is present, and when retailers and manufacturers can advertise their products, than in either of the benchmark cases.

In the next section we develop the theoretical model. In Section III we document some empirical regularities about store brands in the British grocery market and relate the predictions from the model to these empirical facts. In Section IV we discuss the welfare implications of the model, in light of the empirical evidence. A final section summarises and concludes.

II. A MODEL OF STORE BRAND PENETRATION

We specify a simple model of firm behaviour in grocery retailing in order to highlight the relationship between store brand penetration and primitive characteristics of the market. The primitive that we are most interested in is the responsiveness of consumer demand in the category to advertising. Advertising is endogenously chosen (by retailers over the store brand and by the manufacturer over the national brand); prices and within category market share are set endogenously. The aim of this analysis is not to provide a definitive theory of store brand penetration, but rather to highlight several key features of the market and how they help to rationalise several key empirical facts.

Our model is parsimonious, but allows us to capture many of the features highlighted as important by the literature. In order to make the model tractable we assume that demand is Hotelling, that supermarkets are local monopolies, and that all retailers sell both a store brand and a national brand. We discuss robustness to these key assumptions and argue that relaxing various assumptions should not alter the main conclusions; our intuition is that the forces that we emphasise will also be at play in a wider class of alternative models.
We parameterise the size of individual (symmetric) retailers to help explain the prevalence of store brands in the (highly concentrated) supermarket industry, and gain insights into the variation in retailers’ store brand strategies. We restrict our analysis to the largest national brand per product category. This is motivated by the fact that, empirically, the dominance of the largest national brand does not appear to be correlated with the level of store brand penetration. We consider the implications of relaxing this assumption.

The model includes both vertical and horizontal product differentiation. Horizontal differentiation is exogenously given. However, vertical differentiation arises endogenously. By advertising, retailers and national brand manufacturers can increase the perceived quality of their product, and this also changes the scale of vertical differentiation relative to horizontal differentiation. The key feature that drives the results is the fact that, compared with national brand manufacturers, retailers have strikingly different incentives to advertise their store brands. Hence, depending on the primitive characteristics of demand (i.e., how consumers respond to advertising), the relative advertising outlays on the two types of products varies, which, in turn, affects the store brand penetration.

II(i). **Model Set-Up**

Consider a single product category with two product varieties: a store brand (variety 1, SB for short), and a national brand (variety 2, or NB). Each variety is produced by a different manufacturer and at constant marginal cost, where $c_i$ denotes the cost of producing variety $i \in \{1, 2\}$. There are $n$ retailers, indexed $j \in \{1, \ldots, n\}$, each purchasing both varieties from the two manufacturers and reselling them to consumers.

The game is played in three stages:

1. The NB manufacturer and each of the $n$ retailers simultaneously choose advertising efforts, where $a_2$ denotes the effort of the NB manufacturer advertising its NB, and $a'_j$ is the effort of retailer $j \in \{1, \ldots, n\}$ advertising variety 1 as its unique store brand.
2. Aware of the Stage 1 action choices, the NB manufacturer and the SB manufacturer simultaneously choose their wholesale (linear) prices, where $w'_i$ denotes the unit price of product variety $i \in \{1, 2\}$ at which the manufacturer is willing to sell it to retailer $j \in \{1, \ldots, n\}$.
3. Aware of the Stage 1 and Stage 2 action choices, each retailer sets its retail prices of both its SB and the NB (product varieties 1 and 2), simultaneously with other retailers, and where $p'_j$ denotes the price of product variety $i \in \{1, 2\}$ at retailer $j \in \{1, \ldots, n\}$.
Note on assumed timing and vertical relations
The above timing is common in the literature, reflecting the idea that retail prices are relatively easy to change and are usually set given, and in response to, wholesale prices, and that both wholesale and retail prices are easier to adjust than advertising and the image of the brand. While the retailers’ advertising efforts might seem fairly flexible, the image of a store brand is still created over a long period of time (often in line with the overall brand of the supermarket chain) and is likely to influence and inform the pricing decisions just as happens in our model.

Related to this, by controlling the advertising of their store brands, retailers can alter the terms of trade with the SB manufacturer. Since they cannot do the same with the NB, the bargaining position of its manufacturer is different from that of the manufacturer of the SB. Indeed, all of our main theoretical results continue to hold under an alternative specification, where either competition between multiple SB manufacturers or their vertical integration with retailers allows the latter to obtain product variety 1 at a price equal to its production cost (see Appendix A for details).5

Consumer demand
We model demand according to the classic Hotelling framework. The two product varieties are positioned at the opposite ends of the Hotelling line. The utility of a consumer with tastes characteristic $x$ of buying a unit of product variety $i$ from retailer $j$, is given by:

$$U_j^i(x) = V_j^i - p_j^i - t[x - (i - 1)],$$

where $t > 0$ is a parameter representing the degree of horizontal differentiation between the two product varieties, which may reflect differences in objective product features, or the consumers’ preferences for store vs. national brands. $V_j^i \geq 0$ denotes the valuation of variety $i$, which is the same for all consumers. We endogenize $V_j^i$, which allows for vertical differentiation in terms of quality that affects all consumers’ perception of the value of the product. Specifically, we allow $V_j^i$ to be determined by advertising in the following manner:

$$V_j^1 = v_1 + r d_1^j + g(a_1^j + a_2), V_j^2 = v_2 + r a_2 + g(a_1^j + a_2),$$

where $v_j$ is a parameter representing the ‘innate valuation’ of product variety $i$. This may be thought of as a ‘blind test’ quality of product variety $i$. In the absence of advertising, i.e., when $d_1^j = a_2 = 0$, we have $V_j^i = v_j$.

The parameters $r$ and $g$ capture the way in which consumer demand responds to advertising. In particular, $r \geq 0$ captures the strength of the ‘rivalrous’ effect of advertising (the extent to which advertising makes the advertised

5 See Hristakeva [2017] for a study of how including lump-sum payments affects the manufacturer-retailer interaction.
brand more attractive relative to the other brand). In contrast, $g \geq 0$ represents the expansionary effect (the extent to which advertising makes both products more attractive). The effect of advertising, whether rivalrous or expansionary, is to make the advertised brand more attractive to all consumers.

In line with the standard Hotelling framework, we assume that consumer tastes (as captured by $x$) are uniformly distributed on $[0, 1]$, and that this is the same for all retailers. A consumer with tastes $x$ shopping at retailer $j$ purchases a single unit of product variety $i$ if and only if:

$$U^j_i(x) > \max \left\{ U^j_i(x), 0 \right\}.$$  

We fix at $1/n$ the share of the total (unit) mass of consumers who shop at any given supermarket. We also denote by $x^j_i$ the fraction of all consumers loyal to retailer $j$ who choose to purchase product variety $i$ (i.e., ones for whom inequality (3) holds).

The above specification gives manufacturers and retailers control, by means of their advertising decisions, over the overall quality $V^j_i$ of each product variety perceived by the consumers (in particular, we could set $v_1 = v_2 = 0$, in which case $V^j_i$ is entirely dependent on advertising). Even though the consumers are differentiated in terms of their preferences for each variety rather than in terms of their valuation of quality, the incentive to differentiate the products in terms of quality and price (typical of vertical differentiation models) is also present here, as the equilibrium analysis in the next section will show.

**Note on the unit demand assumption**

The Hotelling set-up of the model assumes that consumers have unit demand for each product category. This is a strong assumption, but it makes the model much more tractable (in particular, it ensures the uniqueness of optimal retail prices, allowing for the equilibrium to be identified by backward induction). In addition, category demand in the model is not completely inelastic: if prices are too high, those consumers who cannot attain their reservation utility opt out of buying either brand. The only restriction is therefore fixing the quantity that a consumer buys when not choosing to opt out. In fact, even this requirement might be a fairly accurate approximation of the market that we investigate. For instance, it might be consistent with the behaviour of consumers who have a fixed quantity requirement, driven by calorie needs, or storage or transport costs (e.g., a family with two children that buys a gallon of milk a week).

**Payoffs**

We assume that the cost of advertising effort (whether by the NB manufacturer or by any of the retailers) is quadratic. Thus, the profit of retailer $j$ is given by:
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Observe that the smaller the values of \( r \) and \( g \), the larger the effective cost of advertising, since a larger advertising expenditure is required to achieve the same change in demand (i.e., \( x^j \)). Hence, we do not introduce an additional cost parameter as a multiplier of the quadratic cost component of \( \Pi^j \).

The total profits of the two manufacturers from selling to all retailers (\( \Pi^m_1 \) for the SB manufacturer and \( \Pi^m_2 \) for the NB manufacturer) are given by,

\[
\Pi^m_1 = \left( \frac{1}{n} \right) \left[ \sum_j (w^j_1 - c_1) x^j_1 \right]
\]

\[
\Pi^m_2 = \left( \frac{1}{n} \right) \left[ \sum_j (w^j_2 - c_2) x^j_2 \right] - (a_2)^2
\]

(note that the SB manufacturer does not conduct any advertising).

Note on the local monopoly assumption and the impact of store brand advertising

We do not directly model price competition between retailers, however, we can think of the consumers’ reservation utility as a factor that approximates it. In our model \( 1/n \) consumers shop in a given supermarket by default, for example, because of their location and convenience of the store, without actually monitoring prices at rival retailers. However, if prices at their preferred supermarket increase beyond a certain point then they opt out of purchasing. Most major U.K. supermarkets discourage shopping around by issuing loyalty cards and offering price match guarantees, and empirically we see that there is persistence in consumers’ supermarket choice.

Relatedly, it could be that store brand advertising might attract additional consumers into the store, with the mass of consumers no longer fixed at \( 1/n \), but instead increasing with \( a^j_1 \). This would constitute an additional effect of advertising, but one that is likely to affect the equilibrium outcome in a way similar to the existing expansionary effect. In particular, in Section II(iii) we demonstrate that only the retailers (as opposed to the manufacturers) have an interest in the expansionary effect of advertising, and that an increase of the associated \( g \) parameter increases the retailers’ revenues and advertising outlays. This is because, even though the mass of consumers stays at \( 1/n \) despite more SB advertising, its expansionary effect on the consumers’ utility means that the existing consumers increase their spending on the product category (while their tastes for different product varieties are unchanged). Thus, from the point of view of the retailer it is as if SB advertising could attract more consumers into the store via its expansionary effect.
To illustrate, consider the example of the ‘fresh fruit and vegetables’ category, in which (as our analysis in Section III shows) store brand penetration is relatively high. One could argue that the main reason why retailers would advertise in this case is because they might see the category as a ‘demand driver’ and hope to attract more consumers into the store, possibly at the expense of their rivals. While we acknowledge that we do not directly model this effect, it could nevertheless be approximated in the present framework via a value of $g$ being high relative to $r$. This means that the retailer’s advertising makes people willing to spend more on fruit and vegetables regardless of its exact variety, increasing the retailer’s revenue from the category without changing the relative prices of the products. As we shall see, the main point is that this makes retailers more interested in advertising compared with the national brand producers, a tendency that would still hold if $g$ instead represented the extent to which advertising can persuade consumers to switch retailers. While we refer to this scenario as ‘non-rivalrous’ advertising, we do not mean to say that this implies no rivalry of any type between the firms, only that the extent to which advertising of an individual brand gets the consumers to switch from other brands is relatively low.

Note on restricting to a single product category
It might be important to consider the potential impact of allowing for multiple product categories, and the potential spillover effects of advertising any SB on other SB’s offered by the same retailer in other categories (a tendency that could be strengthened by advertising an entire SB product range). This would likely have a similar effect as decreasing $n$ (increasing market concentration) does in the present model. In both cases, SB advertising of any single retailer affects a larger mass of consumers, increasing the retailers’ incentives to advertise in any product category. Hence, this would not change our conclusions about the role of different effects of advertising in the across-category variation in store brand penetration, or about the role of other parameters that we consider.

Existing studies (e.g., Thomassen et al. [2017]) demonstrate a potential pro-competitive effect of consumers buying products from several categories from the same supermarket, driven by cross-category price effects. However, this comes at the cost of not allowing for advertising decisions, interactions between retailers and suppliers, or product choices within product categories. In this paper we focus on these factors, which we consider likely to be important in explaining the cross-category variation in store brand penetration. A recent paper by Seiler and Yao [2017], which uses pathtracking data on consumers’ movements within a store, shows that advertising spillover between product categories is rather limited.
Parameter assumptions
In order to derive a unique Subgame-Perfect Nash Equilibrium (SPNE) of the game described above, we make the following three assumptions about the parameters:

1. Full market coverage: The innate valuations of the two varieties are sufficiently large relative to their production costs and the degree of horizontal differentiation between them:

\[(A1) \quad 4(v_1 + v_2) > 5(c_1 + c_2) + 24t.\]

This ensures that in the SPNE every consumer makes a purchase, i.e., we have \(x_1^j + x_2^j = 1\) for all \(j\). Thus, we eliminate equilibria in which the two product varieties are not substitutes, in the sense that a small change in the retail price of one does not affect the sales of the other. As a result, we may refer to \(x_1^j\) as the share of the store brand in retailer’s sales (abbreviated to SB share or SB penetration).

2. Positive market shares: The innate valuation of one product variety relative to its production cost is not much greater than a similar ‘relative valuation’ of the other variety:

\[(A2) \quad (v_1 - c_1) - (v_2 - c_2) \in \left[\frac{(2n - 1)r^2 - 3gr}{6n} - 6t, 6t - \frac{3gr + 2r^2}{6n}\right].\]

In other words, neither of the two product varieties is much ‘better’ than the other in terms of its innate valuation relative to cost. This is equivalent to having \(x_1^j, x_2^j > 0\) for all \(j\) in the SPNE, i.e., the SB and the NB each attract at least some consumers (this is consistent with our data).

3. Decreasing returns from advertising: The strength of the rivalrous effect of advertising is not too great relative to the degree of horizontal differentiation:

\[(A3) \quad r^2 < 24t.\]

This ensures that, given optimal choice of prices, the change in profits due to a marginal increase in stage-one advertising decreases with the existing level of advertising.

We also specify an additional assumption, which is not essential to obtaining the SPNE, but is required for some of the comparative statics results:

\[(A4) \quad v_1 - c_1 = v_2 - c_2.\]
This states that, although one variety may offer a higher quality to consumers than the other in the absence of advertising, it must also then be equally more costly to produce.

II(ii). Equilibrium

We solve the game by backward induction. The full details of the derivation (and proofs of the subsequent comparative statics results) are in Appendix A. In a subgame resulting from given stage one advertising choices, let $\hat{w}_i^j, \hat{p}_i^j$ and $\hat{x}_i^j$ denote the equilibrium wholesale and retail prices and SB shares (also let $\hat{W}_i$ and $\hat{P}_i^m$ denote the corresponding retailer and manufacturer profits). We then have:

\[
\begin{align*}
\hat{w}_1^j - \hat{w}_2^j &= \left( c_1 - c_2 + 2 \left[ V_1^j - V_2^j \right] \right) / 3 \\
\hat{p}_1^j - \hat{p}_2^j &= \left( c_1 - c_2 + 5 \left[ V_1^j - V_2^j \right] \right) / 6 \\
\hat{x}_1^j &= 1 - \hat{x}_2^j = (1/2) + \left( c_2 - c_1 + V_1^j - V_2^j \right) / (12t)
\end{align*}
\]

and recall that the values of $V_i^j$ are determined by advertising.

The equilibrium price formulae, substituted into the firms’ profit functions, in turn lead to the unique SPNE values of stage one advertising efforts. As is to be expected, in the SPNE $a_i^*$ is the same for all $j$ (and so, as a consequence, are the wholesale and retail prices). Hence, we drop the $j$ index and use $a_i^*$, $w_i^*$ and $p_i^*$ to denote the SPNE advertising efforts and prices. In addition, let $a_D^* = a_1^* - a_2^*$, $w_D^* = w_1^* - w_2^*$ and $p_D^* = p_1^* - p_2^*$ denote the equilibrium advertising and price differentials, and let $x^*$ denote the SPNE value of $x_1^j$, the same for all $j$.

II(iii). Comparative Statics

We now report and discuss the effect of the parameters of the model on various aspects of the equilibrium outcome, specifically the values of the retail price differential, $p_D^*$, the wholesale price differential, $w_D^*$, the advertising differential, $a_D^*$, and the level of store brand penetration, $x^*$. We begin with those effects that are relatively straightforward, in the sense that they have the same sign over the entire parameter range, without any additional assumptions.

Proposition 1. Under assumptions (A1)–(A3), the signs of the ceteris paribus effects of parameters $c, g, m$ and $v_i$ on the retail price differential, $p_D^*$,
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The wholesale price differential, \( w^*_p \), the advertising differential, \( a^*_p \), and the level of store brand penetration, \( x^* \), are as follows (the sign in each cell represents the sign of the derivative of the endogenous variable in the corresponding column with respect to the parameter in the corresponding row):

|                      | Retail price differential | Wholesale price differential | Advertising differential | Store brand penetration |
|----------------------|----------------------------|-----------------------------|--------------------------|-------------------------|
|                      | \( p^*_D \)                | \( w^*_D \)                 | \( a^*_D \)              | \( x^* \)               |
| SB cost              | \( c_1 \)                  | +/-                         | -                        | -                       |
| NB cost              | \( c_2 \)                  | +/-                         | +                        | +                       |
| Expansionary         |                            |                             |                          |                         |
| effect of            |                            |                             |                          |                         |
| advertising         |                            |                             |                          |                         |
| Number of            |                            |                             |                          |                         |
| retailers            | \( n \)                    | -                           | -                        | -                       |
| SB innate           | \( v_1 \)                  | 0                           | +                        | +                       |
| valuation            |                            |                             |                          |                         |
| NB innate           | \( v_2 \)                  | 0                           | -                        | -                       |
| valuation            |                            |                             |                          |                         |

The effect of changes in costs, \( (c_1, c_2) \) on the retail and wholesale price differentials, \( p^*_p, w^*_p \), depends on the values of the other parameters, hence the sign is left unspecified. However, the effect of a change in \( c_1 \) is always of the opposite sign to the effect of a change in \( c_2 \). ■

Innate valuations and costs of production

We now provide the economic intuition for the above results. To begin with, observe from equations (7)–(9) that it is beneficial for the retailer if one product variety becomes a lot more attractive relative to the other, i.e., if \( V^j_1 - V^j_2 \) is large, and this is true even if \( V^j_1 + V^j_2 \) remains unchanged. This is because the retailer can then price discriminate more effectively, by increasing the price of the more attractive (and more popular) variety. Even when simultaneously decreasing the price of the other variety (thereby keeping the market fully covered), the retailer therefore improves its profit margin on the more popular variety, which offsets the reduced margin on the less popular one. Naturally, manufacturers anticipate this and adjust the wholesale prices accordingly (making the more attractive variety more expensive for the retailer to obtain), but this only moderates the effect without offsetting or reversing it. Indeed, observe that the change in relative wholesale prices (equation 7) is always smaller in magnitude than the accompanying change in relative retail prices (equation 8), and that the variety that becomes more attractive increases its market share (equation 9).
As a result, for given advertising efforts, an increase in the innate valuation \( v_i \) increases \( V_i \), and so shifts the retail and wholesale price differentials in favour of \( i \), as well as increasing the brand’s share in total sales. In addition, brand \( i \) attracts more advertising expenditure, as it is more profitable to invest in the advertising of a product that appeals to a greater number of consumers (for a given advertising effort). This makes \( V_i \) even larger relative to \( V_{-i} \), further strengthening the effect in question.

Similarly, given the advertising efforts, an increase in the production cost \( c_i \) is reflected in the increase of the relative wholesale price of that variety, which in turn causes a change in relative retail prices in the same direction. However, as \( V_i \) is not affected, the share of variety \( i \) in total sales goes down. The last effect is reinforced by the fact that relative advertising of brand \( i \) decreases (as it is less profitable to advertise a less popular product). This in turn reduces \( V_i \) relative to \( V_{-i} \) with the negative effect on the retail price of \( i \), potentially offsetting the otherwise positive effect of \( c_i \) on the relative prices of \( i \). Whether or not this happens depends on other parameters, hence the sign of the corresponding effect is left unspecified in Proposition 1 (however, the effect of \( c_1 \) is always opposite to that of \( c_2 \)).

**Expansionary effect of advertising and market concentration**

Regarding the effects of \( g \) and \( n \), observe that, given the advertising efforts, these parameters do not affect \( V_1^j - V_2^j = v_1 - v_2 + r(d_1^j - a_2) \), and hence have no effect on the retail and wholesale price differentials (7 and 8), or the varieties’ market shares (9). Thus, the effect of each of those parameters on the equilibrium outcome variables is entirely down to any changes in \( a_{D}^* \) that they induce (which affects \( V_1^j - V_2^j \)), and has the same sign.

In particular, the effect of \( g \) on \( a_{D}^* \) is positive, because increasing both \( V_1^j \) and \( V_2^j \) by the same amount (due to the associated expansionary effect of advertising) leaves the wholesale prices and market shares unchanged, whilst increasing both retail prices (see Appendix A). In other words, the retailer captures the entire benefit from this change, while competition between manufacturers remains unaffected. This is because the retailer’s decision whether to sell more of one product instead of the other only depends on their relative attractiveness to consumers and relative wholesale prices, and the way they respond to wholesale price changes is unaffected if both products become equally more attractive. As a result, the expansionary effect of advertising is only of interest to retailers, but not to the national brand manufacturer, so that when \( g \) goes up only the former advertises more and \( a_{D}^* \) increases.

In contrast, an increase in \( n \) means individual retailers each sell to a smaller mass of loyal consumers. Hence, they each have less motivation to advertise their store brand, since any shift in consumer attitudes that advertising would cause is now applied to a smaller mass of customers. However, the same is not the case for the national brand manufacturer, whose product
WHY DO RETAILERS ADVERTISE STORE BRANDS DIFFERENTLY

is being offered by every retailer, and so any advertising of the national brand affects the same total mass of consumers in the market irrespective of how that mass is divided between retailers. Thus, an increase of \( n \) means individual retailers each advertise less relative to the national brand manufacturer, so that \( a_D^* \) falls. This may be related to existing empirical research that demonstrates that larger retailer size puts more competitive pressure on the upstream national brand manufacturers (Draganska and Klapper [2007]). Note that the same intuition would apply even if some retailers were larger than others. In particular, it readily follows from the model that, for any given \( a_2 \), the profit-maximizing \( a_1^* \) (and \( x_j^* \)) of any retailer \( j \) would increase with the individual size (consumer mass) of this retailer.

Rivalrous effect of advertising and degree of horizontal differentiation

The effects of the remaining two parameters, the rivalrous effects of advertising, \( r \), and the degree of horizontal differentiation, \( t \), on the equilibrium outcome are more complicated, and may change sign depending on the other parameters. Once again we may observe from equations (7)–(9) that the effects of a ceteris paribus change in \( r \) on \( p_D^* \), \( w_D^* \), and \( x^* \) all have the same direction. The same is easy to show with regards to \( t \), where, in addition, the direction of the effect on \( a_D^* \) is also necessarily the same. In order to be able to say more, we need to impose some additional restrictions on the parameters.

Proposition 2. Suppose assumption (A4) holds, and we have:

\[
g < (2n - 3)r/6,
\]

then the sign of the ceteris paribus effect of \( r \) on \( p_D^* \), \( w_D^* \), \( a_D^* \), and \( x^* \) is negative, and the sign of the ceteris paribus effect of \( t \) on \( p_D^* \), \( w_D^* \), \( a_D^* \), and \( x^* \) is positive.

Condition (10) states that the strength of the expansionary effect of advertising and the degree of market concentration are not too large (relative to the strength of the rivalrous effect). As discussed above, this means that the retailers’ incentives to advertise are small compared with the national brand manufacturer. In fact, under assumption (A4), (10) is equivalent to \( a_D^* < 0 \), i.e. the individual store brand’s being advertised less heavily than the national brand. Indeed, (10) is a sufficient, overly strong condition, and the results of Proposition 2 hold more generally when the retailers’ advertising outlays are ‘not much greater’ than those of the national brand manufacturer.

The reason behind this is that when advertising adds little to the attractiveness of the product category (and would in any case affect only a
small mass of consumers), the retailers’ primary motive is to ensure that
the two varieties differ in how attractive to consumers they are, in order to
facilitate discriminatory pricing. Rather than trying to outspend the na-
tional brand manufacturer, a less costly way to achieve this objective is
to let it conduct all (or most of) the advertising and bear the associated
cost. When \( r \) increases, this tendency is further strengthened, because the
national brand manufacturer is willing to advertise more, recognizing
that \( V^j_2 - V^j_1 = r \left( a_2 - a_1^j \right) + v_2 - v_1 \) now increases more with \( a_2 \), and so does
\( w^j_2 \) and \( x^j_2 \) (for every \( j \)). Thus, \( a^*_D \) decreases, along with the other outcome
variables.

Put in this context, the fact that the effect of \( t \) is positive (i.e., the opposite
of the effect of \( r \)) is not surprising. An increase in \( t \) means that consum-
ers have stronger a priori preferences towards the two product varieties (or
more generally towards store brands vs. national brands), so that it takes
a greater advertising effort to sway their choices. Hence, an increase in \( t \) is
intuitively analogous in its effect to a decrease in \( r \).

Lastly, note that since \( x^* \) has been shown to move in the same direction
as \( p^*_D \), the comparative statics of \( x^* \) are the same as those of the share of the
SB in the total sales within the product category.

**Note on the informative effects of advertising**

In our model we assume that advertising plays a persuasive role in affecting
consumer demand. If we were to model advertising as having informative
effects, we do not think this would necessarily cause a qualitative change
in the results.

Suppose that the rivalrousness of advertising means that each firm can
use it to increase the visibility of its product, i.e., increase the fraction of
consumers who know about its product relative to those who are informed
about the rival product. The retailer would be less interested in advertis-
ing its store brand (compared with the national brand manufacturer), and
may prefer a situation in which the national brand, which it can sell it at a
premium, is more widely known by shoppers, while targeting the better-in-
formed customers with the store brand and reducing its advertising outlays.
The retailer would instead be more interested in the kind of informative
advertising that would inform potential consumers more generally about its
product offering (rather than about a specific product), thereby increasing
the mass of consumers who visit the store. Consequently, these two ways in
which informative advertising could enter the model would have impacts
that are similar to our rivalrous versus global varieties of (persuasive) ad-
vertising. Either way, observing a within-category price differential that
is large relative to the advertising differential would be indicative of rival-
rousness, and can be explained (as above) via differences in the motives
for advertising on behalf of retailers versus national brand manufacturers.
This, in turn, translates into store brand penetration being inversely related to rivalrousness across categories.

III. EVIDENCE FROM THE U.K. GROCERY MARKET

In this section we document empirical evidence on the pricing and advertising of store brands and show that it is consistent with several predictions of the model.

III(i). Retailers and Product Categories

The U.K. grocery retail market is concentrated: the largest retailer chain, Tesco, accounts for over 25% of sales, and the top four retailer chains for 70% of sales. There are four dominant retail formats, shown in Table I. Retailers vary in the size of their stores, the shopping experience that they provide, and their product offering. Mid-range supermarkets offer a complete range of branded and store brand products across all product categories. The high-value supermarkets offer a more limited range of higher quality items and a more attractive shopping experience, and charge higher prices, while the discounters also offer a more limited range, but with a cheaper and less attractive shopping experience. Within the mid-range supermarkets, the

| Table I                                                                 |
|------------------------------------------------------------------------|
| U.K. Grocery Retail Market                                             |
| Share of U.K. grocery sales                                           |
| **Mid-range large supermarkets (‘Big 4’)**                            |
| Tesco                                                                  | 26.6 |
| Sainsbury                                                              | 16.2 |
| Asda                                                                   | 15.2 |
| Morrisons                                                              | 12.3 |
| **Mid-range small supermarkets**                                       |
| Co-op                                                                  | 6.4  |
| Spar                                                                   | 0.2  |
| Budgen                                                                 | 0.2  |
| **High-value supermarkets**                                            |
| Waitrose                                                               | 4.8  |
| Marks + Spencers                                                       | 3.8  |
| **Discount supermarkets**                                              |
| Aldi                                                                   | 2.2  |
| Lidl                                                                   | 2.5  |

Notes: The retailer’s share of U.K. grocery sales is across all grocery purchases (food, drinks, toiletries, household goods) in 2011.
'Big 4' supermarkets are large national chains that mainly have large out of town stores with average floor space of 25–60,000 sq. ft.; and the smaller chains, which tend to be smaller stores with average floor space ranging from 3,000 to 25,000 sq. ft., and are located nearer to city centres.

We use data on grocery purchases (food, drinks, toiletries, household goods) made by a representative sample of roughly 20,000 British households from the Kantar Worldpanel (from January, 2005 to December, 2011). The data are collected using handheld scanners in the home. They are recorded at the barcode (UPC) level and contain details on the exact price, the brand (including whether or not it is a budget or quality-equivalent store brand), the retailer in which the product was purchased and a range of other product, household and store characteristics. This type of market research data is widely used for empirical research in both the U.K. and U.S.; for example, Aguiar and Hurst [2005, 2007] and Dubois et al. [2018]. For further details on this and similar U.S. data, see Einav et al. [2008] and for U.K. data see Leicester and Oldfield [2009].

Kantar identifies 205 product categories, which are used by retailers and food manufacturers to group products in way that approximates an economic market (goods that are seen by consumers as close substitutes); examples include poultry, household cleaners, chilled ready meals, biscuits, wine, and milk. We focus on the 60 largest product categories and on purchases made in the U.K.'s 11 largest supermarket retailers; together these account for over 70% of total consumer grocery expenditure in 2011. Table BI in the Appendix lists the product categories.

There is considerable variation in store brand penetration across product categories, but little over time. We measure store brand penetration as the share of expenditure on store brands in total expenditure. Figure 1(a) shows that over the period 2005 to 2011, the average level of store brand penetration across all product categories and retailers has remained stable at around 50%. This is consistent with the results from Dubé et al. [2016], who find that the Great Recession had little impact on store brand penetration in the U.S.. Figure 1(b) shows store brand penetration across product categories in 2011, which varies from almost zero to almost 100%. Table BI in the Appendix lists store brand penetration for all sixty product categories in each year. We see the same pattern over time within each product category, indicating that 1(a) is not being driven by compositional effects.

In Section II we made the assumption (A4) that, although one variety may offer a higher quality to consumers than the other in the absence of advertising, it must also then be equally more costly to produce. In order to consider the empirical relevance of this assumption we first use the categorisation by the market research firm Kantar. Kantar distinguishes store and national brands, and within store brands they distinguish 'quality-equivalent' and 'budget' store brands. Quality-equivalent store brands
are typically similar to the national brands in terms of how they are priced and packaged. Budget store brands are typically cheaper than the national and quality-equivalent store brands and are sold in plain packaging. See Figure 2 for some examples of the packaging of national brands, quality-equivalent and budget store brands. Table II shows that the bulk of store brands sold in the Big 4 supermarkets are quality-equivalent. Discounters, on the other hand, sell mainly budget store brands.

III(ii).  

Store Brand Penetration Across Retailers

Table II shows variation in the store brand penetration across retailers. In this section, we relate the variation across retailer formats to two predictions from the theory: (i) the relationship between costs and innate valuations and store brand penetration, and (ii) the relationship between retailer size and store brand penetration.

Innate valuations, costs and store brand penetration

Table II shows that the high-value and discounter retailers appear to follow different strategies to the mid-range large supermarkets. Differences in the innate valuations and costs of production might explain the variation in store brand penetration and advertising/pricing strategies pursued by different retailer formats.
The categorisation of products by Kantar suggest that consumers view the store brands in the high-value supermarkets as equivalent, or even higher quality than their national brand equivalents, and this is consistent with the patterns of store brand penetration that we see in the data. However, the Kantar categorisation also suggests that consumers view store brands in the discounters as inherently lower quality, which might lead us to expect lower store brand penetration, which is not what we see. In the model we assume that that any difference in innate quality is accompanied by an

Figure 2
Examples of Store and National Brands.

Notes: For three product categories (top row: baked beans; middle row: pizza; bottom row: ice cream) the national brand, quality-equivalent and budget store brands (Tesco store brands) are pictured. [Colour figure can be viewed at wileyonlinelibrary.com]
increase in production cost, see assumption (A4). If the cost of producing store brands, $c_1$, is sufficiently lower than the cost of the national brand, $c_2$, then we would expect to see higher store brand penetration, despite $v_1 < v_2$. We look at the price differentials between the store and national brands within different retailers to lend support to this assumption.

The high-value supermarkets offer a more limited range of higher quality items and a more attractive shopping experience, but charge higher prices, while the discounters also offer a more limited range but with a cheaper and less attractive shopping experience. This is reflected in the relative price differentials of store and national brands across retailer formats. We calculate the price differential for each retailer-category combination as:

| Table II |
| Store Brand Penetration, by Retailer |
| Share of sales within store |
| Store brand | National brands |
| quality-equivalent | budget | total | (1) | (2) | (3) | (4) |

For Mid-range large supermarkets ('Big 4')
- Tesco: 45.0 4.7 49.7 50.3
- Sainsbury: 48.0 4.9 52.9 47.1
- Asda: 43.9 4.7 48.6 51.4
- Morrisons: 45.0 2.9 47.9 52.1

For Mid-range small supermarkets
- Co-op: 43.2 1.1 44.3 55.7
- Spar: 30.6 0.1 30.7 69.3
- Budgen: 27.6 0.0 27.6 72.4

For High-value supermarkets
- Waitrose: 57.8 0.0 57.9 42.1
- Marks + Spencers: 98.6 0.0 98.6 1.4

For Discount supermarkets
- Aldi: 1.4 89.1 90.5 9.5
- Lidl: 5.4 71.1 76.5 23.5

Notes: Numbers are for 2011. Columns (1)–(2) show the share of sales within each retailer of quality-equivalent and budget store brands; column (3) shows the sum of the numbers in columns (1) and (2). Column (4) shows the remaining share of sales, on national brands.
which is the level difference in the prices of the store brand, $p_{1jk}$, and national brand, $p_{2jk}$, in retailer $j$ and category $k$, scaled by the average price in the retailer-category pair. A value of zero means the two products are priced the same, a value of -0.5 says that the store brand price is half of the average within category price, a value of +0.5 says that the store brand price is 50% higher than the average within category price.

Figure 3 plots the distributions of $\Delta p_{jk}$ across categories for the big four (Tesco, Sainsbury’s, Asda and Morrisons), the high-value retailers (Waitrose and Marks & Spencer) and the discounters (Aldi and Lidl). The mean price differential ($\Delta p_{jk}$) across all categories for Marks & Spencer is 0.12 (i.e., the store brands are on average 12% more expensive than the average within-category price sold in Marks & Spencer). For Waitrose it is below zero (−0.12). The distribution shows this varies from around −1.5–1.0. In contrast, the majority of the distribution for Aldi and Lidl is below zero: their store brand products are a lot cheaper than the national brands that they sell. The mean for Aldi it is −0.46 and for Lidl −0.42. The Big 4 supermarkets are in between, the average range across the stores between −0.32 and −0.40.

![Figure 3](image-url)

**Figure 3**
Density of Price Differentials for Different Retailer Formats.

_Notes:_ Kernel densities are estimated using the 60 largest product categories for each retailer. If the store brand price is missing for a category within a retailer, the average across all retailers is used. The price differential is calculated using equation (11).
These patterns accord with what we would expect if assumption (A4) holds. The price levels are most similar in the retailers that are generally thought of as offering the highest quality store brand products, and the price levels are most different in those retailers that are perceived to offer a lower quality product, the ‘discounters.’ The remainder of our analysis relies on assumption (A4), namely that although one variety may offer a higher quality to consumers than the other in the absence of advertising, it must also then be equally more costly to produce.

Retailer size and store brand penetration

The mid-range supermarkets also vary in size, and seem to follow different strategies. This can be rationalised within the model developed in Section II by using the comparative statics with respect to retailer size. Specifically, the model predicts that, all else equal, store brand penetration is higher for larger retailers. This is because they each sell to a greater mass of loyal consumers, which increases their incentives to advertise relative to the national brand manufacturer.

The empirical evidence that larger retailers have higher levels of store brand penetration is consistent with this prediction. Figure IV shows the distributions of store brand penetration in the large (the Big 4 supermarkets)
and smaller retailers (Co-op, Spar and Budgen). The distribution of store brand penetration for the small supermarkets is to the left of the distribution for the large supermarkets.

There may be a concern that this result is due to different product categories being sold by different sized supermarkets. For example, if smaller stores are more often frequented for top-up shopping trips (see Bliss [1988], Armstrong and Vickers [2001]), and different product categories (which have different levels of store brand penetration) are disproportionately purchased on these trips, then this could lead to an observed correlation between store brand penetration and retailer size. To deal with this potentially confounding effect, we calculate the average store brand penetration for each set of supermarkets within each product category. Figure 5 shows that for all but three categories (eggs, spirits, and wine), store brand penetration is higher in the large supermarkets than the small ones. The relationship between retailer size and store brand penetration therefore still holds, even after controlling for the potentially confounding compositional effects.

III(iii). Store Brand Penetration Across Product Categories

Figure 1(b) shows that there is substantial variation in the levels of store brand penetration across product categories. In this section we explore further this variation, and relate it directly to the predictions derived in

[Image: Figure 5]

Store Brand Penetration for the Large and Small Supermarkets by Product Category. Notes: Bars show the average store brand penetration in each category for retailers in the set of large and small supermarkets, respectively.
Section II regarding the relationship between store brand penetration and the effects of advertising on consumer demand.

*Retailer advertising of store brands*

To measure advertising expenditure we use information from Nielsen [2011]. These data record all advertising expenditure (on adverts on television, radio, in the printed press, on billboards and online) in the U.K. each month by brand.

We match the purchase data from Kantar with the data from Nielsen on the total advertising expenditure in 2011 at the brand level for the eleven store brands and for the two largest national brands in each of the sixty product categories. Table III shows advertising expenditure by retailer.

Supermarkets advertise in two ways: they advertise specific products and they advertise their product ranges. For example, an advert for Sainsbury’s dry cure bacon is an advert for specific product, while an advert for Sainsbury’s ‘Be Good to Yourself’ range is an advert for the entire store brand range of products.

Table III shows the total advertising expenditure by the major retailers in 2011, and how it is split between the advertising of its product range and specific products. A significant proportion of supermarkets advertising is spent on advertising its entire product ranges. However, between 25% and 45% of the Big 4’s expenditure is spent on advertising specific store brand products; the numbers are similar for Co-op, Waitrose, Marks & Spencer and Aldi, with much lower levels for the other supermarkets. This equates to roughly £ 80 million in 2011 across the Big 4 supermarkets. This is a non-trivial advertising outlay – we are interested in how this is split across product categories, and what might explain the variation across categories.

In the empirical analysis relating to the theoretical predictions, below, we include both range and product specific advertising in the calculation of advertising spending on store brands in each category. However, we first describe the variation in product specific advertising across categories.

Advertising levels differ across product categories for both national brands and store brands. For the remainder of this section, we focus on the advertising decisions of the four large supermarkets (Tesco, Sainsburys, Asda and Morrisons). These retailers cover all product categories, appear similar in their strategy towards store brand provision, and conduct almost 70% of the advertising done by supermarkets.

For each retailer we calculate the percentage of their product-specific advertising that they spend on each product category, and take the average value across retailers within each product category. We split the sixty product categories into quartiles based on the average of share of retailer advertising that they account for, see Table IV. The fifteen most advertised product categories account for most (86%) of the total product-specific
advertising conducted by retailers. The average store brand penetration within these product categories is 0.55, compared to 0.25 for the least advertised categories. The most advertised categories have twice the level of sales of the least advertised categories, but attract more than seven times the amount of advertising expenditure.

Retailers appear to be concentrating their product-specific advertising in a small number of product categories, which have higher than average levels of store brand penetration, see Table IV. Product categories that attract the majority of retailer advertising include meat, fresh fruit and vegetables, pizza, cakes, cheese and ready meals – all of which have substantial store brand presence. The store brands in these categories are also characterised by the fact that they are of comparable quality to the national brands, and, in some cases, actually marketed as luxury alternatives to the national brands.

| Table III | Advertising Expenditures, by Retailer |
|-----------|--------------------------------------|
|           | Advertising expenditure              | Percentage on: |
|           | (£ million) | Ranges | Products |
|           | (1)         | (2)    | (3)      |
| Mid-range large supermarkets (’Big 4’) | | | |
| Tesco     | 85.56       | 67.0   | 33.0     |
| Sainsbury | 46.28       | 72.0   | 28.0     |
| Asda      | 71.38       | 72.5   | 27.5     |
| Morrisons | 57.16       | 58.7   | 41.3     |
| Mid-range smaller supermarkets | | | |
| Co-op     | 21.97       | 65.8   | 34.2     |
| Spar      | 1.08        | 99.6   | 0.4      |
| Budgen    | 0.94        | 96.5   | 3.5      |
| High value supermarkets | | | |
| Waitrose  | 23.80       | 61.8   | 38.2     |
| Marks + Spencers | 22.76 | 69.8 | 30.2 |
| Discount supermarkets | | | |
| Aldi      | 22.63       | 63.1   | 36.9     |
| Lidl      | 24.15       | 99.0   | 1.0      |

Notes: Column (1) is the total advertising expenditure incurred by each retailer in 2011. Columns (2) and (3) show the proportion spent advertising its product ranges and specific products.
## Table IV

**Product-Specific Store Brand Advertising Across Categories**

| % of retailer advertising on category | Store brand penetration |
|--------------------------------------|------------------------|
| (1)                                  | (2)                    |

### Quartile 1 (least advertised)

| Category                              | (1) | (2) |
|---------------------------------------|-----|-----|
| Kitchen Towels                        | 0.0 | 0.25|
| Meat And Veg Extract                  | 0.0 | 0.13|
| Canned Meat                           | 0.0 | 0.33|
| Ambient One Shot Drinks               | 0.0 | 0.22|
| Frozen Chips                          | 0.0 | 0.38|
| Frozen Veg                            | 0.0 | 0.72|
| Diet Cola                             | 0.0 | 0.06|
| Fruit Squash                          | 0.0 | 0.38|
| Washing Up Products                   | 0.0 | 0.17|
| Fresh Yogurt Drinks                   | 0.0 | 0.14|
| Baked Beans                           | 0.0 | 0.25|
| Fabric Conditioners                   | 0.0 | 0.17|
| Deodorants                            | 0.0 | 0.03|
| Sweets                                | 0.0 | 0.20|
| Coffee                                | 0.0 | 0.19|

### Quartile 2

| Category                              | (1) | (2) |
|---------------------------------------|-----|-----|
| Butter                                | 0.0 | 0.23|
| Tea                                   | 0.0 | 0.17|
| Non-Lemonade                          | 0.0 | 0.14|
| Home Baking                           | 0.0 | 0.61|
| Ambient Soup                          | 0.0 | 0.18|
| Margarine                             | 0.0 | 0.11|
| Rice                                  | 0.0 | 0.35|
| Hens Eggs                             | 0.0 | 0.50|
| Canned Fish                           | 0.1 | 0.37|
| Other Meat And Offal                  | 0.1 | 0.84|
| Bacon                                 | 0.1 | 0.83|
| Crisps                                | 0.2 | 0.15|
| Fruit Juice                           | 0.2 | 0.59|
| Machine Wash Products                 | 0.2 | 0.12|
| Cooking Sauces                        | 0.3 | 0.28|

### Quartile 3

| Category                              | (1) | (2) |
|---------------------------------------|-----|-----|
|                                      | 12.2| 0.36|
| Product Category                              | % of retailer advertising on category (1) | Store brand penetration (2) |
|----------------------------------------------|------------------------------------------|-----------------------------|
| Toilet Tissues                               | 0.4                                      | 0.31                        |
| Skincare Products                            | 0.4                                      | 0.07                        |
| Milk                                         | 0.4                                      | 0.57                        |
| Yoghurt                                      | 0.4                                      | 0.20                        |
| Pasta                                        | 0.5                                      | 0.64                        |
| Lager                                        | 0.6                                      | 0.08                        |
| Meat/Veg Pastry Products                     | 0.7                                      | 0.74                        |
| Biscuits                                     | 0.8                                      | 0.30                        |
| Morning Goods                                | 0.9                                      | 0.72                        |
| Desserts And Custard                         | 0.9                                      | 0.56                        |
| Chocolate Bars                               | 0.9                                      | 0.11                        |
| Breakfast Cereals                            | 1.0                                      | 0.22                        |
| Pet Food                                     | 1.1                                      | 0.18                        |
| Cider                                        | 1.1                                      | 0.12                        |
| Sausages                                     | 1.2                                      | 0.61                        |
| Quartile 4 (most advertised)                 | 86.4                                     | 0.55                        |
| Pizza                                        | 1.2                                      | 0.63                        |
| Bread                                        | 1.3                                      | 0.26                        |
| Cakes And Pastries                           | 1.3                                      | 0.66                        |
| Ale                                          | 2.0                                      | 0.05                        |
| Chocolate Boxes                              | 2.0                                      | 0.10                        |
| Ice Cream                                    | 2.6                                      | 0.36                        |
| Cheese                                       | 2.7                                      | 0.59                        |
| Poultry                                      | 3.9                                      | 0.87                        |
| Fish                                         | 4.1                                      | 0.76                        |
| Frozen Ready Meals                           | 4.9                                      | 0.50                        |
| Spirits                                      | 5.6                                      | 0.28                        |
| Fresh Fruit And Veg                          | 9.8                                      | 0.98                        |
| Wine                                         | 10.2                                     | 0.29                        |
| Chilled Ready Meals                          | 10.6                                     | 0.89                        |
| Meat Products                                | 25.4                                     | 0.95                        |

Notes: Product categories are split into four equal groups with 15 categories in each according to the average (across Big 4 supermarkets) share of retailer product-specific advertising; quartile 1 (the least advertised) each account for less than 0.005%, quartile 2 for 0.005–0.3%, quartile 3 for 0.3–1.2% and quartile 4 (the most advertised) for more than 1.2%. Column (1) shows the percentage of advertising expenditure that is spent on each product category. Column (2) shows the level of store brand penetration in each product category.
Rivalrous effects of advertising and store brand penetration

The model developed in Section II provides us with a framework through which we can relate the empirical facts to the underlying characteristics of the product category. In particular, the asymmetry between retailers’ and national brand manufacturers’ incentives to advertise generates the prediction that we expect store brand penetration to be higher in product categories that are characterised by more rivalrous advertising.

There is a large literature on how advertising affects demand, see Bagwell [2007] for a survey. Advertising may be rivalrous, i.e., its main effect is to steal market share from rivals, or it may be expansionary, i.e., its main effect is to increase demand for all products in the market. Credibly estimating the effects of advertising on demand is challenging (see, *inter alia*, Sweeting [2013], Dubois *et al.* [2018], Erdem *et al.* [2008], Ackerberg [2001], Shapiro [2018], Sahni [2016]). All of these papers focus on a particular market, employing innovative identification strategies and detailed data to credibly identify the effect of advertising on demand. It is a non-trivial task to do this convincingly for one market, never mind for all sixty product categories that we are interested in. In order to make cross-category comparisons of the effect of advertising on demand, and how this relates to store brand penetration, we therefore take an alternative approach.

We draw on the theoretical insights to rank categories according to their rivalrous effects of advertising using observable information on their advertising expenditures, prices and market shares. We do this in two complementary ways. First, we use the fact that a number of papers have shown that if advertising is primarily rivalrous, then firms are likely to over-advertise; this provides a relationship between the advertising-to-sales ratio and the relative strength of the rivalrous effect. Second, we use the equilibrium conditions from our model, to derive a relationship between the price and advertising differentials that is proportional to the rivalrous effect. Following this section, we discuss how potentially confounding factors might affect our results.

In both the analyses below we incorporate both the range and product specific advertising in our calculation of the advertising expenditures of store brands in each product category. Specifically, we assume that the range advertising is allocated across the product categories in each range, in proportion to the category’s market share within the range.7

Rivalrous effects and the advertising–sales ratio

A number of papers have shown that if advertising is primarily rivalrous, then firms are likely to advertise beyond the joint profit-maximising level, largely cancelling each other out in their efforts (von der Fehr and Stevik [1998], Bloch and Manceau [1999], Netter [1982] and Buxton *et al.* [1984]). In contrast, if advertising is primarily expansionary, then there is less advertising.

7 Our results are robust to excluding range entirely and focusing only on product-specific advertising.
than the joint profit-maximising level. Shapiro [2018] finds a similar result empirically, namely, that advertising of pharmaceuticals has strong market demand increasing effects, which leads to an underprovision of advertising relative to a cooperative scenario. The advertising to sales ratio should give us an indication of the relative effects of advertising across product categories. If the advertising to sales ratio is higher than average, it is suggestive that the effect of advertising on demand in that category are more rivalrous than in the average industry. On the other hand, if it is less than average, it suggests that the effect of advertising on demand is more likely to be more expansionary than the average. Column (1) of Table V shows this ratio for the fifteen largest product categories.

We also look at the advertising to sales ratio of a single firm, the largest national brand, in the market. The well known Dorfman and Steiner [1954] condition states that a firm that produces a differentiated product and has some degree of market power chooses, in a static framework (i.e., current advertising does not affect future demand), sets advertising expenditure according to:

$$\frac{adv}{sales} = \frac{\eta}{\epsilon},$$

where $\eta$ is the firm’s elasticity of demand with respect to advertising expenditure, and $\epsilon$ is the firm’s elasticity of demand with respect to price. A high ratio suggests that advertising is more rivalrous in that industry than in one that has a lower ratio. We cannot rule out that this is instead due to differences in price elasticities, but we discuss below why we think that this is not the whole story.

Column (2) of Table V shows the advertising to sales ratio of the largest national brand for the fifteen largest product categories. This is highly correlated with the market level advertising-sales ratio (correlation coefficient equal to 0.85), with several categories having a larger ratio for the largest national brand than for the whole market. The largest national brand advertising to sales ratio ranges between 0 and 0.2 (across all product categories).

Figure 6 show that there is a clear negative relationship between both of these ratios and store brand penetration. Abstracting from the price elasticity (or assuming it has a value of 1 everywhere), this is suggestive that in markets where advertising is more rivalrous there are lower levels of store brand penetration. If price and advertising elasticities are negatively correlated (if more price elastic demand is associated with less elastic advertising effects) then we would overestimate the relationship between the advertising elasticity and store brand penetration. However, as highlighted by Erdem et al. [2008], we would expect higher $\eta$ and higher $\epsilon$ in more competitive markets.

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8 Nerlove and Arrow [1962] derive a similar result for the case when current advertising affects future demand (i.e., the advertising stock depreciates and is augmented by current advertising).
It seems more reasonable to assume that advertising and price elasticities are *positively* correlated. In this case, the estimated relationship in Figure 6 would underestimate the correlation between the rivalrous effect of advertising and store brand penetration.

**Rivalrous effects and the ratio of price to advertising differential**

In Figure 6 we show that categories that have high advertising to sales ratios, and, are therefore more likely to be characterised by rivalrous advertising effects, have lower levels of store brand penetration. This is consistent with the comparative statics prediction of the model. In Figure 6 we used a relationship between rivalrousness and advertising/sales that has been established in models that do not necessarily assume the presence of a store brand. However, we can also estimate rivalrousness by using relationships between observables derived from the present model, and show that our conclusions about the role of the nature of advertising continue to hold. Under the previously specified assumptions, and condition (10), we derive the following proposition.
Figure 6

Store Brand Penetration and the Advertising to Sales Ratios.

Notes:
- The y-axis shows store brand penetration defined within category-retailer.
- The left-hand panel: the x-axis shows the total advertising to total sales ratio in the category.
- The right-hand panel: the x-axis shows the advertising to sales ratio of the largest national brand in the category.
- The lines are fitted using an Epanechnikov kernel estimator using 240 observations (category-retailer pairs), data on the big four retailers and 60 product categories.
- 95% confidence intervals shown.
Proposition 3. Suppose assumptions (A1)–(A4) and condition (10) hold, and that we have:

\[ v_1 - v_2 > \frac{5t \left[ 6g + (3 - 2n)r \right]^2}{(2n+1)r \left[ 12g + (3 - 2n)r \right] + 72n(3 - 2n)t} \in (-\infty, 0) \]

Then \( R^* = p_D^*/a_D^* \) is increasing in \( r \) and decreasing in \( v_1 - v_2 \), the innate quality differential between the store and national brand. If, in addition, \( v_1 - v_2 \leq 0 \), then \( R^* \) is increasing in \( t \).

Condition (13) states that the store brand is not much worse in terms of its ‘blind-test’ (i.e., in the absence of advertising) quality than the national brand. This seems to be a realistic restriction, Figure 2 suggests that the quality-equivalent store brands are similar to the national brands in

![Figure 7](image_url)

**Figure 7**

Store Brand Penetration and the Price Differential to Advertising Differential Ratio. 
*Notes:* The y-axis shows store brand penetration defined within category-retailer. The x-axis shows the median (across retailers) ratio of the price to advertising differentials in each product category. The lines are fitted using an Epanechnikov kernel estimator using 240 observations (category-retailer pairs); data on the big four retailers and 60 product categories. 95% confidence intervals shown. Table BII shows the value of the price differential-advertising differential ratio for each category.
appearance and quality. In addition, the threshold in the right-hand side of inequality (13) is increasing in \( g \) and decreasing in \( n \), i.e., the condition is more easily satisfied when the strength of the expansionary effect of advertising and the degree of market concentration are small. In this sense, condition (13) is similar to condition (10), and the fact that the latter is satisfied by the data means that the former is also likely to hold.

Consequently, Proposition 3 suggests that those product categories in which the store brand versus national brand retail price differential is large relative to the store brand versus national brand advertising differential, are likely characterized by a substantial rivalrous advertising effect. Based on Proposition 3, this should be accompanied by low SB penetration. Figure 7 shows that this is indeed the case – there is a clear negative relationship between the price to advertising differential and store brand penetration. Although the proxy, \( R^* \), depends on \( t \), the relationship between \( t \) and \( R^* \) is positive so long as the SB is not strictly better in blind test quality than the NB. Since the same is also true about the relationship between \( t \) and \( x^* \) (Proposition 3), the observed negative relationship between \( R^* \) and \( x^* \) could not be explained by variation in \( t \) alone.

Both the advertising-sales ratios and price-advertising differentials paint a similar picture with respect to how the inferred rivalrous effects of advertising and store brand penetration are related. It seems likely therefore that at least part of the variance in SB penetration across categories can be attributed to differences in how consumer demand responds to advertising, specifically the strength of the rivalrous effect.

**Discussion of alternative explanations**

We use two alternative measures to rank product categories by the strength of the rivalrous effect of advertising. We show that, consistent with the predictions of the model, these are negatively related to the levels of store brand penetration across product categories. However, there may be other potentially confounding factors driving this relationship.

One possibility is that the market structure varies across product categories, which is driving the observed relationship between advertising and store brand penetration. For example, Scott Morton and Zettelmeyer [2004] argue that retailers have an incentive to introduce store brands when the national brand is particularly dominant, in order to improve its bargaining position with the national brand manufacturer. If the national brand manufacturer, also engages in substantial advertising, then this could drive the correlation that we see in the data.

To investigate this, we look at the relationship between the dominance of the national brand (measured as the largest national brand’s sales as a share of all national brand sales). Larger values of the concentration measure mean that the largest national brand is more dominant in the market. Figure 8 shows that there is no relationship between the dominance of the largest national brand and store brand penetration.
This is not to say that other factors might play a role in determining retailers’ advertising of their store brands, but that the empirical evidence is consistent with a model in which the effects of advertising on demand determine, in part, the levels of store brand penetration.

IV. SOCIAL WELFARE

Under the particular framework that we have set out above we are able to draw conclusions about the effect that store brands have on welfare. These welfare conclusions are derived using a model that is consistent with the empirical patterns that we observe. However, alternative models of store brand penetration might also be consistent with these data, and might generate different qualitative welfare predictions; we cannot rule this out. What we want to highlight in this section is the mechanism by which the presence of store brands can impact consumer and producer surplus, once we account for the strategic behaviour of retailers and manufacturers. Our intuition is that these results would continue to hold under the relaxation of the assumptions discussed throughout Section II.
Let $CS(a_1, a_2)$ represent the equilibrium level of consumer surplus in the subgame following from a choice of $a_1, a_2$ at stage one, i.e. with retail prices given by $\hat{p}_i(a_1, a_2)$. The consumer surplus is measured by the total utility of all consumers from buying their chosen product variety:

\begin{equation}
CS(a_1, a_2) = \int_0^1 \max \left\{ U_1(x,a_1,a_2), U_2(x,a_1,a_2) \right\} \, dx
\end{equation}

where $U_i(x,a_1,a_2) = V_i - \hat{p}_i(a_1, a_2) - r|x-(i-1)|$, $V_i = v_i + ra_i + g(a_i + a_2)$.

Similarly, let $PS(a_1, a_2)$ denote the equilibrium level of producer surplus (total profit of all manufacturers and retailers) in the subgame following from a choice of $a_1, a_2$ at stage one, i.e., with wholesale and retail prices given by $\hat{w}_i(a_1, a_2)$ and $\hat{p}_i(a_1, a_2)$.

\begin{equation}
PS(a_1, a_2) = \hat{\Pi}_1^w (a_1, a_2) + \hat{\Pi}_2^w (a_1, a_2) + \sum_j \hat{\Pi}_j^v (a_1, a_2)
\end{equation}

We compare the values of $CS^*$ and $PS^*$ (corresponding to the SPNE values of $a_1$ and $a_2$) against two benchmark cases. First, to measure the effect of advertising on welfare we consider the counterfactual situation in which there is no advertising; let $CS^0 = CS(0, 0)$ and $PS^0 = PS(0, 0)$ denote the corresponding levels of the consumer and producer surplus. Second, to measure the impact of store brand presence, consider the counterfactual situation in which there are two national brands and no store brands (2NB). In other words, at stage one, two manufacturers independently choose advertising efforts, with manufacturer one maximizing $\hat{\Pi}_1^w (a_1, a_2) - (a_1)^2$ with respect to $a_1$ and manufacturer two maximizing $\hat{\Pi}_2^w (a_1, a_2)$ with respect to $a_2$. Note that the optimal wholesale and retail prices depend on the chosen $a_j$ in exactly the same way as before. Let $a'_1$ denote the resulting SPNE levels of advertising, and let $CS' = CS (a'_1, a'_2)$ denote the associated level of consumer surplus. The producer surplus is given by $PS' = PS (a'_1, a'_2) - (n-1)(a'_1)^2$, since the cost of advertising variety one is now incurred only once (by its manufacturer) instead of separately by each of the $n$ retailers.

**Proposition 4.** Under assumptions (A1)–(A4), we have $CS^* > CS' = CS^0$ and $PS > PS^0$. There also exists a threshold $\phi(r, t) > 1$ such that for $n < \phi(r, t)$, we have $PS^* > PS'$, and given either $n < \phi(r, t)$ or condition (10) we have $\partial CS^*/\partial r > 0$ and $\partial PS^*/\partial r > 0$ and $\partial [((a'_1 + a'_2)/2 - (na'_1 + a'_2)/(n + 1))/\partial r] > 0$.

A common result in models with rivalrous advertising is that the rival firms’ advertising efforts cancel each other out in equilibrium, whilst leaving them with advertising cost. This is indeed what happens to the manufacturers in the benchmark case of no store brands being present, as their wholesale prices and market shares remain unchanged despite the
advertising outlays. However, the retailers benefit considerably from national brand advertising, which makes both varieties more attractive in the eyes of the consumers, allowing retailers to increase retail prices; as a result consumer utility is the same in this counterfactual as if there were no advertising, i.e., we have $CS' = CS^0$. The increase in retailers’ profits exceeds the lost profits of manufacturers so that overall $PS' > PS^0$.

In contrast, when store brands are present, consumers do benefit from advertising. This is because the retailers internalize the global effect of store brand advertising (which they now control). They are also interested in creating an asymmetry in the products’ perceived attractiveness, so as to price discriminate more effectively. This increased asymmetry is not only beneficial to the sellers, but also enlarges the consumer surplus. To see why, observe that an important aspect of this process is that, in equilibrium, retail prices do not fully offset the changes in vertical differentiation between the product varieties. In other words, the product that is advertised more gives more utility to consumers than the other product, despite the associated increase in its retail price. As the retailers seek to keep the market fully covered, the price of the other, less attractive, product is adjusted so that each consumer’s utility from consuming it decreases by as much as the increase in the utility from consuming the more attractive product. Naturally, this means that the market share of the more attractive product increases. Overall this amounts to an increase in the utility of buyers consuming the more popular product and a decrease in the utility of those consuming a relatively smaller quantity of the less popular one. Hence, the change in aggregate consumer surplus is positive.

While retailers benefit from enhanced discriminatory pricing, from the producer surplus perspective the cost of advertising the product variety available as a store brand now has to be incurred by each retailer separately, instead of only once by a national brand manufacturer. Hence, it is only in the case where the number of retailers is sufficiently small that the overall change in the producer surplus resulting from introducing store brands is positive.

From this we can conclude that consumers benefit from the presence of a store brand, and that when the retail market is sufficiently concentrated, producers also benefit. Relatedly, advertising has a positive effect on both the consumer and the producer surplus, and this effect is stronger than in the absence of store brands. In addition to this, the difference in consumer welfare in the presence of store brands and the two national brand case is greater the more rivalrous the effect of advertising. This is because in the absence of a store brand, the increased attractiveness of two national brands is captured entirely by the retailer, whereas when a store brand is present, the consumer benefits from the price discrimination of the retailer, the value of which is increasing in $r$. In Section III we show that the grocery
market is concentrated and store brand penetration in certain categories, for example, chocolate bars, is small (Table IV). Figures 6 and 7 together with the model then suggest that this is likely caused by a strong rivalrous advertising effect. Hence, despite their small share, the presence of store brands in those categories is particularly beneficial to consumers and welfare generally.

The results may also be interpreted in the context of existing models with rivalrous advertising, in which advertising is typically over-provided by the market relative to the efficient level. In particular, the last result in Proposition 4 states that any increase of rivalrousness will cause a smaller increase in average advertising (per firm) when a store brand is present than when it is not (the 2NB case). In other words, the presence of a store brand softens the market’s overall tendency to increase (and possibly over-provide) advertising when its effect is rivalrous, and means that there is then less advertising relative to the 2NB scenario.

V. SUMMARY

We document patterns in store brand penetration across product categories and retailers using detailed data on sales and advertising of products in the British grocery market. We show that there is considerable variation in the degree of store brand penetration across product categories, which appears to be correlated with advertising activity in the category. Different types of retailers appear to follow different strategies with respect to their store brands, with high-value and discounter retailers selling a greater share of store brands compared to the mid-range supermarkets. However, while the store brands sold by the high-value supermarkets are potentially of a higher quality than the national brands in the same market, discounter supermarkets opt to sell cheaper ‘budget equivalents.’ We show that these patterns of store brand penetration are stable over time.

We develop a model to understand these empirical patterns. In the model, manufacturers and retailers choose advertising levels, wholesale and retail prices. The sub game perfect equilibrium of the model gives the values of advertising and prices as functions of characteristics of the market and retailer. The model incorporates the effect of differential brand attractiveness on both retail and wholesale price setting, capturing the competing incentives faced by retailers. The model explains the cross-category variation in store brand penetration via variation in primitive demand conditions, i.e., how consumer demand responds to advertising. This makes a contribution to the existing literature, which has hitherto focused on variation in advertising without explicitly modelling why retailer and manufacturers’ advertising strategies vary across product categories.
We use the model to gain insight into the possible impact of store brands on welfare. When advertising is rivalrous, advertising is lower in the presence of a store brand, because retailers internalise some of the negative externalities associated with rivalrous advertising. We show that under the assumptions of the model, consumer surplus is higher in the presence of store brands, due to the price discrimination that the store brand facilitates. If the market is sufficiently concentrated, then producer surplus is also higher in the presence of store brands. We argue that these conclusions would survive relaxing a number of assumptions, but that, given the growing importance of store brands in the retail market, an important avenue for future research is to further investigate the robustness of these results.

APPENDIX

A. PROOFS

Below, we provide the outline of the SPNE derivation.

Stage three: retail prices

Consider the decision of retailer $j$ on how to set the retail prices $p^1_j$ and $p^2_j$, given wholesale prices $w^1_j$ and $w^2_j$ and advertising efforts $a^1_j$ and $a^2_j$ (which determine the values of $V^1_j$ and $V^2_j$). Observe that when the retail prices are set too high, the market is not fully covered,

$$p^1_j + p^2_j > V^1_j + V^2_j - t \Leftrightarrow \tag{16}$$

$$x^1_i = \bar{x}^1_i = \left( V^1_i - p^1_i \right) / t \text{ for } i \in \{1,2\}, \text{ and } \bar{x}^1_1 + \bar{x}^1_2 < 1. \tag{17}$$

Let us show that such prices cannot be optimal. Substituting $\bar{x}^1_i$ for $x^1_i$ and $\bar{x}^2_i$ into retailer’s profit (formula 4), differentiating with respect to $p^1_j$ and $p^2_j$, and solving the FOC’s gives retail prices equal to:

$$\bar{p}^1_i = \left( V^1_i + w^2_i \right) / 2, \ i \in \{1,2\}. \tag{18}$$

These prices are only optimal if they satisfy (16), i.e.:

$$\bar{p}^1_1 + \bar{p}^1_2 > V^1_1 + V^2_2 - t \Leftrightarrow \tag{19}$$

$$w^1_1 + w^2_2 > V^1_1 + V^2_2 - 2t. \tag{20}$$

That is to say, the retailer does not choose to cover the entire market when wholesale prices are too high relative to advertising. When that is not the case, optimal retail prices must be such that $x^1_1 + x^2_2 = 1$ and,

$$U^1_1 \left( x^1_1 \right) = U^2_2 \left( x^1_2 \right) = 0, \ x^1_i = \tilde{x}^1_i = \left( p^2_i - p^1_i + t + V^1_i - V^2_i \right) / (2t). \tag{21}$$
In other words, the marginal consumer who is indifferent between the two product varieties (located at \( x_j^1 \)) must also be indifferent between them and buying nothing at all. If the latter were not the case, then the retailer could increase both prices by the same amount without changing \( x_j^1 \) and \( x_j^2 \), thereby increasing profits. Consequently, the optimal retailer price of product variety 2 must equal:

\[
\hat{p}_2^j = V_1^j + V_2^j - p_1^j - t.
\]

Substituting \( \hat{x}_1^j \) (formula 17) for \( x_1^j \), \( 1 - \hat{x}_1^j \) for \( x_2^j \) and \( \hat{p}_2^j \) for \( p_2^j \) into retailer’s profit (formula 4), differentiating with respect to \( p_1^j \), solving the FOC and combining with equation (22) gives us the pair of prices:

\[
\hat{p}_1^j = \left( w_i^j - w_{-i}^j - 2t + 3V_i^j + V_{-i}^j \right) / 4,
\]

when the opposite of condition (20) holds (wholesale prices are not too high), these retail prices are optimal and ensure that the market is fully covered.

**Stage two: wholesale prices**

Suppose first wholesale prices are high enough to satisfy condition (20). We show that such prices cannot be optimal. As shown when discussing Stage Three, such wholesale prices result in retailer \( j \) in turn setting its retail prices so high that the market is not fully covered. Thus, for each \( i \in \{1, 2\} \) we may substitute \( \hat{x}_i^j \) (formula 11) for \( x_i^j \) and \( \hat{p}_i^j \) (18) for \( p_i^j \) into the profit function of the manufacturer of variety \( i \), differentiate with respect to \( w_i^j \) and solve the FOC to obtain the candidate optimal wholesale prices (that would lead to the market’s not being fully covered):

\[
\tilde{w}_i^j = \left( c_i + V_i^j \right) / 2.
\]

In order to be optimal, those prices would again need to satisfy (20), i.e.: 

\[
\tilde{w}_1^j + \tilde{w}_2^j > V_1^j + V_2^j - 2t \iff c_1 + c_2 + 4t > V_1^j + V_2^j.
\]

Since \( V_1^j + V_2^j \geq v_1 + v_2 \), this cannot be the case under assumption (A1). Hence, any set of wholesale prices such that no manufacturer would benefit from unilaterally changing its price, must satisfy \( w_1^j + w_2^j \leq V_1^j + V_2^j - 2t \) (the opposite of 20) and ensure the market is fully covered.

Thus, let us now substitute \( \hat{x}_1^j \) (formula 21), \( 1 - \hat{x}_1^j \) and \( \hat{p}_1^j \) and \( \hat{p}_2^j \) (formula 23) for \( x_1^j, x_2^j, p_1^j \) and \( p_2^j \) respectively into the profits \( \Pi_1^m \) and \( \Pi_2^m \) (formulae 5 and 6). We then differentiate the obtained profit functions with respect to \( w_1^j \) and \( w_2^j \) respectively, and solve the two FOC’s to obtain the candidate optimal wholesale prices (that would lead to the market’s being fully covered):

\[
\hat{w}_1^j = \left( c_1 + V_1^j \right) / 2.
\]
(26) \[ \hat{w}_i = \left(2c_i + c_{-i} + 6t + V_i^j - V_{-i}^j\right) / 3. \]

The opposite of condition 20 then holds iff:

(27) \[ \hat{w}_1^i + \hat{w}_2^j \leq V_1^j + V_2^j - 2t \Leftrightarrow V_1^j + V_2^j > c_1 + c_2 + 6t, \]

which is true under assumption (A1), since \( V_i^j \geq v_i \) for all \( i, j \). Hence, given the competitor’s price \( \hat{w}_j^i \), none of the two manufacturers would wish to unilaterally deviate to a \( \hat{w}_j^i \neq \bar{w}_j^i \) such that \( \hat{w}_j^i + \hat{w}_{-j}^i \leq V_1^j + V_2^j - 2t \). Similarly, one could not benefit from deviating to a \( \bar{w}_i^j \neq \tilde{w}_i^j \) such that \( \tilde{w}_i^j + \tilde{w}_{-i}^j > V_1^j + V_2^j - 2t \), as for this to happen we would need:

(28) \[ \tilde{w}_i^j + \tilde{w}_{-i}^j > V_1^j + V_2^j - 2t \Leftrightarrow 5V_1^j + 4V_{-i}^j < 5c_i + 4c_{-i} + 24t, \]

which cannot be the case under assumption (A1). Consequently, the market is always covered in equilibrium, with wholesale prices given by \( \hat{w}_i^j \) and retail prices \( \bar{p}_i^j \). This also means we have:

(29) \[ w_1^i - w_2^j = \left(c_1 - c_2 + 2 \left[V_1^j - V_2^j\right]\right) / 3, \]

(30) \[ p_1^j - p_2^j = \left(1 - x^j - x^i\right) + 5 \left(V_1^j - V_2^j\right) \]

Stage one: advertising efforts

Substitute the retail prices \( \bar{p}_i^j \) (formula 23), then wholesale prices \( \hat{w}_i^j \) (formula 26), and finally \( V_i^j = v_i + r\hat{a}_i^j + g(a_i^j + a_2) \) into the profit functions \( \hat{\Pi}_1^j \) and \( \hat{\Pi}_2^m \) (formulae 4 and 6). Let \( \hat{\Pi}_1^j \) and \( \hat{\Pi}_2^m \) respectively denote the resulting reduced-game profit functions, which depend on the parameters of the model, as well as advertising efforts \( a_1^j \) and \( a_2 \). We find that:

(31) \[ \frac{\partial^2 \hat{\Pi}_1^j}{\partial \left(a_1^j\right)^2} = r^2 / (36t) - 2, \]

(32) \[ \frac{\partial^2 \hat{\Pi}_2^m}{\partial \left(a_2\right)^2} = r^2 / (18t) - 2, \]

both of which are negative under assumption (A3), i.e., the profit functions are concave in own advertising effort. Thus, we obtain the unique equilibrium advertising efforts \( a_1^j \) and \( a_2 \) by solving \( \partial \hat{\Pi}_1^j / \partial a_1^j = \partial \hat{\Pi}_2^m / \partial a_2 = 0 \). It can also be verified that, under assumptions (A1) ; (A2) and (A3), we have \( a_1^* \geq 0, a_2^* \geq 0 \) and \( x^* \in (0, 1) \), i.e., we have a valid interior solution.
### APPENDIX B.

#### TABLES

**Table BI**

**AVERAGE STORE BRAND PENETRATION ACROSS CATEGORIES**

| Product category          | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---------------------------|------|------|------|------|------|------|------|------|
| Ale                       | 0.07 | 0.06 | 0.06 | 0.06 | 0.07 | 0.06 | 0.05 | 0.05 |
| Ambient One Shot Drinks   | 0.21 | 0.21 | 0.22 | 0.22 | 0.23 | 0.23 | 0.22 | 0.23 |
| Ambient Soup              | 0.20 | 0.19 | 0.17 | 0.18 | 0.16 | 0.16 | 0.18 | 0.18 |
| Bacon                     | 0.77 | 0.86 | 0.90 | 0.84 | 0.80 | 0.83 | 0.84 | 0.82 |
| Baked Beans               | 0.30 | 0.32 | 0.31 | 0.33 | 0.33 | 0.29 | 0.26 | 0.26 |
| Biscuits                  | 0.28 | 0.29 | 0.29 | 0.29 | 0.28 | 0.28 | 0.30 | 0.28 |
| Bread                     | 0.29 | 0.29 | 0.30 | 0.33 | 0.31 | 0.30 | 0.31 | 0.29 |
| Breakfast Cereals         | 0.20 | 0.21 | 0.21 | 0.22 | 0.22 | 0.22 | 0.23 | 0.23 |
| Butter                    | 0.17 | 0.16 | 0.17 | 0.18 | 0.19 | 0.21 | 0.23 | 0.23 |
| Cakes And Pastries        | 0.64 | 0.63 | 0.62 | 0.61 | 0.61 | 0.63 | 0.66 | 0.66 |
| Canned Fish               | 0.40 | 0.39 | 0.38 | 0.41 | 0.37 | 0.34 | 0.38 | 0.37 |
| Canned Meat               | 0.37 | 0.36 | 0.36 | 0.36 | 0.38 | 0.37 | 0.33 | 0.36 |
| Cheese                    | 0.67 | 0.65 | 0.65 | 0.64 | 0.60 | 0.61 | 0.61 | 0.60 |
| Chilled Ready Meals       | 0.91 | 0.90 | 0.89 | 0.88 | 0.88 | 0.89 | 0.89 | 0.89 |
| Chocolate Bars            | 0.10 | 0.11 | 0.11 | 0.11 | 0.10 | 0.10 | 0.10 | 0.10 |
| Chocolate Boxes           | 0.10 | 0.12 | 0.13 | 0.12 | 0.12 | 0.12 | 0.11 | 0.11 |
| Cider                     | 0.15 | 0.13 | 0.13 | 0.13 | 0.11 | 0.10 | 0.12 | 0.12 |
| Coffee                    | 0.17 | 0.18 | 0.18 | 0.19 | 0.21 | 0.20 | 0.20 | 0.19 |
| Product category                      | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------------------------------|------|------|------|------|------|------|------|------|
| Cooking Sauces                       | 0.25 | 0.26 | 0.26 | 0.27 | 0.26 | 0.26 | 0.27 | 0.28 |
| Crisps                               | 0.19 | 0.17 | 0.17 | 0.16 | 0.14 | 0.15 | 0.15 | 0.15 |
| Deodorants                           | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.03 | 0.03 | 0.03 |
| Desserts And Custard                 | 0.61 | 0.61 | 0.60 | 0.60 | 0.58 | 0.56 | 0.57 | 0.57 |
| Diet Cola                            | 0.22 | 0.21 | 0.21 | 0.21 | 0.20 | 0.18 | 0.17 | 0.16 |
| Fish                                 | 0.76 | 0.76 | 0.75 | 0.74 | 0.73 | 0.70 | 0.68 | 0.66 |
| Fresh Fruit And Veg                  | 0.99 | 0.99 | 0.99 | 0.98 | 0.98 | 0.97 | 0.96 | 0.95 |
| Fresh Yogurt Drinks                  | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 |
| Frozen Chips                         | 0.36 | 0.36 | 0.35 | 0.34 | 0.33 | 0.31 | 0.31 | 0.31 |
| Frozen Ready Meals                   | 0.44 | 0.44 | 0.43 | 0.42 | 0.41 | 0.40 | 0.39 | 0.39 |
| Frozen Veg                           | 0.73 | 0.73 | 0.72 | 0.71 | 0.70 | 0.69 | 0.68 | 0.67 |
| Fruit Juice                          | 0.59 | 0.59 | 0.58 | 0.57 | 0.56 | 0.55 | 0.54 | 0.53 |
| Fruit Squash                         | 0.39 | 0.39 | 0.38 | 0.37 | 0.37 | 0.36 | 0.36 | 0.36 |
| Hens Eggs                            | 0.64 | 0.64 | 0.63 | 0.62 | 0.61 | 0.60 | 0.59 | 0.59 |
| Home Baking                          | 0.63 | 0.63 | 0.62 | 0.61 | 0.60 | 0.59 | 0.59 | 0.59 |
| Ice Cream                            | 0.54 | 0.54 | 0.53 | 0.52 | 0.51 | 0.50 | 0.49 | 0.49 |
| Kitchen Towels                       | 0.70 | 0.70 | 0.69 | 0.68 | 0.67 | 0.66 | 0.65 | 0.65 |
| Lager                                | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Machine Wash                         | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Margarine                            | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| Meat And Veg Extract                 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| Machine Wash Products                | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Meat And Veg Extract                 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| Product category          | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------------------|------|------|------|------|------|------|------|------|
| Meat Products            | 0.92 | 0.92 | 0.92 | 0.92 | 0.93 | 0.94 | 0.94 | 0.95 |
| Meat/Veg Pastry Products | 0.72 | 0.74 | 0.75 | 0.75 | 0.74 | 0.73 | 0.74 | 0.74 |
| Milk                     | 0.58 | 0.56 | 0.55 | 0.55 | 0.54 | 0.55 | 0.57 | 0.57 |
| Morning Goods            | 0.76 | 0.75 | 0.75 | 0.75 | 0.74 | 0.73 | 0.72 | 0.71 |
| Non-Lemonade             | 0.16 | 0.16 | 0.17 | 0.16 | 0.14 | 0.14 | 0.14 | 0.15 |
| Other Meat And Offal     | 0.83 | 0.83 | 0.85 | 0.85 | 0.84 | 0.83 | 0.84 | 0.85 |
| Pasta                    | 0.57 | 0.59 | 0.61 | 0.66 | 0.62 | 0.64 | 0.64 | 0.63 |
| Pet Food                 | 0.17 | 0.17 | 0.21 | 0.22 | 0.21 | 0.19 | 0.18 | 0.18 |
| Pizza                    | 0.60 | 0.59 | 0.60 | 0.61 | 0.57 | 0.60 | 0.63 | 0.61 |
| Poultry                  | 0.80 | 0.83 | 0.84 | 0.83 | 0.81 | 0.83 | 0.86 | 0.85 |
| Rice                     | 0.44 | 0.40 | 0.38 | 0.42 | 0.40 | 0.38 | 0.35 | 0.35 |
| Sausages                 | 0.64 | 0.65 | 0.65 | 0.64 | 0.62 | 0.62 | 0.61 | 0.59 |
| Skincare Products        | 0.08 | 0.08 | 0.07 | 0.09 | 0.08 | 0.08 | 0.07 | 0.07 |
| Spirits                  | 0.28 | 0.28 | 0.30 | 0.29 | 0.27 | 0.26 | 0.27 | 0.32 |
| Sweets                   | 0.22 | 0.21 | 0.23 | 0.21 | 0.21 | 0.20 | 0.20 | 0.20 |
| Tea                      | 0.19 | 0.19 | 0.17 | 0.16 | 0.18 | 0.17 | 0.17 | 0.16 |
| Toilet Tissues           | 0.33 | 0.29 | 0.31 | 0.34 | 0.32 | 0.30 | 0.30 | 0.32 |
| Washing Up Products      | 0.26 | 0.25 | 0.24 | 0.24 | 0.22 | 0.19 | 0.17 | 0.19 |
| Wine                     | 0.32 | 0.32 | 0.30 | 0.29 | 0.27 | 0.28 | 0.30 | 0.32 |
| Yoghurt                  | 0.24 | 0.23 | 0.23 | 0.23 | 0.20 | 0.19 | 0.20 | 0.21 |

Notes: * Numbers shown are the quantity weighted average store brand market shares across retailers within each product category-year.
### Table BII

**Advertising Descriptives**

| Product category              | Advertising exp. (£million) | Advertising-Sales ratio | Ratio of price differential to advertising differential |
|-------------------------------|-----------------------------|--------------------------|--------------------------------------------------------|
|                               | (1)                         | (2)                      | (3)                      | (4)                      |
| **Ale**                       | 7.3                         | 0.049                    | 0.015                   | 0.81                     |
| **Ambient One Shot Drinks**   | 5.7                         | 0.034                    | 0.095                   | 0.43                     |
| **Ambient Soup**              | 3.6                         | 0.013                    | 0.009                   | 0.26                     |
| **Bacon**                     | 0.8                         | 0.001                    | 0.000                   | -0.03                    |
| **Baked Beans**               | 3.1                         | 0.010                    | 0.016                   | 0.27                     |
| **Biscuits**                  | 5.6                         | 0.007                    | 0.014                   | 0.26                     |
| **Bread**                     | 5.5                         | 0.005                    | 0.005                   | 0.19                     |
| **Breakfast Cereals**         | 65.7                        | 0.068                    | 0.120                   | 0.33                     |
| **Butter**                    | 10.6                        | 0.029                    | 0.032                   | 0.04                     |
| **Cakes And Pastries**        | 3.0                         | 0.003                    | 0.005                   | 0.00                     |
| **Canned Fish**               | 1.9                         | 0.005                    | 0.000                   | 0.11                     |
| **Canned Meat**               | 0.0                         | 0.000                    | 0.000                   | 0.35                     |
| **Cheese**                    | 12.8                        | 0.011                    | 0.035                   | 0.08                     |
| **Chilled Ready Meals**       | 8.0                         | 0.005                    | 0.000                   | -0.18                    |
| **Chocolate Bars**            | 21.5                        | 0.036                    | 0.034                   | 0.10                     |
| **Chocolate Boxes**           | 2.9                         | 0.013                    | 0.004                   | 2.41                     |
### Table BII (Continued)

| Product category                      | Advertising exp. (£million) | Advertising-Sales ratio | Ratio of price differential to advertising differential |
|---------------------------------------|-----------------------------|-------------------------|------------------------------------------------------|
|                                       | (1)                         | (2)                     | (3)                                                  | (4)                                                  |
| Cider                                 | 10.6                        | 0.048                   | 0.042                                                | 0.14                                                 |
| Coffee                                | 11.9                        | 0.024                   | 0.031                                                | 0.20                                                 |
| Cooking Sauces                        | 11.3                        | 0.035                   | 0.093                                                | 0.16                                                 |
| Crisps                                | 13.4                        | 0.014                   | 0.014                                                | 0.11                                                 |
| Deodorants                            | 9.3                         | 0.040                   | 0.031                                                | 0.32                                                 |
| Desserts And Custard                  | 7.2                         | 0.015                   | 0.062                                                | −0.05                                                |
| Diet Cola                             | 6.8                         | 0.016                   | 0.014                                                | 0.47                                                 |
| Fabric Conditioners                   | 13.3                        | 0.048                   | 0.034                                                | 0.14                                                 |
| Fish                                  | 8.2                         | 0.007                   | 0.012                                                | −0.28                                                |
| Fresh Fruit And Veg                   | 10.4                        | 0.002                   | 0.000                                                | −0.56                                                |
| Fresh Yogurt Drinks                   | 6.4                         | 0.032                   | 0.042                                                | −0.00                                                |
| Frozen Chips                          | 4.4                         | 0.010                   | 0.019                                                | 0.25                                                 |
| Frozen Ready Meals                    | 4.4                         | 0.015                   | 0.011                                                | −0.68                                                |
| Frozen Veg                            | 0.7                         | 0.002                   | 0.008                                                | 0.25                                                 |
| Fruit Juice                           | 9.3                         | 0.013                   | 0.020                                                | 0.28                                                 |
| Fruit Squash                          | 8.7                         | 0.022                   | 0.013                                                | 0.13                                                 |
| Hens Eggs                             | 1.5                         | 0.014                   | 0.043                                                | 0.02                                                 |
| Product category          | Advertising exp. (£million) | Advertising-Sales ratio | Ratio of price differential to advertising differential |
|--------------------------|------------------------------|--------------------------|-------------------------------------------------------|
|                          | (1)                          | (2)                      | (3)                      | (4)                      |
| Home Baking              | 1.3                          | 0.005                    | 0.000                   | 0.28                     |
| Ice Cream                | 7.4                          | 0.025                    | 0.084                   | 0.65                     |
| Kitchen Towels           | 4.8                          | 0.021                    | 0.043                   | 0.05                     |
| Lager                    | 19.4                         | 0.034                    | 0.054                   | 0.22                     |
| Machine Wash Products    | 23.6                         | 0.056                    | 0.072                   | 0.13                     |
| Margarine                | 12.3                         | 0.032                    | 0.053                   | 0.20                     |
| Meat And Veg Extract     | 1.6                          | 0.009                    | 0.017                   | 0.24                     |
| Meat Products            | 22.0                         | 0.012                    | 0.032                   | 0.31                     |
| Meat/Veg Pastry Products | 1.7                          | 0.003                    | 0.011                   | 0.14                     |
| Milk                     | 5.3                          | 0.010                    | 0.051                   | 0.04                     |
| Morning Goods            | 1.1                          | 0.001                    | 0.001                   | −0.04                    |
| Non-Lemonade             | 14.2                         | 0.068                    | 0.131                   | 0.49                     |
| Other Meat And Offal     | 2.4                          | 0.002                    | 0.017                   | −0.16                    |
| Pasta                    | 1.6                          | 0.005                    | 0.013                   | 0.07                     |
| Pet Food                 | 7.6                          | 0.009                    | 0.012                   | 0.27                     |
| Pizza                    | 3.2                          | 0.006                    | 0.009                   | −0.09                    |
| Product category     | Advertising exp. (£million) | Advertising-Sales ratio | Ratio of price differential to advertising differential |
|----------------------|-----------------------------|-------------------------|--------------------------------------------------------|
|                      | (1)                         | (2)                     | (3)                      | (4)                 |
| Poultry              | 5.6                         | 0.003                   | 0.007                   | 0.26                |
| Rice                 | 10.4                        | 0.035                   | 0.099                   | 0.51                |
| Sausages             | 4.6                         | 0.010                   | 0.012                   | 0.08                |
| Skincare Products    | 23.0                        | 0.120                   | 0.215                   | 0.77                |
| Spirits              | 13.0                        | 0.021                   | 0.030                   | 0.15                |
| Sweets               | 5.8                         | 0.024                   | 0.054                   | 0.17                |
| Tea                  | 11.7                        | 0.035                   | 0.031                   | 0.14                |
| Toilet Tissues       | 5.7                         | 0.011                   | 0.008                   | 0.07                |
| Washing Up Products  | 7.2                         | 0.019                   | 0.017                   | 0.33                |
| Wine                 | 10.2                        | 0.009                   | 0.000                   | −0.08               |
| Yoghurt              | 23.0                        | 0.033                   | 0.035                   | 0.12                |

Notes: Column (1) shows the sum of advertising expenditures in 2011 on the two largest national brands and all store brands advertised by the Big 4 retailers in each category. Columns (2) and (3) show the advertising to sales ratios for the market (two largest national brands and Big 4 retailers) and for the largest national brand, respectively. Column (4) shows the median (across Big 4 retailers) ratio of the price to advertising differential.
For full details and proofs of the comparative statics results, see the Journal’s editorial website http://www.jindec.org.

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