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Do private labels increase retailer bargaining power?

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Abstract Like any new product, private label entry increases competition within a category leading to downward pressure on both wholesale and retail prices. But, given the higher margins for private labels and potential bargaining benefits for retailers, they have incentives to help private labels gain market share. The paper addresses two questions: First, do private labels enhance a retailer's bargaining power with respect to manufacturers? Second, given the higher profitability and potential increase in bargaining power, does the retailer strategically set retail prices to favor and strengthen the private label? We find support for the "bargaining power" hypothesis, but qualified support for the "strategic retailer pricing" hypothesis. Retailers gain bargaining power through lower wholesale prices on imitated national brands. But the gain is greater in niche categories than in mass categories, suggesting that niche national brands with limited "pull" power lose greater bargaining power. In terms of strategic pricing, the retailer, on initially introducing the private label, strategically sets prices to help private labels gain market share in high volume mass market categories. But retail prices revert to the category profit maximizing price after a year when the private label gains a stable market share.

Keywords Store brands · Retailing · Private labels · Bargaining breakfast cereal · Positioning · Channels

JEL Classification L11 · M31 · D40 · C10 · C30

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1 Introduction

Private labels or store brands continue to gain market share at the expense of national brands. Private labels now account 22.3% of the units sold in U.S. supermarkets; further, they are category leaders in as many as 25% of the 775 categories in which they are represented (Private Label Yearbook 2009, published by the Private Label Manufacturer Association). The growing importance of private labels has spawned an academic literature empirically investigating the factors that facilitate its success (Hoch and Banerji 1993; Starzynski 1993; Raju et al 1995; Hoch 1996; Narasimhan and Wilcox 1998; Dhar and Hoch 1997; Chintagunta et al. 2002; Cotterill et al 2000; Hoch et al 2006; Sethuraman 2000). Researchers have empirically identified three sets of factors: (1) demand characteristics (consumer demographics and preferences) (2) costs and benefits of private labels (e.g. lower quality with respect to national brands, lower prices) and (3) competitive conditions of the category (e.g. number of competing brands, advertising levels).

Despite the large volume of recent empirical research on private labels, there is limited empirical understanding of the how private labels provide value to retailers. Many argue that private labels provide strategic bargaining power to retailers against manufacturers in negotiating supply terms for national brands. Better supply terms could include lower wholesale prices (Narasimhan and Wilcox 1998; Sayman et al 2002; Ailawadi and Harlam 2004) or better trade deals (Giblen 1993; Lal 1990). Scott-Morton and Zettelmeyer (2004) formalize the bargaining benefit with an analytical model. They argue that retailers are able to get bargaining power with store brands because they can *imitate* the leading national brand in a category. This strategic positioning gives the retailer the greatest disagreement payoff in negotiations with manufacturers, leading to better terms in negotiations. But there is little empirical evidence on whether private labels provide retailers with greater bargaining power.

There are other benefits from private labels for a retailer. Private labels provide higher margins than national brands (Hoch and Banerji 1993; Sayman et al 2002; Narasimhan and Wilcox 1998; Ailawadi and Harlam 2004; Pauwels and Srinivasan 2004). They may also increase retailer loyalty (Corstjens and Lal 2000; Sudhir and Talukdar 2004; Ailawadi et al. 2008; Seenivasan et al. 2009) engendering retailer differentiation and greater long-run retail profits. Hence it is in a retailer's interest not only to introduce private labels but also help it achieve a high market share. A retailer can theoretically favor store brands against national brands, because it has the power to set the retail marketing mix (price, shelf space position and promotion) of not only the private label, but also those of national brands (Hoch and Banerji 1993; Raju et al 1995; Hoch 1996; Narasimhan and Wilcox 1998; Dhar and Hoch 1997). In fact, Progressive Grocer's annual surveys of retailers find that the most likely action by retailers from 1999–2003 was to "stress private labels." However there is little empirical evidence that retailers favor private labels over national brands when setting retail prices.

The goal of this paper is to shed empirical light on two questions. First, do private labels enhance a retailer's bargaining power? Specifically, we will look at whether the introduction of a private label helps the retailer gain lower wholesale prices. We refer to this as the "bargaining power" hypothesis. Second, given the benefits accruing from private labels, does the retailer use its ability to set prices for both private labels and national brands to strategically favor private labels? We refer to this as the "strategic retail pricing" hypothesis.

The empirical testing of the hypotheses is complicated by the fact that when a private label is introduced, the resulting change in market structure itself leads to increased competition (just as with any new product entry). The increased competition will cause profit maximizing manufacturers and the category profit maximizing retailer to both change their wholesale and retail prices with respect to the period before store brand introduction. The resulting market shares of brands will also change. Therefore a simple wholesale price reduction after the introduction of a private label does not imply that retailers have gained bargaining power. To infer a bargaining advantage, one has to control for the effect on wholesale prices of the increased competition resulting from the new entry, and then see if the decline in wholesale price is greater than what could be simply due to the greater competition.[1]

Similarly, the increased competition among brands at the retail level due to a new product introduction can suppress retail prices of all brands. To infer whether a retailer strategically deviates to favor the private label, one has to control for the price change that automatically results from the increased competition and then see whether private label prices are kept lower or national brands are kept higher relative to the prices that what would be optimal given the new market structure.

Our empirical strategy for testing the bargaining power and strategic retail pricing hypotheses should therefore "control" for the effect of the changed market structure on wholesale and retail prices. We use a structural approach to address this challenge. We begin by estimating a flexible demand model that allows us to measure the underlying demand substitution patterns across brands in the market. Given the estimated demand model, we solve for the equilibrium retail and wholesale prices. We then look for the deviations between the observed and predicted equilibrium wholesale and retail prices to test the bargaining and strategic retail pricing hypotheses.

Two natural questions arise: First, why would a retailer want to deviate from its static category profit maximizing price? After all, the higher margin effects and any retail loyalty effects are directly incorporated into the static profit maximizing price. Longer term benefits not captured in the static model could be an impetus. For example, when a brand is introduced, the producer typically uses an introductory marketing to induce trial. As consumers try the product and consumer preferences evolve, market shares will evolve and attain their long-run steady state market share. If this were the reason, the strategic pricing deviations from the static price should be limited to an introductory period. Another reason to deviate from the static retailer prices is the improvement in bargaining power which facilitates lower wholesale price over the long-run. If this were the reason, one should find that departures from the static price are longer-term.

Second, how would the retailer deviate from the static profit maximizing price to help increase the share of the private label? A retailer can either lower the price of

[1] We note that a reduction in wholesale prices is only one of several ways in which the retailer may benefit from increased bargaining due to store brands. So a negative result for this test does not rule out bargaining rationale.

store brands or raise the price of competing national brands to help a store brand. Since store brand quality is not well-established when the product has just been introduced, lowering prices of store brands can hurt the price-quality associations and hurt long-term trial and adoption. Instead raising the relative attractiveness of store brands by raising the price of national brands might be a better strategy to help induce store brand trial.

An alternative approach to measure bargaining power based on a Nash Bargaining Model between manufacturers and retailers has been recently proposed in the literature (Iyer and Villas-Boas 2003; Misra and Mohanty 2008; Draganska et al. 2010). To assess the robustness and convergent validity of our findings about changes in bargaining power, we also obtain estimates of bargaining power before and after private labels were introduced.

Our empirical analysis uses the Dominicks data at the University of Chicago on the cereal category over a 2 year period from 1989–91. This category and period are attractive because several store brands were introduced in different categories during this data period. Retailers use two types of positioning strategies in private label introductions: an imitation ("me-too") positioning and a differentiated positioning. The imitation ("me-too") positioning strategy is the more common store brand strategy and accounts for more than 50% of the store brand introductions in the grocery industry (Scott-Morton and Zettelmeyer 2004). The alternative differentiation strategy, where retailers use a high quality positioning as with "President's Choice" from Loblaw's in Canada, "World Classics" from Topco, and "Sam's Choice" from Wal-Mart or a low quality or white-label generic positioning (e.g., A&P's " Savings Plus line") targeted to low quality oriented customers (Hoch 1996) is less common.

Dominicks always used the imitation strategy: the national brands it imitated are sales leaders in their respective market segments and among the largest brands in the overall cereal market: Cheerios (#1 in sales), Frosted Flakes (# 2 in sales), Rice Krispies (#3 in sales), Corn Flakes (#5 in sales), Raisin Bran (#6 in sales), and Froot Loops (#10 in sales).[2] Increasing price of the imitated national brands is most effective for helping private labels gain market share, so we expect the most effective deviation from the category profit maximizing price will be on imitated national brands. The retailer's strategic motivation to support private labels may differ by the size of the segment. We therefore distinguish between the large "mass-market" and small "niche" segments. For the cereal category, we treat the "Family" and "Kids" segments as mass market and "Health and Nutrition" and "Taste Enhanced" segments as niche.

[2] We use the names of the store brands to identify which national brand it imitated. In some cases, Dominicks used the same names as the national brands i.e., "Corn Flakes", "Raisin Bran" and "Frosted Flakes". For others, it used different but suggestive names indicating the national brands that it imitates. We treat "Crispy Rice" as an imitator of "Rice Krispies". "Fruit Rings" as an imitator of "Froot Loops" and "Tasteeo's" as an imitator of "Cheerios". In our empirical analysis, we verify whether our interpretation of these as "imitation brands" is appropriate. We indeed find that the cross-elasticity between the store brand and the appropriate imitated brand is much larger than with respect to other brands (see Table 7). Further, imitated national brands pull away much more sales from the corresponding store brand with a price cut rather than vice versa. This asymmetry in cross-elasticity is consistent with Blattberg and Wisniewski (1989) and Sethuraman (1995).

This paper is related to a few papers that have looked at strategic pricing behavior of retailers in the context of store brands. Chintagunta (2002) finds that the retailer deviates from category profit maximizing behavior in order to favor the store brand in the analgesics category. Chintagunta et al. (2002) find that after a store brand is introduced, retail margin for Quaker Oats (the only major incumbent in the oatmeal category they analyze) increases indicating that the retailer gained power. However neither paper tests for differences in retailer behavior towards imitated and non-imitated national brands, which we believe provides a more nuanced understanding of the retailer's motivations in deviating from the category profit maximizing prices. Pauwels and Srinivasan (2004) show that only second-tier (mass market) brands are affected by store brand entry, but the premium first tier (niche) brands are unaffected by store brands. While we consider both mass and niche segments, we also specifically look for pricing differences between imitated brands and non-imitated brands within each of the segments. Further we look at short-run and long-run reactions of manufacturers and retailers to store brand entry. Also our analysis separates effects due to the natural competition induced by any new entry from the effects due to strategic retailer behavior that considers long-run benefits of supporting store brands and the effects of greater retail bargaining power due to the introduction of the store brand. From a methodological perspective, ours is the first paper that simultaneously models and estimates manufacturer and retailer pricing equations in a structural supply side model with demand following a flexible heterogeneous logit specification.[3]

Our key results are as follows: Manufacturers of imitated brands lower their wholesale price below the short-run category profit maximizing wholesale price, providing support for the bargaining power hypothesis. Further, retailers strategically support private labels by keeping the prices of the imitated national brands at levels higher than the category profit maximizing prices. Interestingly, the retailer deviates only in the mass market segment. The selective strategic pricing in the large mass market segments suggests the retailer is more motivated to build overall market share for the private label. Further, the retailer returns to category profit maximizing pricing after the first 6 months, providing support for the "induce trial" and market share building rationale. But the manufacturer of imitated national brands continues to keep wholesale prices lower than the static profit maximizing price. This indicates that the retailer does gain a permanent bargaining power advantage by introducing private labels.

The rest of the paper is organized as follows. Section 2 describes the empirical model and how we operationalize the hypotheses. Section 3 the estimation strategy. Section 4 describes the data and results. Section 5 concludes.

2 The model

As explained in the introduction, our empirical strategy requires us to look for departures by manufacturers and retailers from the static profit maximizing prices.

[3] Kadiyali et al (2000) estimate both manufacturer and retailer equations; however they employ a linear demand model where demand elasticities across time are invariant and cannot be applied to our context with a large number of products. On the supply side, they use a conjectural variations approach to measure deviations from short-run profit maximizing prices.

To this end, we develop first a demand model. In developing the supply model, we derive the static profit maximizing wholesale price and retail prices. We then estimate the relationship between the deviations of the observed prices from the inferred static profit maximizing price after store brand entry to test our hypotheses. We begin with the demand model.

2.1 Demand model

Our empirical application uses the breakfast cereal category, which has over 40 brands. To develop a parsimonious demand system for such a category with a large number of brands, we use a logit model where utility for a product is modeled as a function of attributes. To accommodate flexibility in the demand model, we allow for heterogeneity in consumer preferences for attributes using a random coefficients specification.

Since our data is observed at the level of each store, we specify a demand model at the store level. As different stores cater to different demographics and the intrinsic preferences for products and price sensitivity are a function of demographics, we allow the preferences for product attributes (distribution of the random coefficients associated with attributes) to be a function of the empirical distribution of customers in the store's trading area. We thus allow for observed and unobserved heterogeneity into our demand specification.

We observe data for each store s=1,..., S of the chain for t=1,..., T periods of time. The conditional indirect utility of consumer i for brand j shopping at store s at period t is given by:

$$u_{ijst} = x_j\beta_i^* - \alpha_i^* p_{jst} + \xi_j + \varepsilon_{ijst} \tag{1}$$

where x_j is the k dimensional vector of observable characteristics, p_{jst} is the price of j at store s at time t, ξ_j is the chain-level mean of brand specific valuation of j, ε_{ijst} is a mean zero error term, and $(\alpha_i^*\beta_i^*)$ are k+1 individual-specific coefficients.

We allow the consumer not to choose any of the J brands; i.e., we treat non-purchase as the outside good whose average utility across individuals is normalized to zero. Thus we allow consumers to choose out of the category, if they find the prices are too high.

Define $\theta_i^* = (\alpha_i^*\beta_i^*)$ as a k+1 column vector containing the individual-specific coefficients. We decompose the individual specific coefficients into an observable and unobservable component as follows:

$$\theta_i^* = \theta_1 + \Pi D_i + \Sigma v_i, v_i \sim N(0, I_{k+1}), \tag{2}$$

Here θ_1 contains the parameters (α,β), D_i is a vector of demographic variables, Π is a matrix that measures how the tastes for characteristics vary with observable demographics, Σ is a scaling matrix, and ν_i represents the additional unobserved characteristics not explained by the observed demographics.

Assuming vector $\theta_2 = (vec(\Pi), vec(\Sigma))$ and combining Eqs. 1 and 2, we have:

$$\begin{gathered} u_{ijst} = \delta_{jst}\left(x_j, p_{jst}, \xi_j; \theta_1\right) + \mu_{ijst}\left(x_j, p_{jst}, v_i, D_i; \theta_2\right) + \varepsilon_{ijst} \\ \delta_{jst} = x_j\beta - \alpha p_{jst} + \xi_j,\ \mu_{ijst} = \left[p_{jst}, x_j\right]'(\Pi D_i + \Sigma v_i) \end{gathered} \tag{3}$$

δ_{jst} represent the mean utility from brand j at store s at time t, that does not vary by individual, while μ_{ijst} represents the individual level utility that varies across individuals.

Given this utility specification, a utility maximizing consumer i will purchase one unit of j if for all $k \neq j$, if $u_{ij} > u_{ik}$. So the probability of an individual i choosing brand j from store s at time t is given by

$$P_{ijst} = \frac{\exp\left(\delta_{jst} + \mu_{ijt}\right)}{1 + \sum_{l} \exp(\delta_{lst} + \mu_{ilt})} \tag{4}$$

As we observe only aggregate store level shares, we integrate out these individual level probabilities over the population distribution of the observed (demographics) and unobserved heterogeneity. Given the population distribution functions of D_s and ν denoted by $P^*(.)$ and assuming independence among these distributions, the market share of j in store s at time t is given by:

$$s_{jst}(x, p_{.st}, \delta_{.st}; \theta_2) = \int_{D_s} \int_{\nu} P_{ijst}\, dP^*(D_s) dP^*(\nu) \tag{5}$$

The demand q_{jst} for each store is obtained by multiplying the market share in (4) by the total potential market M_{st} of each store. The demand q_{jst} for product j at time t at the store level is given by:

$$q_{jst} = M_{st} s_{jst}(x, p_{.st}, \delta_{.st}; \theta_2) \tag{6}$$

2.2 Retailer pricing

To solve for the static profit maximizing price we assume the Manufacturer Stackelberg model. This model has considerable empirical support in the literature (e.g., Sudhir 2001a,b; Besanko et al. 2003; Villas-Boas and Zhao 2005).[4] Given that the manufacturer moves first, the game can be solved by backward induction solving first for the retailer price and then the manufacturer price. We therefore begin with the retailer pricing model.

Dominicks, the chain whose data we analyze, uses zone pricing. Instead of setting prices for each store separately, they group all their stores into three different pricing zones and select for each week a unique price for each SKU in all the stores of a given zone. We therefore define our supply equations at the zone level (denoted by z) rather than the store level.[5] The category profit maximizing retailer for zone z at time t maximizes the following objective function.

$$\Pi_{zt} = \sum\nolimits_{J} \left(p_{jzt} - w_{jzt}\right) s_{jzt} M_{zt} \tag{7}$$

[4] We tested for Vertical Nash in our empirical analysis, but this game was rejected.

[5] It is inappropriate to estimate the supply model at the store level when the prices are set at the zone level because it will make it appear that we have far more degrees of freedom than is warranted in the data. This inflates the significance of the supply side coefficients by a factor of $\sqrt{\frac{\#\,Stores}{\#\,Zones}}$. Given that we have 90 stores and 3 price zones, we will inflate significance by a factor of 5.47.

where j indexes brands, p denotes retail prices, w denotes wholesale prices, s denotes shares and M indicates total potential market size in the category. Assuming that consumers of each pricing zone do not shop outside of their zone, first order conditions for retail prices in each zone z is of the form:

$$s_{jzt} + \sum_{k=1}^{J} (p_{kzt} - w_{kzt}) \cdot \frac{\partial s_{kzt}}{\partial p_{jzt}} = 0 \tag{8}$$

Solving the first order conditions in (8) and re-arranging the terms in matrix form, the category profit maximizing retailer's price at the zone level is of the form:

$$p_{zt} = w_{zt} - \left(\frac{\partial s_{zt}}{\partial p_{zt}}\right)^{-1} s_{zt} \tag{9}$$

Where $\frac{\partial s_{zt}}{\partial p_{zt}}$ is the retailer's cross price elasticity matrix at zone z.

Equation 9 does not consider potential deviations from the static category profit maximizing price. Consider the following "as if" objective function for the retailer at time t, for zone z:

$$\Pi_{zt} = \sum_{J} \left[\left(p_{jzt} - w_{jzt}\right) s_{jzt} - \phi^{R}_{jzt} s_{jzt} \right] M_{zt} \tag{10}$$

where j indexes the brands sold, p indicates prices, w indicates wholesale prices, s indicates shares and M indicates total potential market size in the category. The first part of the objective $\left(p_{jzt} - w_{jzt}\right) s_{jzt} M_{zt}$ is brand profit as before in Eq 7. By summing it over all brands, we capture the category profit. The second term $-\phi_{jzt} s_{jzt} M_{zt}$, allows the retailer to suppress (aid) the share of a given brand by placing a negative (positive) weight on that brand's share ϕ_{jzt} (which needs to be estimated). This leads to the following retailer pricing equation in matrix form.

$$p_{zt} = \underbrace{w_{zt}}_{wholesale\,price} \underbrace{- \left(\frac{\partial s_{zt}}{\partial p_{zt}}\right)^{-1} s_{zt}}_{retail\ margin} + \underbrace{\phi^{R}_{zt}}_{deviations} \tag{11}$$

Equation 11 allows us to capture systematic departures from category profit maximizing prices. From Eqs. 10 and 11 it follows that a positive ϕ^{R}_{jzt} implies a higher price relative to the category profit maximizing price in order to "disfavor" the brand. In contrast, a negative value of ϕ^{R}_{jzt} implies prices will be set lower than the category profit maximizing price "favoring" that brand in terms of improving its market share. We further parameterize ϕ^{R}_{jzt} in terms of variables d^{R}_{jzt}. The variables can not only capture the effect of store brand introductions, but can also control for other brand and promotion effects on prices.

$$\phi^{R}_{jzt} = d^{R}_{jzt} + \omega^{R}_{jzt} \quad \omega^{R}_{jzt} \sim N(0, \sigma^2) \tag{12}$$

2.3 Manufacturer pricing equations

We now turn to the manufacturer pricing equation. Manufacturer f selling to the retail chain the set of brands j in the set F_f in each period t, maximizes the following profit function (note that the manufacturer only offers one price brand to the retailer chain):

$$\Pi_t^f = \sum_{j \in F_f} \left(w_{jt} - c_{jt} \right) q_{jt} \tag{13}$$

Where is the wholesale price to the retailer, c is the manufacturer's marginal cost, and q is the quantity sold by the retailer chain. Solving for all manufacturers' first order conditions with respect to wholesale prices, we obtain in matrix notation:

$$w_t = \underset{Cost}{c_t} + \underbrace{\left[\left(-\frac{\partial q_t}{\partial w_t} \right) \cdot *(\Omega) \right]^{-1} q_t}_{Margin} = c_t + mg_t^M \tag{14}$$

Where w_t,c_t, q_t *and* mg_t^M are vectors of dimension $J \times 1$, $\frac{\partial q_t}{\partial w_t}$ is the J×J manufacturer's quantity cross-elasticity matrix and Ω is the J×J ownership matrix which elements in row m and column n are of the form:

$$\Omega_{\mathrm{mn}} = \begin{cases} 1 & \text{if m, n belong to the manufacturer} \\ 0 & \text{otherwise} \end{cases}$$

Since quantity q_t sold by the retailer is the sum of sales at each zone z, q_t and $\frac{\partial q_t}{\partial w_t}$ can be expanded as:

$$q_t = \sum_{z=1}^{3} s_{zt} M_{zt} \quad \frac{\partial q_t}{\partial w_t} = \sum_{z=1}^{3} \frac{\partial s_{zt}}{\partial w_t} M_{zt} \tag{15}$$

Where

s_{zt} is the J×1 vector of market shares at the zone z, $\frac{\partial s_{zt}}{\partial w_t}$ is the J×J manufacturer's share cross-elasticity matrix at the zone z, and M_{zt} is the total market for each zone.

To further expand $\frac{\partial s_{zt}}{\partial w_t}$, first note that $\frac{\partial s_{zt}}{\partial w_t} = \frac{\partial s_{zt}}{\partial p_{zt}} \cdot \frac{\partial p_{zt}}{\partial w_t}$ where $\frac{\partial s_{zt}}{\partial p_{zt}}$ is the well known retailer's cross price elasticity at zone z and $\frac{\partial p_{zt}}{\partial w_t}$ is the zone specific pass-through matrix. The pass-through matrix is derived by totally differentiating retailers first order conditions for a given brand j (Eq. 8) with respect to all prices and wholesale price w_f with variation d_{wf}[6] (see Appendix A).

Similar to the retailer deviations, we allow for deviations from the static profit maximizing price of the manufacturer; with a similar "as-if" profit maximizing function for the retailer that puts a weight on market share. We then obtain the following manufacturer pricing equation.

$$w_t = \underbrace{c_t}_{Cost} + \underbrace{mg_t^M}_{\substack{manufacturer \\ Profit\ Maximization \\ Margin}} + \underbrace{\phi_t^M}_{Deviations} \tag{16}$$

[6] See for example Villas-Boas 2007 and Che et al. 2007. Note however in our analysis, wholesale prices are at the chain level an retail prices are at the zone level, a reality that is abstracted away from these earlier papers.

We further parameterize ϕ^M_{jzt} in terms of variables d^M_{jzt}. As with the retailer equation, the variables can not only capture the effect of store brand introductions, but can also control for other brand and promotion effects on prices.

$$\phi^M_{jzt} = d^M_{jzt} + \omega^M_{jzt} \qquad \omega^M_{jzt} \sim N\left(0, \sigma^2\right) \tag{17}$$

3 Estimation

We estimate the model in two steps. First, we estimate the demand model. Then conditional on the demand estimates, we estimate the retailer and manufacturer pricing equations.

For the demand model, we use the Generalized Method of Moments (GMM) estimation procedure similar to that outlined in Berry (1994) and BLP (1995) and extended by Nevo (2001). Since the error ξ_{jst} in the demand equation is correlated with a regression variable (price), we need to use instrumental variable estimation techniques. But errors ξ_{jt} enter Eq. (6) nonlinearly. Since instrumental variable estimation techniques are not well developed for nonlinear equations, Berry (1994) suggests an iterative contraction mapping approach that enables the use of well-developed linear instrumental variables estimation. Following Berry (1994) and Berry et al. (1995), we compute the mean utility δ_{jst} (θ_2) iteratively where the h iteration is given below.

$$\delta^{h+1}_{sjt} = \delta^h_{sjt} + \ln\left(S_{sjt}\right) - \ln\left(s\left(p_{sjt}, p_{sjt}, \delta^h_{sjt}, P_n; \theta_2\right)\right) \tag{18}$$

In practice, to reduce computing logarithms, we follow Nevo (2000) by solving for $w_{jt} = \exp\left(\delta_{jt}\right)$with the following contraction mapping

$$w^{h+1}_{sjt} = w^h_{sjt} \frac{S_{sjt}}{s\left(p_{sjt}, x_{sjt}, \delta^h_{sjt}, P_n; \theta_2\right)} \tag{19}$$

We iterate on this equation until we get convergence. To get quick convergence, we need good starting values, i.e., $\delta^0_{.t}$. We use $\delta^0_{sjt} = \ln\left(S_{sjt}\right) - \ln(S_{s0t})$, the solution to the homogeneous logit model as our starting values.

We then compute the demand side errors conditional on θ_2 as

$$\xi_{sjt} = \delta_{sjt}(\theta_2) - x_{sjt}\theta_1 \tag{20}$$

Since ξ_{sjt} enters linearly in δ_{sjt}, we can use linear instrumental variables estimation methods.

For instruments, we need to find variables that are correlated with the price shocks, but are independent of the error term. BLP (1995) consider the average of product characteristics of competing products as instruments. Sudhir (2001a) uses a similar average but computes them for each segment. Nevo (2000) uses the average prices of other regions as instruments for a region's price, since he used data from multiple markets. We use the spirit of the instruments used in the above papers by using (a) the average price in other price zones, (b) the average price of all competing products in each segment and (c) the prices of input factor. The prices of input factors used are the monthly national average prices of each of the main ingredients (cereals and sugar) as reported by the US Department of Agriculture[7]. As discussed in Nevo (2001) to the extent that there might be common demand shocks across the zones, the average price across zones may not be a valid instrument. We tested for the sensitivity of the results with and without these instruments, and found the estimates to be not very sensitive. Hence we retain the instruments.

Using the parameters from the demand estimation, in the second step we estimate the supply side parameters. This required several sub-steps. First we compute retail and manufacturer short-run profit maximizing margins conditional on the observed share derivatives (which are a function of demand parameters).

$$mg^R_{jzt}\left(w_{jt}, s_{jzt}, s^*_t\right) \text{ and } mg^M_{jzt}\left(s_{jzt}, s^*_t\right)$$

where, s^*_t represents the partial derivatives of shares as a function of prices.

Then from Eqs. 11 and 12 we derive the retail pricing equation error as the difference between observed retail margins and calculated short-run category profit maximizing margins plus "deviations":

$$\omega^R_{jzt} = Mg^R_{jzt} - mg^R_{jzt}\left(w_{jt}, s_{jzt}, s^*_t\right) - d^R_{jzt} = y^R_{jzt} - d^R_{jzt} \tag{21}$$

Similarly, the manufacturer pricing equation error is given by the difference between manufacturer margins $w_{jt} - c_{jt}$ and calculated short-run profit maximizing manufacturer margins plus "deviations":

$$\omega^M_{jt} = \left(w_{jt} - c_{jt}\right) - mg^M_{jt}\left(w_{jt}, s_{jzt}, s^*_t\right) - d^M_{jt} = y^M_{jt} - d^M_{jt} \tag{22}$$

We estimate Eqs. 21 and 22 using Seemingly Unrelated Regression (SUR). Note however that unlike the retail margin Eq. 21, we do not observe manufacturer margins. Instead we just observe wholesale prices, which leaves manufacturer cost to be estimated along with the deviations. To separately identify manufacturer costs from the deviations, we set deviations from the short-run profit maximizing price to be zero in the pre-store brand introduction period (as in past research) and allow for deviations from the short-run profit maximizing margins only in the post-store brand introduction period.

4 Data

We use data on the cereal category in the Dominicks Finer Foods (DFF) Database at the University of Chicago for our empirical application. The cereal category is ideal for our study for multiple reasons: (1) Dominicks introduced several store brands into different segments of the cereal category in 1990 during the period of the data availability. (2), the cereal category is an economically important category to the

[7] Input factor prices are not correlated with the demand shocks across time, but wholesale and retail prices are likely to be correlated with common demand shock across all zones. We use the input factor prices to account for the variation in prices across time, and the differences in retail prices across zones to capture zone specific shocks.

retailer (it is the second largest category in terms of dollar sales), suggesting that strategic behavior if any, is more likely in this category.

Our analysis is of the top 40 brands which account for 67% of sales in the category. We follow Nevo (2001) in dividing brands into the following segments: (1) Family, (2) Kids, (3) Health and Nutrition and (4) Taste Enhanced. Dominicks introduced six store brands using an imitation strategy. The six store brands introduced imitated six of the top ten brands in terms of chain sales. The imitated brands are: Cheerios (#1), Frosted Flakes (#2), Rice Krispies (#3), Corn Flakes (#5), Raisin Bran (#6), and Froot Loops (#10). Table 1 lists the 40 brands, describes which segments they belong to and whether they were imitated or not. Table 2 summarizes the brands by manufacturers and segments. While the top two firms, Kellogg's and General Mills offer brands in all segments, smaller manufacturers offer brands in fewer segments.

We use weekly sales, price and promotion data from 94 Dominick's stores.[8] The stores are classified into three prices zones on the basis of similarity in demographic characteristics and responsiveness to marketing mix. Our primary analysis is based on data for a period of 78 weeks centered around the introduction of store brands by Dominicks. The first 22 weeks cover the period before store brands are introduced and begin the week of Nov 28, 1990. Thereafter there is a four week period in which store brands are gradually introduced into stores(April 26–May 23 1990). We ignore this period because it is a transitionary period. The next 52 weeks (ending May 22, 1991) constitute the post-store brand introduction period. Subsequently, to study longer-term effects of store brand introduction, we analyze another half year's data over the next 26 weeks from May 23, 1991 to Nov 20, 1991.

Our analysis is at the brand level. Hence we use quantity adjusted retail prices ($/oz) to aggregate across package sizes. Given the computational complexity of dealing with over 40 brands, we do not model demand at the SKU level as in recent research by Van Nierop et al. (2008). We use the retail margin data computed by Dominicks in computing wholesale prices.[9]

To obtain an estimate of the share of the outside good, we estimate the potential market size at a store in a given week using the following procedure. Each individual in a household can potentially consume one serving per day on 33% of the days. One serving is estimated as 30 g (as defined in the Cheerios box). The potential market (in servings) is obtained by multiplying the number of household visits in a given week times the average number of household members for each store, times the percentage of days the consumer consumes RTE cereal.[10] The share of the outside good is then given by $1 - \frac{\text{Quantity Purchased}}{\text{Market Potential}}$.

[8] Since price changes are based on a weekly cycle from Thursday to Wednesdays; we use the same cycle for our analysis.

[9] Dominicks uses the average acquisition cost (AAC) of the items in inventory in computing margins. In the presence of forward buying, it is well-known that acquisition costs vary even when wholesale prices do not change. The issue has been discussed at length in recent research (e.g., Meza and Sudhir 2006) in the context of retail passthrough. We recognize that the wholesale prices may be distorted due to the procedure employed by Dominicks, but do not expect systematic errors on our inference about the average effects of private label introductions.

[10] We did the analysis with alternative assumptions of 28%, 30%, 40% and 60%. Our results are robust to these assumptions.

Table 1 The 40 brands included in the study

#	Description	Manufacturer	Segment	Total Sales (US$m)	Sales ranking
1	CORN FLAKES	Kellogg's	Family	8.00	5
2	RAISIN BRAN	Kellogg's	Taste enhanced	7.46	6
3	FROSTED FLAKES	Kellogg's	Family	11.58	2
4	RICE KRISPIES	Kellogg's	Family	10.57	3
5	FROSTED MINI WHEATS	Kellogg's	health/nutrition	6.95	7
6	FROOT LOOPS	Kellogg's	Kids	5.58	10
7	SPECIAL K	Kellogg's	health/nutrition	6.26	9
8	JUST RIGHT	Kellogg's	Taste enhanced	1.68	40
9	CRISPIX	Kellogg's	Family	3.54	19
10	APPLE JACKS	Kellogg's	Kids	3.48	20
11	PRODUCT 19	Kellogg's	health/nutrition	1.75	38
12	CORN POPS	Kellogg's	Kids	4.16	14
13	CRACKLIN OAT BRA	Kellogg's	Taste enhanced	2.86	26
14	KELLOGGS COCOA KRISP	Kellogg's	Kids	2.04	36
15	CHEERIOS	General Mills	Family	12.09	1
16	HONEY NUT CHEERIOS	General Mills	Family	8.66	4
17	WHEATIES	General Mills	Family	3.78	17
18	TOTAL	General Mills	health/nutrition	3.90	15
19	LUCKY CHARMS	General Mills	Kids	5.11	11
20	GOLDEN GRAHAMS	General Mills	Family	4.25	13
21	TRIX	General Mills	Kids	3.73	18
22	RAISIN NUT	General Mills	Taste enhanced	2.52	29
23	OATMEAL RAISIN CRISP	General Mills	Taste enhanced	2.32	31
24	CINNAMON TOAST CRUNCH	General Mills	Kids	4.40	12
25	COCOA PUFFS	General Mills	Kids	2.54	28
26	KIX	General Mills	Kids	3.02	24
27	APPL CINNAMN CH	General Mills	Family	3.40	21
28	TOTAL RAISIN BRAN	General Mills	health/nutrition	3.02	25
29	WHOLE GRAIN TOTAL	General Mills	health/nutrition	3.06	23
30	POST RAISIN BRAN	Post	Taste enhanced	1.91	37
31	GRAPE NUTS	Post	health/nutrition	3.81	16
32	FRUITY PEBBLES	Post	Kids	2.23	32
33	COCOA PEBBLES	Post	Kids	2.07	35
34	HONEY BUNCHES OF OATS	Post	Taste enhanced	3.16	22
35	LIFE	Quaker	Kids	2.14	34
36	CAP N CRUNCH	Quaker	Kids	6.75	8
37	OAT SQUARES	Quaker	Family	2.39	30
38	RICE CHEX	Ralston	Family	2.22	33
39	CORN CHEX	Ralston	Family	1.72	39
40	SPOON SIZE SHREDD	Nabisco	health/nutrition	2.82	27

Imitated brands in bold

Table 2 Number of brands by manufacturer offered in each segment

	Segments				Totals by Manufact
	Family	Kids	Simple health/ nutrition	Taste enhanced Wholesome	
Manufacturer					
Kellogg's	4	4	3	3	14
General Mills	5	5	3	2	15
Post	0	2	1	2	5
Quaker	1	2	0	0	3
Ralston	2	0	0	0	2
Nabisco	0	0	1	0	1
Totals by Segment	12	13	8	7	40

5 Results

5.1 Descriptive analysis

We provide a summary characterization of the data in Table 3. Here and in subsequent tables we split the data into three periods: (1) a 22 week pre-store brand introductory period, (2) a 4 week transition period during which the six store brands were introduced gradually into different stores of the chain. By this 4 week period, the introduced six store brands had achieved penetration in 90% of the stores and (3) a 26 week post-store brand introductory period. We exclude from our estimation the four-week transition period where store brands are gradually being introduced throughout the chain. We further categorize the brand by whether they were imitated or not.

We expected the imitated brands to be treated more unfavorably than the non-imitated brands and therefore retail margins to increase more for the imitated brands. For imitated brands in all categories, retail margins increase in the post SB introduction period. Surprisingly, the retail margins also increased for the non-imitated brands except in the Health/Nutrition segment. But the percentage change in retail margin is considerably higher for the imitated brands, indicating these are being treated more unfavorably than the non-imitated brands.

The overall increase in retail prices did not lead to a decline in sales in all of the segments. In fact, the national brand sales increased overall indicating that the cereal category was growing during this period. This growing demand should have also contributed to the overall increase in retail prices. There is a significant reduction in promotions for imitated brands in the family and kids segments, but a significant increase in promotions for the non-imitated brands in these segments. Thus it appears there is a big shift in promotions to the non-imitated brands in these segments.

Table 4 reports information on the market attractiveness of the four different segments. It is clear that Family and Kids segments are the larger segments in terms

Table 3 Descriptive statistics of the data by segments and imitated vs non-imitated RTE cereal category

Segment	Period	Wholesale Price ($)	Margin ($)	Price ($)	Proportion of brands on promotion	Weekly sales ($)	Weekly sales (Oz)
Family (Non Imitated)	Before SB	0.1490	0.0264	0.1754	7.48%	65,670	374,416
	SB Intro	0.1499	0.0312	0.1811	21.66%	84,317	4 65,632
	After SB	0.1534	0.0284	0.1818	11.46%	83,154	4 57,370
Kids (Non Imitated)	Before SB	0.1678	0.0271	0.1949	1.51%	76,326	391,716
	SB Intro	0.1649	0.0257	0.1906	22.76%	98,190	515,111
	After SB	0.1681	0.0280	0.1961	11.85%	106,505	543,139
Health & Nutrition (Non Imitated)	Before SB	0.1438	0.0242	0.1680	3.85%	55,732	331,701
	SB Intro	0.1533	0.0212	0.1745	8.74%	55,299	316,838
	After SB	0.1515	0.0230	0.1745	3.87%	69,655	399,073
Taste Enhanced (Non Imitated)	Before SB	0.1538	0.0234	0.1773	11.60%	27,751	156,552
	SB Intro	0.1467	0.0295	0.1762	42.30%	40,466	229,720
	After SB	0.1510	0.0284	0.1794	8.16%	38,166	212,763
Family (Imitated)	Before SB	0.1345	0.0197	0.1542	16.34%	116,776	757,534
	SB Intro	0.1322	0.0208	0.1530	5.10%	80,731	527,774
	After SB	0.1148	0.0254	0.1402	8.70%	1 04,882	747,971
Kids (Imitated)	Before SB	0.1740	0.0283	0.2024	29.75%	13,468	66,551
	SB Intro	0.1820	0.0261	0.2082	0.00%	7,965	38,266
	After SB	0.1784	0.0317	0.2101	11.66%	10,671	50,781
Health & Nutrition (Imitated)	Before SB	0.1613	0.0239	0.1853	1.06%	6,422	34,661
	SB Intro	0.1649	0.0253	0.1902	0.00%	6,240	32,812
	After SB	0.1653	0.0291	0.1944	0.00%	9,477	48,759
Taste Enhanced (Imitated)	Before SB	0.1270	0.0167	0.1437	4.70%	15,463	107,583
	SB Intro	0.1286	0.0183	0.1469	0.00%	14,397	98,016
	After SB	0.1203	0.0198	0.1401	16.31%	18,673	133,281

Table 4 Segment attractiveness—RTE cereal category

Segments	Number of brands	Share of segment in categ.	Ave. mark. share per brand	Contribut to total profits	Margin (% retail price)	Contrib. to Herfindahl Index
Family	17	35.4%	2.08%	37.16%	15.26%	54.6%
Kids	20	25.1%	1.26%	24.43%	14.15%	19.1%
Health/ Nutrition	17	19.7%	1.16%	18.92%	13.97%	15.3%
Taste Enhanced	25	19.9%	0.80%	19.49%	14.24%	10.9%
Mass Brands	37	60.5%	1.64%	61.58%	15.0%	73.7%
Niche Brands	42	39.6%	0.94%	38.42%	14.1%	26.3%

of sales, contribution to total profits and contribution to a Herfindahl measure of concentration. We therefore categorize the family and kids segments as "Mass" segments, while the Health/Nutrition and Taste enhanced brands with smaller sales are treated as "Niche" brands.

5.2 Demand estimates

The demand side estimates are reported in Table 5. The estimates have considerable face validity. The mean coefficient of price is negative as expected and the standard deviation of the price coefficient is significant indicating that there is heterogeneity in the price sensitivity of customers. Income reduces price sensitivity, though this coefficient is insignificant. Fiber has a mean positive coefficient, indicating that the population on average values the health benefits of a fibrous diet that cereal is touted to be. However there is heterogeneity in the valuations of fiber in cereal. Not surprisingly, people with higher incomes value a diet with high fiber, but kids do not value this. The surprising result is the Education Variable; college educated consumers seem to not value the fiber attribute. On average, the presence of sugar reduces the valuation for the product. Kids consumed more of the sugary cereals. High income and college-educated consumers also sought sugary cereals. Perhaps it is these consumers who buy the more expensive sugary cereals for their kids rather than add sugar at home to reduce inconvenience. As expected we obtained a positive coefficient on promotion, indicating that consumers value promotions. In particular, seniors value them highly. The coefficient for the interaction term between price and promotions is negative. Its magnitude reflects that price sensitivity increased around 33% in the presence of promotions, a result that is consistent with other research (Van Heerde et al. 2001; Sudhir 2001b).

Prior research (Hoch and Banerji 1993; Dhar and Hoch 1997; Starzynski 1993, and Hoch 1996) identified several demographic characteristics of the population to be correlated with the success of store brands. By incorporating these demographic

Table 5 Demand model

	Mean	Sigma	Income	Senior	Education (College)	Children (< 9 Y old)
Constant	2.652*** (0.028)	−0.132 (0.316)	−7.569*** (0.196)	5.341*** (0.512)	5.017*** (0.258)	–
Price ($/oz)	−65.382*** (0.765)	−2.113 (1.291)	2.050** (0.943)	–	–	–
Fiber (gr/serving)	0.0819*** (0.002)	0.099*** (0.034)	0.228*** (0.006)	−2.2960*** (0.399)	−4.8556*** (0.066)	0.3455*** (0.037)
Sugar (gr/serving)	−0.140*** (0.003)	–	0.579*** (0.017)	–	1.800*** (0.031)	−0.085** (0.038)
Promotion	3.082*** (1.039)	1.239 (0.815)	–	8.899*** (0.606)	–	–
Price x Promotion	−33.000*** (6.388)	–	–	–	–	–
Trend	0.536*** (0.036)	–	–	–	–	–

variables and accounting for their effects on demand, we can now be more certain that our inferences about the strategic behavior of the retailer are not contaminated by unobserved demand side factors.

Like Chintagunta et al. (2002), we also find that there were no significant differences in demand parameters before and after store brand introduction. This is not surprising because the demand parameters we estimate are individual level characteristics, which should not be affected by store brand introduction. We would not however expect the parameters to be the same if we had estimated a reduced form linear or log-linear model. However the elasticities do increase on average. We show the average own-price elasticities of the brands in Table 6 classified by segments before and after store brand introduction. The average elasticity after the store brand has been introduced is greater (based on a paired t-test of the difference in estimated elasticities for each brand, $p<0.001$), indicating that the introduction of the store brand increased the elasticity of the category itself. However, what is also particularly interesting is that the elasticities of all brands do not increase. In fact, for some brands the elasticities decline. This could be due to the fact that some of the price sensitive customers who purchased national brands now completely switch to the store brand and the national brands are now left with only the less price sensitive customers. This highlights the flexible nature of the random coefficients logit model that accounts for consumer heterogeneity. Even though consumer parameters and therefore the logit model estimates do not change after the introduction of the store brand, there is a fairly rich change in the pattern of changes in the elasticities.

We also check the nature of the estimated elasticities in two other ways to assess the face validity of our estimates. First in Table 7, we check whether the cross-elasticity between Dominicks store brands and its corresponding imitated brands are higher than its cross-elasticity with respect to other brands. In fact, for all of the brands except for Corn Flakes, this pattern holds. For example, the cross-elasticity of Dominicks Cheerios with respect to General Mills Cheerios is 1.786, considerably higher than the cross-elasticity with respect to the other brands. However, the cross-elasticity of General Mill Cheerios with respect to Dominicks Cheerios is considerably lower indicating a considerable asymmetry in the nature of the elasticity. This asymmetric elasticity between store brands and national brands is well documented in the literature (e.g., Blattberg and Wisniewski 1989; Sethuraman

Table 6 Own-price elasticities—RTE cereal category

Segments	Imitated / non imitated	Before SB	After SB	General
Family	Non Imitated	−10.62	−11.34	−11.01
	Imitated	−8.80	−8.95	−8.88
Kids	Non Imitated	−11.85	−12.14	−12.01
	Imitated	−11.70	−12.33	−12.04
Health & Nutrition	Non Imitated	−10.85	−11.45	−11.18
	Imitated	−9.14	−10.08	−9.65
Taste enhanced	Non Imitated	−9.93	−10.26	−10.11
	Imitated	−7.09	−6.84	−6.95

Table 7 Own & cross-price elasticities store brands and imitated national brands—RTE cereal category

	Domminick's Tasteo's	Domminick's Corn Flks	Domminick's Rice Crisp	Domminick's Frost Flk	Domminick's Fruit Rings	Domminick's Rais Bran	Cheerios (GM)	Corn Flakes (Kellogg's)	Rice Krispies (Kellogg's)	Frosted Flakes (Kellogg's)	Froot Loops (Kellogg's)	Raisin Bran (Kell, Pst, GM)
Domminick's Tasteo's	−8.172	0.061	0.059	0.043	0.000	0.000	0.118	0.069	0.072	0.063	0.000	0.000
Domminick's Corn Flakes	0.053	−4.730	0.119	0.176	0.000	0.000	0.046	0.091	0.086	0.072	0.000	0.000
Domminick's Rice Crispies	0.053	0.114	−7.538	0.118	0.000	0.000	0.049	0.095	0.091	0.079	0.000	0.000
Domminick's Frosted Flakes	0.050	0.295	0.245	−7.089	0.000	0.000	0.042	0.104	0.103	0.132	0.000	0.000
Domminick's Fruit Rings	0.000	0.000	0.000	0.000	−9.104	0.000	0.000	0.000	0.000	0.000	0.338	0.000
Domminick's Raisin Bran	0.000	0.000	0.000	0.000	0.000	−5.534	0.000	0.000	0.000	0.000	0.000	0.592
Cheerios (GM)	1.786	0.923	0.908	0.676	0.000	0.001	−10.90	0.948	1.024	0.885	0.000	0.000
Corn Flakes (Kellogg's)	0.530	0.918	0.833	0.612	0.000	0.000	0.498	−6.248	0.891	0.805	0.000	0.000
Rice Crispies (Kellogg's)	0.617	0.962	0.89	0 0.684	0.000	0.000	0.590	0.930	−10.38	0.808	0.000	0.000
Frosted Flakes (Kellogg's)	0.700	1.016	0.964	0.822	0.000	0.000	0.671	1.137	1.035	−9.325	0.000	0.000
Froot Loops (Kellogg's)	0.000	0.000	0.000	0.000	0.961	0.000	0.000	0.000	0.000	0.000	−12.17	0.000
Raisin Bran (Kell, Post, GM)	0.000	0.000	0.000	0.000	0.000	1.347	0.000	0.000	0.000	0.000	0.000	–

Table shows % changes in market share of brands in columns due to % changes in prices of brands in rows.

1995) and indeed our random coefficients logit model is able to capture this asymmetry well. The cross-elasticity between Kellogg's Corn Flakes and Dominicks Corn Flakes however is not higher than with respect to other brands. This suggests that Cornflakes is a staple cereal in the consideration set of most households and therefore it has high cross-elasticity with respect to all other types of cereals, a finding that is not very surprising with hindsight.

We also verify whether the general definition of segments that we define has face validity based on the estimated demand elasticities. Table 8 shows the average cross price elasticity within and across the segments we define. In general the higher values in the diagonal provide support for the segment classification used. The only exception is that Health/Nutrition demand is affected highly by the changes in prices in the family segment. This is primarily due to the substantial cross-elasticity between Cheerios (which is a relatively healthy cereal and promoted as a heart-friendly product in the Family segment) and the brands in the Health/ Nutrition segment. Removing the impact of Cheerios from the average reduces the elasticity to .22.

5.3 Retailer and manufacturer pricing

We report the retailer and manufacturer price equation estimates in Tables 9 and 10. Model 1 in both tables reports the estimates of primary interest to us—deviations from short run retailer and manufacturer prices in the different segments controlling for whether the brands were imitated by store brands or not. Models 2–4 provide additional control variables that may systematically explain deviations (such as manufacturer dummies and the use of promotions) to assure that the key findings are robust. As the estimates of primary interest are virtually identical across the different models, we discuss only the estimates from Model 1.

From Table 9, we see that the retailer raises prices for imitated mass national brands, while reducing prices for non-imitated mass national brands. But, the retailer does not strategically deviate from the category profit maximizing price for the niche brands. Thus the retailer exerts its strategic power to support the private label gain market share by making imitated national brands less attractive to the consumer in the mass market segments, where gains in market share are likely to be substantially more valuable longer-term

Table 10 reports how the manufacturer wholesale prices change in response to store brand introductions. We find that manufacturer wholesale prices are lower than the category profit maximizing price for imitated national brands across both the

Table 8 Average cross-price elasticities by segment—RTE cereal category

	Family	Kids	Health & Nutrition	Taste enhanced
Family	0.4624	0.1174	0.3198	0.0405
Kids	0.0771	0.3646	0.0170	0.0031
Health & Nutrition	0.1401	0.0228	0.2904	0.0973
Taste enhanced	0.0110	0.0029	0.1308	0.6071

Table 9 Retailer pricing model

			Model 1	Model 2	Model 3	Model 4
$C^R_{j..}$	Relative Traffic Change					0.007 (0.007)
	Manufacturer Specific intercept	Kellogg's			0.004 (0.005)	0.004 (0.005)
		GM			0.019*** (0.005)	0.019*** (0.005)
		Post			0.002 (0.005)	0.002 (0.005)
		Quaker			0.026*** (0.006)	0.026*** (0.006)
		Ralston			0.012* (0.006)	0.012* (0.006)
	Promotion			−0.063*** (0.004)	−0.062*** (0.004)	−0.062*** (0.004)
	Segment type x product type	Mass Brands	−0.018*** (0.002)	−0.016*** (0.002)	−0.030*** (0.005)	−0.031*** (0.005)
		Mass Bs x Imitated	−0.013*** (0.004)	−0.013*** (0.004)	−0.006 (0.004)	−0.006 (0.004)
		Niche Brands	−0.030*** (0.002)	−0.028*** (0.002)	−0.037*** (0.005)	−0.037*** (0.005)
		Niche Bs x Imitated	−0.046*** (0.005)	−0.046*** (0.005)	−0.045*** (0.005)	−0.045*** (0.005)
$\phi^R_{j..}$	Mass Brands	SB Introduced	−0.011*** (0.002)	−0.008*** (0.002)	−0.008*** (0.002)	−0.008*** (0.002)
		SB Introduced x Imitated	0.016*** (0.005)	0.014*** (0.005)	0.014*** (0.005)	0.014***(0.005)
	Niche Brands	SB Introduced	0.002 (0.003)	0.002 (0.003)	0.002 (0.003)	0.002 (0.003)
		SB Introduced x Imitated	0.002 (0.006)	0.003 (0.006)	0.003 (0.006)	0.003 (0.006)

Table 10 Manufacturer pricing model

			Model 1	Model 2	Model 3	Model 4
$C^{M}_{j..}$	Relative Traffic Change					−0.019** (0.008)
	Manufacturer Specific intercept	Kellogg's			−0.003*** (0.001)	−0.003*** (0.001)
		GM			−0.007*** (0.001)	−0.007*** (0.001)
		Post			−0.006*** (0.001)	−0.006*** (0.001)
		Quaker			−0.007*** (0.001)	−0.007*** (0.001)
		Ralston			0.000 (0.001)	0.000 (0.001)
	Promotion			−0.004*** (0.001)	−0.006*** (0.001)	−0.006*** (0.001)
	Segment type x product type	Mass Brands	0.000 (0.000)	0.000 (0.000)	0.006*** (0.001)	0.006*** (0.001)
		Mass Bs x Imitated	0.000 (0.001)	0.000 (0.001)	−0.002*** (0.001)	−0.002*** (0.001)
		Niche Brands	0.000 (0.000)	0.000 (0.000)	0.005*** (0.001)	0.005*** (0.001)
		Niche Bs x Imitated	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)	0.001 (0.001)
$\phi^{M}_{j..}$	Mass Brands	SB Introduced	−0.002*** (0.000)	−0.002*** (0.000)	−0.002*** (0.000)	−0.002*** (0.000)
		SB Introduced x Imitated	−0.002** (0.001)	−0.002** (0.001)	−0.002** (0.001)	−0.002** (0.001)
	Niche Brands	SB Introduced	0.001** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001** (0.000)
		SB Introduced x Imitated	−0.005*** (0.001)	−0.005*** (0.001)	−0.005*** (0.001)	−0.005*** (0.001)

mass and niche segments, suggesting that retailers gain bargaining power upon introducing store brands. Wholesale prices are lower than the category profit maximizing price for non-imitated brands only in the mass segment, where the private labels can induce competitive pressure even on non-imitated brands and thus increase retailer bargaining power.

Our results here shows two effects: (1) retailers gain bargaining power against manufacturers through introduction of the private label, that helps it obtain lower wholesale prices and (2) retailers strategically deviate from the short-run category profit maximizing prices in order to gain short-run market share. A third effect on prices due to the introduction of the private labels is directly on the short-run profit maximizing prices of the manufacturers and retailer due to the increased competition induced by private labels. To understand the relative magnitudes of these effects, we compare the changes in retail and wholesale margins that results from simply increased competition due to private labels relative to the effects increased bargaining power and strategic retailer behavior. These results are reported in Tables 11 and 12.

The first rows of Tables 11 and 12 show the effect of increased competition due to private labels, while the second rows in Tables 11 and 12 show the effect of strategic retailer behavior and changes in retail bargaining power respectively. Note that the second row estimates are obtained from Tables 9 and 10. What is obvious from Table 11 is that the magnitude of the effect of retailer strategic behavior on prices is much larger than the effect of increased competition. The effect of increased retailer bargaining power on manufacturer margins is also substantially larger than the competition effect as seen in Table 12 (except for the non-imitated brands where we already discussed that the bargaining effect is limited). Thus retailer strategic behavior and increased retailer bargaining power are important qualitative factors that affect retail and wholesale prices during store brand introductions; these effects are substantially larger than the mere "increased competition" effect of store brands.

We now discuss whether our results are robust to other controls. First, we control for price promotions that may be accompanied by lump-sum transfer (side payments) from manufacturers to retailers. Since we do not observe side payments, we check whether our results about manufacturer and retailing pricing continue to hold after controlling for the effects of price promotions, which are typically accompanied by "allowances"—side payments from manufacturers to retailers. The estimates reported in Model 2, show that the results discussed earlier continue to hold. We control for potential manufacturer specific differences in Model 3 and find that the main results continue to remain identical in magnitude. Finally, to test for

Table 11 Changes in retailer margins

Changes in margin due to:	Mass brands		Niche brands	
	Non-imitated	Imitated	Non-imitated	Imitated
Competition	−0.0006	−0.0014	−0.0009	−0.0007
Retailer strategic behavior	−0.0079	0.0062	0.0018	0.0046

Table 12 Changes in manufacturer margins

Changes in margin due to:	Mass brands		Niche brands	
	Non-imitated	Imitated	Non-imitated	Imitated
Competition	−0.0025	−0.0015	−0.0018	−0.0014
Increased Retail Bargaining Power	−0.0021	−0.0038	0.001	−0.0044

potential impact of the effects of store competition, we use store traffic as a control as in Chintagunta (2002) in Model 4. The results continue to be similar to Model 1.

5.4 Longer term effects on retailer and manufacturer pricing

The analysis reported in Tables 9 and 10 focus on how manufacturers and retailers price in the first few months after a store brand introduction. We find that retailers selectively price strategically to support private labels, and they gain bargaining power relative to manufacturers. Do these effects continue a year after the store brand is introduced?

To investigate this, we look for differences in price deviations a year after store brand introduction (weeks 26–78) and thereafter (week 79–104). Table 13 reports retailer pricing results, while Table 14 reports manufacturer pricing results. From Table 13, we find that the retailer stops strategically deviating from the category profit maximizing price a year after the store brand introduction. While weeks 26–78 continue to replicate results from before, none of the deviations in weeks 79–104 are significantly different from the category profit maximizing prices.

In contrast, from the manufacturer pricing results in Table 14, we find the increased bargaining power of retailers continue to remain even over the longer term

Table 13 Retailer pricing model deviations from short run profit maximizing price

			Model 1	Model 2	Model 3	Model 4
Mass brands	Weeks 26 to 78	SB Introduced	−0.011*** (0.003)	−0.008*** (0.003)	−0.008*** (0.003)	−0.009*** (0.003)
		SB Introduced x Imitated	0.013** (0.006)	0.014** (0.006)	0.014** (0.006)	0.014** (0.006)
	Weeks 79 to 104	SB Introduced	−0.003 (0.003)	−0.001 (0.003)	−0.001 (0.003)	−0.002 (0.003)
		SB Introduced x Imitated	0.007 (0.006)	0.008 (0.006)	0.008 (0.006)	0.008 (0.006)
Niche brands	Weeks 26 to 78	SB Introduced	0.001 (0.003)	0.002 (0.003)	0.002 (0.003)	0.001 (0.003)
		SB Introduced x Imitated	0.001 (0.008)	0.001 (0.007)	0.001 (0.007)	0.001 (0.007)
	Weeks 79 to 104	SB Introduced	0.003 (0.004)	0.002 (0.004)	0.002 (0.004)	0.002 (0.004)
		SB Introduced x Imitated	0.002 (0.008)	0.004 (0.008)	0.004 (0.008)	0.004 (0.008)

past the first year. In fact, the wholesale prices for imitated national brands in the niche segment are even lower than in the first year. For the mass segment, the wholesale prices continue to remain lower, but the magnitudes are not as large. This suggests that retailers gain more bargaining power from private labels in niche categories where manufacturers have limited "pull" power in drawing customers to stores.

In summary, we conclude that the strategic pricing behavior of retailers is temporary only to help private labels achieve their steady state market share, but the increased bargaining power that retailer gains from introducing private labels are longer lasting, especially in categories where manufacturers have limited "pull" power.

5.5 Nash bargaining model based metric of bargaining power

Our results above suggest that the retailer has gained bargaining power with the introduction of private labels, especially in the niche segments. We now compute another metric of bargaining power based on the Nash bargaining framework to assess the convergent validity of our conclusion about bargaining power. According to the Nash Bargaining framework (Iyer and Villas-Boas 2003), the gains from trade are split according to the bargaining power of the manufacturer and the retailer. Misra and Mohanty (2008) and Draganska et al. (2010) use this metric to estimate bargaining power. The exact bargaining power metric and the formula are shown in Appendix B.

We compute bargaining power before and after store brand introductions for each brand. To infer how store brand introductions affect bargaining power across the different segments and whether they are imitated, we report the result of a regression explaining how estimated bargaining power of a national brand changes over time across different segments and whether they are imitated in Table 15. We find that the retailer bargaining power has consistently increased relative to the manufacturers for both imitated and non-imitated brands in both mass and niche segments. As before, the increase in bargaining power is greater for imitated brands and in the niche segment. Further, the increase in bargaining power continues to be long-term consistent with results reported in Table 14.

6 Conclusion

In this paper we investigated two key questions related to store brand introductions: (1) Do retailers strategically use their power to set retail prices for all brands to support their own store brands and (2) Do retailers gain bargaining power with the introduction of store brands?

First, we find that retailers indeed use their power to price strategically by keeping prices of imitated national brands higher than the category profit maximizing price. This higher price helps the retailer to build market share for the store brand. However, this strategic pricing is temporary; once the store brand market share has stabilized to its steady state market share, the retailer no longer strategically distorts prices away from the category profit maximizing price. Further, the retailer does

Table 14 Manufacturer pricing model deviations from short run profit maximizing price

			Model 1	Model 2	Model 3	Model 4
Mass brands	Weeks 26 to 78	SB Introduced	−0.001** (0.000)	−0.001** (0.000)	−0.001* (0.000)	−0.001** (0.000)
		SB Introduced x Imitated	−0.002** (0.001)	−0.002** (0.001)	−0.002** (0.001)	−0.002** (0.001)
	Weeks 79 to 104	SB Introduced	−0.001** (0.000)	−0.001** (0.000)	−0.001** (0.000)	−0.001** (0.000)
		SB Introduced x Imitated	−0.001 (0.001)	−0.001 (0.001)	−0.001 (0.001)	−0.001 (0.001)
Niche brands	Weeks 26 to 78	SB Introduced	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)
		SB Introduced x Imitated	−0.008*** (0.001)	−0.008*** (0.001)	−0.008*** (0.001)	−0.008*** (0.001)
	Weeks 79 to 104	SB Introduced	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
		SB Introduced x Imitated	−0.013*** (0.001)	−0.013*** (0.001)	−0.013*** (0.001)	−0.013*** (0.001)

Table 15 Change in retailer bargaining power λ

	Variable	Coefficient
Mass brands	Imitated	0.654*** (0.004)
	Non Imitated	0.638*** (0.002)
Niche brands	Imitated	0.657*** (0.006)
	Non Imitated	0.653*** (0.003)
Mass brands X weeks 26–78	Imitated	0.016*** (0.005)
	Non Imitated	0.019*** (0.003)
Niche brands X weeks 26–78	Imitated	0.023*** (0.007)
	Non Imitated	0.010*** (0.003)
Mass brands X weeks 79–104	Imitated	0.021*** (0.006)
	Non Imitated	0.023*** (0.003)
Niche brands X weeks 79–104	Imitated	0.031*** (0.007)
	Non Imitated	0.010*** (0.004)

such strategic pricing only for the large mass market brands, where gains in market share is more valuable to the retailer.

Second, the benefit of greater bargaining power from the introduction of private labels tends to be longer lasting and continues beyond the first year after store brand introductions in the form of lower wholesale prices. We check the robustness of this result with an alternative metric based on the Nash bargaining framework and our results are consistent across the two metrics. While the increase in retailer bargaining power tends to be smaller for mass market brands which have substantial pull power that favors manufacturers, the increase in bargaining power with respect to smaller niche national brands tend to be larger.

We now discuss some limitations of our analysis which provide opportunities for future research. First our analysis is restricted to one category—RTE cereal. While the presence of multiple segments and the introduction of several private labels targeted against different types of national brands help us gain insights into how private label introductions affect manufacturer-retailer relationships in different market conditions, future research should investigate the relationships across different categories to assess the generalizability of our results.

Further, we have limited our study to price as the strategic variable for the retailer. The retailer has control over not only the retail price, but also other marketing mix variables such as shelf space and position, features, displays and promotions. There could also be lump-sum transfers in the form of allowances to retailers from manufacturers that can be affected. It could be expected that the retailer may change its strategy with respect to these variables also so as to facilitate the long-term penetration of the store brand. Future research needs to address issues related to other strategic variables. For example, it would be interesting to study how the shelf space is relocated from the national to the store brands. For example, Hoch (1996) suggests that because 90 percent of people are right-handed, the retailer invariably places the store brand to the immediate right of the leading national brand it is imitating. It would be also important to study how national brands are compensated by the loss of the shelf space that is taken by the store brands, so that retailers don't lose advertising and promotional support for the category

Future research also needs to consider what other dimensions other than the imitated-non imitated and mass-niche dimensions are appropriate in explaining the retailer's strategic behavior in setting prices. For example, there are cases where the store brand does not imitate a national brand. For example "President's choice" from Loblaw's in Canada, "World Classics" from Topco, and "Sam's Choice" from Wal-Mart are not imitations of national brands, but they are introduced as a high quality differentiated product with respect to national brands. In such a case, the private label may have greater pull power (Seenivasan et al. 2009), which can have greater impact on the retailer's gain in bargaining power. In other cases (as mentioned by Hoch 1996) the strategy for the low-quality tier is to offer either a white-label generic or a second store brand (e.g., A&P's "Savings Plus line"). Here the power gain may be less. Future research needs to evaluate how alternative private label entry strategies affect the relative balance of power between manufacturers and retailers.

Summarizing, our paper takes an important first step in studying the impact of private labels on manufacturer-retailer relationships. Our main conclusions are (1) private labels help a retailer gain bargaining power and (2) retailers initially use their power to set retail prices to favor private labels to help them gain market share. But there remain many opportunities to refine our understanding of the impact of private labels on the balance of power between manufacturers and retailers.

Appendix A

The zone specific pass-through matrix $\frac{\partial p_z}{\partial w}$

Totally differentiating the retailer's first order condition for a given brand j (Eq. 8) with respect to wholesale price w_fw with variation dw_f, we get [11]

$$\sum_{g=1}^{J}\left[\frac{\partial s_{jz}}{\partial p_{gz}}+\frac{\partial s_{gz}}{\partial p_{jz}}+\sum\nolimits_{k=1}^{J}\left((p_{kz}-w_{kz})\cdot\frac{\partial^2 s_{kz}}{\partial p_{jz}\partial p_{gz}}\right)\right]dp_{gz}-\frac{\partial s_{fz}}{\partial p_{jz}}dw_f=0$$

Stacking the equation for all brand j's, it can be shown that the price zone specific f column of the retailer's pass through matrix $\frac{\partial p_w}{\partial w}$ can be defined as follows

$$\frac{dp_z}{dw_f}=G^{-1}\cdot\frac{\partial s_{fz}}{\partial p_z}$$

Where $\frac{\partial s_{fz}}{\partial p_z}$ is the f column of the pricing zone specific retailer's cross-elasticity matrix and the (l, m) element of G is defined as:

$$G_{lm}=\frac{\partial s_{lz}}{\partial p_{mz}}+\frac{\partial s_{mz}}{\partial p_{lz}}+\sum_{k=1}^{J}(p_{kz}-w_k)\frac{\partial^2 s_{kz}}{\partial p_{mz}\partial p_{lz}}$$

[11] For notational simplicity we drop t, but all elements s, p and w are *period-specific.*

Finally, $\frac{\partial^2 s_{kz}}{\partial p_{mz}\partial p_{lz}}$ is estimated based on averages from the N random draws of individuals as[12]

$$\frac{\partial^2 s_k}{\partial p_m \partial p_l} = \begin{cases} \sum_{n=1}^{N} \alpha_n^2 \left(1 - 2s_{k,n}\right) s_{k,n} \left(1 - s_{k,n}\right) & \textit{if } k = m = l \\ -2 \sum_{n=1}^{N} \alpha_n^2 s_{k,n} s_{m,n} s_{l,n} & \textit{if } k \neq m \textit{ and } k \neq l \textit{ and } m \neq l \\ \sum_{n=1}^{N} \alpha_n^2 s_{k,n} s_{l,n} \left(2s_{l,n} - 1\right) & \textit{if } k \neq m \textit{ and } m = 1 \\ \sum_{n=1}^{N} \alpha_n^2 s_{k,n} s_{l,n} \left(2s_{k,n} - 1\right) & \textit{if } k = m \textit{ and } m \neq l \\ \sum_{n=1}^{N} \alpha_n^2 s_{k,n} s_{m,n} \left(2s_{k,n} - 1\right) & \textit{if } k = l \textit{ and } m \neq l \end{cases}$$

Appendix B

Formula for bargaining power of Retailer

To study the bargaining power of the retailer over the manufacturer we use the Nash Bargaining Solution approach and follow the analysis by Draganska et al. 2010[13] and Misra and Mohanty (2008). We start by assuming that the solution to the bargaining problem between the retailer and manufacturer f is the wholesale price of brand $j\left(j \in F_f\right) w_{jt}$ that maximizes the generalized Nash product

$$\left(\Pi_{jt}^R\left(\omega_{jt}\right) - \Delta\Pi_t^{R-j}\right)^{\lambda_{jt}} \left(\Pi_{jt}^f\left(\omega_{jt}\right) - \Delta\Pi_t^{f-j}\right)^{1-\lambda_{jt}} \tag{B.1}$$

Where Π_{jt}^R and Π_{jt}^F are the retailer's and manufacturer f's profits from brand j if negotiation succeeds and brand j is offered; $\Delta\Pi_t^{R-j}$ and $\Delta\Pi_t^{f-j}$ are the change in retailer's and manufacturer f's profits from all the other brands if negotiation fails and brand j is not offered (disagreement profit); and λ_{jt}, $\lambda \in (0, 1)$is the retailer's bargaining power for brand j at time t.

The profits Π_{jt}^R and Π_{jt}^f are defined as:

$$\Pi_{jt}^R\left(w_{jt}\right) = \sum_{z=1}^{3} \left(p_{jzt} - w_{jt}\right) s_{jzt} M_{zt}$$
$$\Pi_{jt}^f\left(w_{jt}\right) = \left(w_{jt} - c_{jt}\right) \sum_{z=1}^{3} s_{zt} M_{zt}$$

[12] For notational simplicity we drop z from the notation, but all elements α, s and p are *zone-specific.*

[13] Similar to Draganska et al. we assume that the negotiation takes place independently between the retailer and each manufacturer for each brand.

And the disagreement profits $\Delta\Pi_t^{R-j}$ and $\Delta\Pi_t^{f-j}$ are defined as:

$$\Delta\Pi_j^{R-j} = \sum_{z=1}^{3} \sum_{\mathrm{k=1,\,k\neq j}}^{\mathrm{J}} (p_{kzt} - w_{kt})\Delta s_{kzt}^{-j} M_{zt}$$

$$\Delta\Pi_t^{f-j} = \sum_{k\in F_f k\neq j} (w_{kt} - c_{kt}) \sum_{z=1}^{3} \Delta s_{kzt}^{-j} M_{zt}$$

Where Δs_{kzt}^{-j} is the time and zone specific difference in market share of brand k (k≠j) if brand j is offered and if it is not.

$$\Delta s_{kzt}^{-j} = \int_{D_z}\int_{\nu}\left[\frac{\exp(\delta_{kzt}+\mu_{ikt})}{1+\sum_{l=1}^{J}\exp(\delta_{kzt}+\mu_{ilt})} - \frac{\exp(\delta_{kzt}+\mu_{ikt})}{1+\sum_{l=1,l\neq j}^{J}\exp(\delta_{kzt}+\mu_{ilt})}\right] dP^*(D_z)dP^*(\nu)$$

From Eq. B.1 We can derive FOC with respect to wholesale price as:

$$\lambda_{jt}\left(\Pi_{jt}^{R} - \Delta\Pi_{jt}^{R-j}\right)^{\lambda_{jt}-1}\frac{\partial\Pi_{jt}^{R}}{\partial\omega_{jt}}\left(\Pi_{jt}^{f-j} - \Delta\Pi_{jt}^{f-j}\right)^{1-\lambda_{jt}} + \left(\Pi_{jt}^{R} - \Delta\Pi_{jt}^{R-j}\right)^{\lambda_{jt}}(1-\lambda_{jt})\left(\Pi_{jt}^{f} - \Delta\Pi_{jt}^{f-j}\right)^{-\lambda_{jt}}\frac{\partial\Pi_{jt}^{f}}{\partial\omega_{jt}} = 0$$

Simplifying, we get:

$$\lambda_{jt}\left(\Pi_{jt}^{f} - \Delta\Pi_{jt}^{f-j}\right)\frac{\partial\Pi_{jt}^{R}}{\partial\omega_{jt}} + (1-\lambda_{jt})\left(\Pi_{jt}^{R} - \Delta\Pi_{jt}^{R-j}\right)\frac{\partial\Pi_{jt}^{f}}{\partial\omega_{jt}} = 0$$

Rearranging terms results in:

$$\frac{1-\lambda_{jt}}{\lambda_{jt}} = -\left(\frac{\Pi_{jt}^{f} - \Delta\Pi_{jt}^{f-j}}{\Pi_{jt}^{R} - \Delta\Pi_{jt}^{R-j}}\right)\frac{\frac{\partial\Pi_{jt}^{R}}{\partial w_{jt}}}{\frac{\partial\Pi_{jt}^{f}}{\partial w_{jt}}}$$

If we further replace: $\frac{\partial\Pi_{jt}^{R}}{\partial w_{jt}} - -\sum_{z=1}^{3}\left[\left(1-\frac{\partial p_{jzt}}{\partial w_{jt}}\right)s_{jzt} - (p_{jzt}-w_{jt})\frac{\partial s_{jzt}}{\partial w_{jt}}\right]M_{zt}$ and $\frac{\partial\Pi_{jt}^{f}}{\partial w_{jt}} = \sum_{z=1}^{3}\left(s_{jzt} + (w_{jt}-c_{jt})\frac{\partial s_{jzt}}{\partial w_{jt}}\right)M_{zt}$[14] the above equation results in:

$$\frac{1-\lambda_{jt}}{\lambda_{jt}} = \left(\frac{\Pi_{jt}^{f} - \Delta\Pi_{jt}^{f-j}}{\Pi_{jt}^{R} - \Delta\Pi_{jt}^{R-j}}\right)\frac{\sum_{z=1}^{3}\left[\left(1-\frac{\partial p_{jzt}}{\partial w_{jt}}\right)s_{jzt} - (p_{jzt}-w_{jt})\frac{\partial s_{jzt}}{\partial w_{jt}}\right]M_{zt}}{\sum_{z=1}^{3}\left(s_{jzt} + (w_{jt}-c_{jt})\frac{\partial s_{jzt}}{\partial w_{jt}}\right)M_{zt}}$$

It follows that:

$$\lambda_{jt} = \frac{1}{1+\left(\frac{\Pi_{jt}^{f}-\Delta\Pi_{jt}^{f-j}}{\Pi_{jt}^{R}-\Delta\Pi_{jt}^{R-j}}\right)\frac{\sum_{z=1}^{3}\left[\left(1-\frac{\partial p_{jzt}}{\partial\omega_{jt}}\right)s_{jzt}-(p_{jzt}-w_{jt})\frac{\partial s_{jzt}}{\partial w_{jt}}\right]M_{zt}}{\sum_{z=1}^{3}\left(s_{jzt}+(w_{jt}-c_{jt})\frac{\partial s_{jzt}}{\partial w_{jt}}\right)M_{zt}}}$$

[14] where $\frac{\partial s_{jzt}}{\partial w_{jt}} = \sum_{k=1}^{J}\frac{\partial s_{jzt}}{\partial p_{kzt}}\frac{\partial p_{kzt}}{\partial w_{jt}}$ and $\frac{\partial p_{kzt}}{\partial w_{jt}}$ is the k,j element of the pass-through matrix—see Appendix A

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