Vertical relations, pass-through, and market definition: Evidence from grocery retailing

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Abstract

We examine how different pass-through rates, from retail input- to final consumer prices, and different vertical contracts affect upstream market definition. Simple theoretical considerations suggest that vertical restraints induce higher pass-through rates and thus lead to a wider market definition when compared to linear wholesale pricing. Data from grocery retailing is used to quantify the empirical implications of our theoretical assertion. We find that resale price maintenance leads to larger upstream market definitions than linear pricing. We therefore advise competition authorities to carefully model vertical market structures, whenever they expect incomplete pass-through to be important.

Keywords: Market Definition, Vertical Relations, Pass-through, Structural Models

JEL Classification: L1, L4, L8, C5

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1 Introduction

The SSNIP test ("Small but Significant Non-transitory Increase in Price") is the workhorse for market definition in both US and EU competition law. It is frequently used to assess (i) cases of mergers and acquisitions, (ii) competitive effects of horizontal and vertical restraints, and (iii) potential abuses of dominant positions or other measures of market power.

The SSNIP test searches for the narrowest set of products for which a hypothetical monopolist could *profitably* raise prices by 5–10% above the competitive level. The SSNIP test therefore compares the additional revenues resulting from a hypothetical price increase with the additional cost coming from a potential demand loss. An unprofitable price increase implies that the cost of the price increase outweighs the benefit because of high consumer substitution to products outside the candidate relevant market. The true market must therefore include the next best substitute products that impose competitive constraints. The final market is defined by the product set for which the price increase benefits outweigh the costs.

When manufacturers sell their products through retailers to final consumers, two fundamental problems of upstream market definition arise. First, retailers—such as in grocery, automotive and computer industries—could strategically dampen input price increases in order to prevent losses at the consumer level (see Chevalier et al. 2003, Villas-Boas 2007a). Second, the specific contracts are often not observable. They can also be quite complex given that firms may specify wholesale prices, but also many other elements, such as fixed payments, rebates or even implicit agreements on resale prices. Thus, making specific assumptions about vertical contracts may very well lead to different predictions about the profitability of a price increase at the manufacturer level. This problem has been articulated quite clearly in the literature (see, e.g., Hastings 2004, Lafontaine and Slade 2008) and is an open issue to which we aim to contribute.

Our study theoretically and empirically examines the role of vertical relations in upstream market definition exercises. While previous literature has clarified how consumer demand and horizontal competition affect the outcomes of the market definition procedures (e.g., Ivaldi and Verboven 2005, Pereira et al. 2013), it is not yet well understood how market definition is implemented in the presence of vertical contracting between retailers and manufacturers. Assumptions on the type of vertical interaction determine how wholesale price increases in the SSNIP test are passed-on to consumer prices, which ultimately determines the market definition outcomes. A recent literature strand studies the magnitude of the pass-through rate in vertical contracts and finds that vertical restraints are likely to increase cost pass-through (Bonnet et al. 2013, Hong and Li 2017). We extend these approaches by analyzing how pass-through rates of different vertical contracts affect upstream market definition outcomes.

We derive a theoretical model that relates the retail price change in several vertical contracts to the profitability changes after hypothetical wholesale price increases. Our model predicts that, under reasonable conditions, the upstream market size, as defined by a SSNIP test, increases with higher cost pass-through rates. The intuition is as follows:

In markets with complete pass-through, the price increase at the retail level is strictly higher than in markets with incomplete pass-through. Higher retail price changes imply higher market share losses and larger profit decreases. Thus, the cost of a hypothetical price increase is higher in a complete than in an incomplete pass-through scenario. SSNIP tests ignoring incomplete pass-through rates erroneously overestimate retail price changes, thereby overestimating the costs of the hypothetical upstream price increase. Consequently, the test defines the upstream market more narrowly compared to a "true model" of incomplete pass-through. Integrating pass-through rates, in contrast, allows correctly estimating the true price increase imposed by the retailer and therefore the true cost of a price increase for the manufacturer. As a result, the hypothetical monopolist market is larger and more aligned to the true model whenever cost pass-through is incomplete. This effect, however, decreases with increasing pass-through rates and is likely to vanish in the special case of complete pass-through.

We further propose a novel empirical framework that integrates the role of vertical contracts into the upstream market definition procedure. For this purpose, we follow Brenkers and Verboven (2007), who develop a SSNIP market definition test in the presence of double marginalization. We extend their approach by adding models of (i) strategic retail pricing and upstream competition as in Villas-Boas (2007a) and (ii) two-part tariff contracts with and without resale price maintenance as in Bonnet and Dubois (2010). Our approach uses data on prices and market shares to test vertical conduct and infer substitution patterns, profit margins, and costs, which are all necessary ingredients for the SSNIP test. We focus on integrating vertical restraints—in the form of resale price maintenance clauses—into the market definition analysis, which we justify with the increasing number of vertical agreements that potentially restrict competition.[1]

Furthermore, we empirically quantify how resale price maintenance clauses affect the manufacturers' ability to pass on upstream supply shocks to consumers. Our study therefore also contributes to the literature on pass-through rate estimation, such as Goldberg and Verboven (2001), Bonnet et al. (2013), and Friberg and Romahn (2018). Goldberg and Verboven (2001), for instance, find that double marginalization can serve to dampen cost pass-through. Bonnet et al. (2013) extend their results by showing that resale price maintenance can increase the pass-through of a cost shock in the case of non-linear contracts with resale price maintenance. Our methodology extends these approaches by (i) considering retailers' private label pricing in the analysis of vertical restraints and (ii) integrating pass-through rates into a market definition setup.

We implement the following three-step strategy. In a first step, we estimate consumer substitution patterns as well as a range of vertical supply-side models, recently developed in the Empirical Industrial Organization literature. In particular, we consider several collusive and non-collusive linear pricing models as well as two-part tariffs with and without resale price maintenance. Subsequently, we use the Rivers and Vuong (2002) test to select the channel margins with the best fit to the observed data. In a second step, to assess the retail pass-through rate across linear and non-linear pricing contracts, we simulate

[1] A non-extensive list of EU and national cases can be found at www.concurrences.com/en/glossary-of-competition-terms/vertical-restraints-or-restrictions

a cost shock in all vertical structures and re-compute the industry equilibria that would emerge. Following Bonnet et al. (2013), we interpret the differential retail price responses as a measure of how vertical structures allow for different strategic margin adjustments. These pass-through rates therefore inform us about how vertical contracts affect the capability of transmitting upstream supply shocks to consumers, which we interpret as a measure of competitive constraints.[2] In a third step, we propose a method to integrate the vertical relations into a framework that is consistent with the SSNIP test proposed by pertinent merger guidelines.

This methodology is applied to study the German disposable diaper market for which we use rich and detailed category-level data obtained from a representative household home-scan survey—including the actual retail store choices of consumers and actual transaction prices. The diaper market is well suited for the analysis given that all diaper products in the category, with a single brand manufacturer and several private labels, are a perfect first guess for the candidate-relevant market. Our empirical evidence suggests that retailer-manufacturer relations are governed by non-linear pricing contracts with vertical restraints in the form of resale price maintenance clauses. This finding could be due to two reasons: first, the law might not be effectively enforced; second, firms often find ways to replicate this equilibrium with alternative, more sophisticated contracting mechanisms that would not actually involve explicit resale price maintenance clauses. In this contracting regime, manufacturers have the market power to seize profits that are close to the monopoly case, which is consistent with anecdotal evidence that retailers do not make much profits from diapers, which they use to attract consumers.[3]

The SSNIP test in this "preferred" resale price maintenance scenario finds that the relevant market consists of the manufacturer brand's products and the private labels of drugstores and discounters. This is consistent with consumer tests finding that discount and drugstore private labels, but not supermarket private labels, are perceived as substitutes. This is an important finding because antitrust authorities often exclude products *a priori* based on anecdotal evidence about production processes or obtained from questionnaires, but without considering demand-substitution patterns.[4] We show how such simple market segmentation approaches might be misleading because they provide incorrect policy advice. In our particular case, private labels are the only source for inter-brand competition in a market structure where a strong manufacturer conducts resale price maintenance. Excluding private labels, based on an ill-advised market definition procedure, would therefore erroneously suggest that there is a monopoly on the supply-side.

In the next step, we analyze how differences across vertical contracts affect the market definition outcomes. We put a specific focus on the comparison of resale price maintenance and linear pricing models. To that end, we conduct a "simulation exercise", in which we

[2]We thank the editor Pierre Dubois and an anonymous referee for this suggestion.

[3]See, e.g., www.welt.de/wirtschaft/article117203610/Das-lukrative-Geschaeft-mit-Babys-Po.html.

[4]For instance, the Bundeskartellamt (2014) and the Competition Commission (2008) excluded private labels and/or discounters from their investigations without testing whether they were substitutes from a consumer point of view.

use the price-cost margin from the preferred model to simulate prices, margins, and cost pass-through for several equilibrium pricing models. In the simulation exercise, we hold marginal costs constant to investigate the effect of pass-through rates on market definition outcomes under several vertical structures. Furthermore, we conduct a "misspecification exercise", in which we intentionally select the "non-preferred" supply models that imply the wrong cost and profit structure. The misspecification exercise is therefore informative about how misjudgment of marginal costs and profit margins affects market definition outcomes.

The findings from the "simulation exercise" show that manufacturer profits are highest when resale price maintenance is prevalent in the market. The manufacturer maximizes industry profits in this quasi-integrated industry outcome by internalizing the cross-price elasticities of all products. Channel profits and prices, however, are highest in the double marginalization scenario, where both the retailers and the manufacturer make a margin on the branded products. In order to learn about the competitive constraints across models, we conduct a cost pass-through analysis simulating how increases of channel costs are passed on to the final retail prices. We find that resale price maintenance increases the pass-through rate of a 10% cost shock by almost 10 percentage points relative to the case of linear pricing contracts. The intuition behind this result is the existence of the so-called double markup problem that arises in linear vertical supply models. Retailers set their prices conditional on the manufacturer decision, which limits the channel members' ability to pass-on cost increases to consumers. The elimination of the double markup, e.g., by the implementation of vertical restraints, allows a higher pass-through of the channel cost increase. Our results thus yield important insights for market power assessment in general, and market definition analysis in particular, by showing that channel members can use vertical restraints to increase their margins and the cost-pass-through rates.

We then conduct a SSNIP market definition test that considers the varying levels of competitive constraints across supply models. Most notably, our analysis highlights that resale price maintenance leads to a wider market definition outcome compared to linear pricing models, which is in line with our theoretical prediction. Resale price maintenance implies a full pass-through rate from wholesale to retail prices, while linear pricing regimes imply incomplete pass-through rates. Given that market shares are a decreasing function of prices, the market share loss is increasing with the retail pass-through rates. Thus, the cost of the hypothetical upstream price increase is strictly higher with resale price maintenance than with linear pricing. Consequently, we find a market that is defined more widely when firms use resale price maintenance clauses.

The results in the "misspecification exercise" outline the existence of a bias from poor model specification even when assuming the correct pass-through rate. For instance, the linear pricing model with a full pass-through rate leads to a market that is defined too widely. The reason is that the profitability changes after hypothetical price increases also depend on the absolute levels of marginal costs and price cost margins. Interestingly, this assumption is the one that is most often applied in the counterfactual exercises in the Empirical Industrial Organization literature (see, e.g., Berry et al. 1995).

All in all, our insights call for a careful investigation into how the SSNIP test is performed. Given that most firms sell their products via intermediaries with potential complex vertical contracts (see e.g., Chevalier et al. 2003), we draw the attention of competition authorities and researchers to the importance of considering the strategic retail behavior in upstream market definition. Our study derives the following policy implications from the analysis: First, it is crucial to carefully model the entire supply chain in the upstream market definition procedure whenever incomplete pass-through is an important market characteristic. Second, models of complete pass-through, such as resale price maintenance, produce results closer to a market definition procedure that ignores the vertical structure. Third, we find that antitrust authorities can avoid modeling the supply chain whenever they expect a full pass-through rate.

Although we focus on a subset of infinitely many possible contract types in the empirical implementation, our results can be generalized to other market structures. In particular, we model take-it-or leave-it-offers with exogenous outside options for retailers, which implies that manufacturers have full bargaining power. A different literature strand models bilateral negotiations with endogenous outside options (see, e.g., Crawford and Yurukoglu 2012, Ho and Lee 2017, Draganska et al. 2011). Hristakeva (2019) looks at a contract where the lump-sum payments of the two-part tariffs are the reverse of our setup. The type of contract choice naturally impacts inference on the profit-sharing rule between manufacturers and retailers. Our general findings on market definition outcomes, however, hold for a range of model specifications, where pass-through rates are important market determinants.

A distinct advantage of our approach is that it allows credible inference on product-level costs and profit margins, requiring solely retail scanner data and assumptions on channel conduct (Nevo and Whinston 2010). Many standard market definition models, in contrast, use information submitted by firms, such as diversion ratios (often based on consumer questionnaires), profits, and cost information. These measures, however, are (i) prone to a reporting bias and (ii) often not available at the product level due to the difficulties of separating common costs from true economic costs (see e.g., Nevo 2001). Our approach can be used instead of (or complementary to) reduced-form approaches, such as price correlations, analysis of accounting data, and questionnaires. It stands undisputed that these reduced-form approaches remain useful screening devices in so-called Phase I proceedings, where quick decisions need to be made based on easy-to-interpret summary statistics. However, these tools typically cannot capture all important market features. We propose to apply a more structural approach like ours in so-called Phase II investigations, where accuracy is more important than practicality (Friederiszick and Roeller 2010).

The remainder of the paper is organized as follows: Section 2 introduces our theoretical model. Section 3 describes the market and the data. Section 4 develops the empirical framework. Section 5 presents results from the demand side, the supply models, and the market definition exercise. Section 6 concludes.

2 Insights from a Simple Theory Model

We derive a simple model to theoretically predict how cost pass-through affects market definition outcomes. For this purpose, we compare the SSNIP market definition test under two scenarios: (i) a linear double mark-up model and (ii) a model with vertical restraints in the form of resale price maintenance. The latter is basically the quasi-vertically integrated case, where the manufacturer extracts the entire channel profits of the business relation with a certain retailer. In this section, we present the economic intuition of the model and refer to the appendix A.1 for details.

As explained above, the SSNIP test compares the additional revenues resulting from a hypothetical price increase with the additional cost coming from a potential demand loss. If the SSNIP test is conducted in upstream markets, an important determinant to consider is the retail cost-pass through that measures how retail prices respond to wholesale price increases. If the cost pass-through is different in both contracting regimes (i) and (ii), then it becomes apparent that market definition outcomes vary as well.

In the linear model, the cost pass-through of a wholesale price increase is typically below one, while it is equal to one with resale price restraints. A low cost pass-through in the linear model makes a 10% wholesale price increase relatively profitable because it means that the retailers' (derived) demands for the manufacturer's goods does not change much. Consequently, the negative demand effect of the wholesale price increase is relatively small, which tends to make it more profitable compared to a high pass-through scenario. In the case of vertical restraints with resale price maintenance, the cost pass-through of the SSNIP test is equal to one; i.e., $dw/w = dp/p = 10\%$. Thus, the negative demand effect of the retail price increase is high compared to an incomplete pass-through scenario. It follows that the price increase in the case of resale price maintenance is less profitable than the price increase in the linear contracting model. According to the SSNIP test logic, we therefore find that a higher cost-pass-through rate under vertical restraints tends to lead to a larger market definition outcome.

Remark. *Lower cost pass-through rates lead to larger upstream market definitions according to the SSNIP test. This implies that larger upstream markets result from the SSNIP test with linear wholesale price contracts than with resale price maintenance.*

3 Market and Data Description

The use of the empirical model is based on the vertical relationships present in grocery markets, which we describe taking the example of the German diaper market. In section 3.1, we provide some stylized facts on the diaper market, including niche products and presumable substitution patterns. Section 3.2 introduces the data set on a German representative household panel and summarizes its distinctive characteristics.

3.1 Stylized Facts on the Diaper Market

The first step in the market definition process is to make a pre-selection of the market in the widest possible sense. Given that the SSNIP test requires us to start with a set of substitute products, it is crucial to exclude complementary products based on reasonable intuitive criteria. Conveniently, the diaper market is particularly well-suited to the purpose of demonstrating the market definition procedure. This is because all products in the category are a good first candidate for constituting a relevant market, given that—relative to other categories, such as drinks, sweets or meat—it seems plausible to assume cross-substitution with other categories. The analysis also has to take into consideration another specific feature. Unlike in other European countries, such as Italy, or in the U.S., in Germany only one manufacturer, which is a global multi-product company, produces a manufacturer label for diapers. The only potential competitors for the manufacturer brand are the of retailers' private label brands.[5]

Diapers are available for consumers through heterogeneous supply channels. Eleven national retailers are active in the German grocery retailing market, which can be grouped into three formats: discounters, drugstores, and supermarkets. Furthermore, there are some alternative distribution channels, such as cash-and-carry stores, pharmacies, and Internet purchasing, which constitute the competitive fringe. Most of the diaper products are purchased at drugstores—market shares of 49%—followed by supermarkets and discounters at 30% and 20% respectively (see table 1). For our market, the high market shares may indicate that neither discounters nor drugstores should be excluded from the analysis *a priori*.

Within the diaper category, virtually all consumers use disposable diapers. Other products, such as cotton, mull, and fleece diapers, have an accumulated market share of less than 1%. Similarly, swimming diapers and training pants are specialized (complementary) products. Disposable diapers are available in several package sizes—ranging from two diaper units up to 192 units. The package sizes at both boundaries are unreasonable substitutes for most consumers given that the former is most likely to be purchased for experimentation purposes and the latter is mostly available only at specialized stores. Table 1 and Figure 1(a) indicate that the manufacturer brand and the private labels offer different package sizes and that retailers from heterogeneous formats carry different packages. Package sizes might be used as a strategic tool to price discriminate between consumer groups, and the pricing decisions might be non-linear.

Figure 1(a) and Table 1 further show that private labels play a major role, with a market share of more than 50%. In particular, discounters and drugstores, which make up most of the market, differentiate themselves with high private label shares of 18% and 24% respectively. The ratio of the manufacturer's products to private labels is higher in supermarkets, representing up to 25% of the whole market for the manufacturer brand and only 6% for the private labels. The ratio of the manufacturer's products to private labels is higher in supermarkets. Preliminary market share analysis provides evidence

[5]Due to contractual agreements with the data provider, Gesellschaft für Konsumforschung (GfK, Germany), we are unable to present the name of the firms.

that private labels are an important market driver.

Nonetheless, *a priori* it cannot be concluded whether or not these label types are different market segments. Private labels may, for instance, target low-income consumers, while the manufacturer brand aims at high-income consumers in order to establish two separate markets with no substitution between them. Indeed, data confirms that consumers of private labels and of the manufacturer brand are in different income brackets, although the gap is not very large (Table 1). Furthermore, we observe substantial price differences for both label types. As expected, the price per diaper is higher for the manufacturer brand than for the private labels at all retail formats, with the standard manufacturer brand costing about two cents more on average. The manufacturer brand also produces a premium label at a higher price level than the private labels and standard manufacturer brand. However, quality tests show that private labels perform as well as the higher priced manufacturer brand.[6] Thus, these quality tests indicate that the two product types could be substitutes, whereas price differences suggest otherwise, generating the need for a more structural approach to define the competitive relationships.

3.2 Descriptive Statistics on Households

For an elaborated outline on the choice-set construction and an extensive summary of the descriptive statistics, we refer to sections A.2 and A.3 in the appendix.

Our analysis is based on a German representative household panel monitored by the GfK Panel Services.[7] The data contain information on actual transactions of up to 20,000 households that track all of their purchases using home-scanning devices, including roughly 5,800 consumers that purchase diapers. In contrast to checkout-scanner data, which can only track purchases within a particular store, this data set enables us to analyze consumer switching behavior more precisely.

Figures 2(a) and 2(b) report, respectively, that 70% of all households conduct one shopping trip per month involving a diaper purchase and that—conditional on shopping—accumulated one-pack and two-pack shoppers constitute roughly 95% of all purchases. These statistics are plausible for two reasons. First, an average diaper pack is the approximate equivalent of one month's consumption. Second, diaper packages are voluminous and heavy, rendering them inappropriate for stockpiling. In case of unexpected shortages, consumers have the option to conduct a second "emergency" shopping trip. Figure 1(a) shows that the retail formats offer different (average) package sizes in order to respond to this kind of shopping heterogeneity. To be more precise, some consumers select the format due to the package size, and consumers with a high diaper consumption will select formats with larger sizes. Therefore, these descriptive statistics suggest the use of a discrete choice model for differentiated products and differentiated retail formats.

[6] See, for instance, the test result from "OEKOTEST" M1401, No.1, January 2014, available online: www.oekotest.de/cgi/index.cgi?action=heft&heftnr=M1401.

[7] See http://www.gfk.com/de/loesungen/verbraucherpanel.

4 Empirical Framework

Our methodology combines demand and supply-side modeling to answer the policy question of interest. We set up our empirical strategy as a three-stage procedure. Step 1(a) is devoted to the estimation of the demand for diapers (section 4.1). Having identified consumer demand, in step 1(b), we use demand estimates and a range of vertical supply chain models to derive profit margins (section 4.2). We then select the supply model that best explains the observed pricing behavior based on cost data. In step 2, we simulate a cost shock in all vertical structures and re-compute the industry equilibria that would emerge. Step 3 consists of applying the SSNIP test to define the relevant market (section 4.3).

4.1 Consumer Demand

We estimate a standard random coefficients discrete choice model for disaggregated household level data, which has been widely used in the literature (e.g., Draganska et al. 2011, Bonnet et al. 2013).[8] We model individual household purchasing decisions to identify the relationship between consumer demand and the equilibrium price, where we explicitly account for heterogeneous consumer tastes for differentiated products. Based on the evidence from the summary statistics, we assume that consumers make monthly decisions. In each month t, consumers choose between $i = 1, ..., J$ products. Thus, consumers' latent indirect utility from product purchase i is defined as:

$$U_{nit} \;=\; \alpha_{ni} \;-\; \beta_{1n}\, p_{it} \;+\; X'_{nit}\, \beta_2 \;+\; \xi_{it} \;+\; \epsilon_{nit}.$$

On the right-hand side, α_{ni} describes consumer n's preferences for unobserved (time-invariant) product characteristics, which can be decomposed into the fixed effects of retailer r, brand b, and package size s: $\alpha_{ni} = \alpha_{r(i)} + \alpha_{b(i)} + \alpha_{ns(i)}$. Preferences for retailer characteristics are fixed over time and consumers, whereas preferences for brands and package sizes are allowed to vary over consumers.[9] p_{it} is the price of product i at time t with coefficient β_{1n} measuring the marginal price disutility for consumer n. X'_{nit} contains additional control variables. These variables include an indicator variable for whether the product was purchased during a promotion, and a loyalty indicator for whether the purchase of brand b at time t is the same as in $t-1$. We introduce heterogeneous loyalty measures for the manufacturer brand and for the private labels. Finally, ξ_{it} identifies the unobserved (by the econometrician) changes in product characteristics, and ϵ_{nit} is the error.

We assume that $\alpha_{nb(i)}$, $\alpha_{ns(i)}$, and β_{1n} vary across consumers. Indeed, consumers can have varying price disutilities or tastes for the unobserved brand and package size characteristics. We assume that distributions of $\alpha_{nb(i)}$, $\alpha_{ns(i)}$, and β_{1n} are independent

[8] The estimation routine is based on the code developed by Hole (2007).

[9] We also tested the interaction of retailer fixed effects with (observed and unobserved) consumer characteristics, but found that they do not improve to the fit of the model.

and that the parameters have the following specification (see Nevo 2001):

$$\begin{pmatrix} \beta_{1n} \\ \alpha_{nb} \\ \alpha_{ns} \end{pmatrix} = \begin{pmatrix} \beta_1 \\ \alpha_b \\ \alpha_s \end{pmatrix} + \Pi D_n + \Sigma v_n,$$

where D_n is a scalar capturing the effect of our demographic income variable, and Π is a vector of coefficients that measures how the taste characteristics vary with demographics. v_n is a vector that captures the unobserved consumers' characteristics. Furthermore, Σ is a diagonal scaling matrix of parameters (σ_α, σ_β) that measures the unobserved heterogeneity of consumers. We assume a parametric distribution for v_n denoted by $\mathcal{P}_v(\cdot)$. $\mathcal{P}_v$ is independently and normally distributed with means collected in α and β as well as standard deviations collected in σ_α and σ_β. Following the literature's standard notation, we can disentangle the indirect utility function into the mean utility δ_{it} and the deviation from this mean μ_{nit} as well as the error term ϵ_{nit} such that $U_{nit} = \delta_{it} + \mu_{nit} + \epsilon_{nit}$, where we denote the deterministic part of utility as $V_{nit} = \delta_{it} + \mu_{nit}$.

We also model an outside good to allow for category expansion or contraction in case the consumer decides not to choose one of the inside products. Not considering an outside good implies that a homogeneous price increase of all inside products would not change the overall quantities purchased. Given that only differences in utilities between choices are considered, the indirect utility for the outside good can be normalized to zero, i.e., $U_{n0t} = 0$.

Random utility models are consistently estimated if the observed characteristics of the specified alternatives—such as the price—are independent of the error term. This independence assumption may be violated in the context of grocery shopping. Factors such as advertisement, in-store promotion, and shelf space and position are unobserved by researchers, but are known to consumers and are not independent of their purchasing decisions. Endogeneity problems arise if these strategic variables are additionally correlated with firms' pricing decisions. In the diaper market, for instance, firms frequently initiate television advertising campaigns, which are expensive and increase firm-level costs. Moreover, firms might adjust prices during advertising periods either in response to stimulated demand or in combination with promotional efforts. Another source of endogeneity could be the shelf space and location assigned to the rather bulky diaper packages. These strategic variables might raise awareness of products and are correlated with retailers' (opportunity) costs and thus prices. As a result of this endogeneity, all parameter estimates will be biased and inconsistent.

Endogeneity problems in household-level discrete choice models are commonly addressed through the control function approach (Petrin and Train 2010). Introducing the control function, we can rewrite the error term of the utility function as $\epsilon_{nit} = \lambda u_{it} + \tilde{\epsilon}_{nit}$. Conditional on the control function, the error term $\tilde{\epsilon}_{nit}$ is independently and identically drawn from a generalized extreme value distribution of type I. Choice probabilities are derived from the assumption that each consumer purchases the utility-maximizing product $U_{ni} > U_{nj} \; \forall \; j \neq i$. If we define $U_{nit} = V_{nit} + \lambda u_{it} + \tilde{\epsilon}_{nit}$, we can write the conditional repeated choice probability (conditional on α_{nb}, α_{ns}, and β_{1n}) for choosing a product as[10]

$$s_{nit}(\alpha_{nb}, \alpha_{ns}, \beta_{1n}) = \prod_{t=1}^{T} \left\{ \frac{e^{V_{int}+\lambda u_{it}}}{1 + \sum_{j}^{J} e^{V_{jnt}+\lambda u_{jt}}} \right\}, \quad (1)$$

The integral over all possible values of α_{nb}, α_{ns}, and β_{1n} yields product-level market shares:

$$s_{it} = \int s_{nit}(\alpha_{nb}, \alpha_{ns}, \beta_{1n}) f(\alpha_{nb}, \alpha_{ns}, \beta_{1n}, \tilde{\epsilon},) d\alpha_{nb} d\alpha_{ns} d\beta_{n} d\tilde{\epsilon}.$$

This integral is solved with simulation methods. For a given random draw from a Halton series, we plug the random draw into equation 1 and calculate the logit choice probability. We do this 100 times and average the results, as suggested by Train (2009) and then compute the elasticity. Elasticities used for the following step are then computed on a per-product level conditional on the per product-month averaged demographics.

4.2 Supply-side Models

In the second step of our empirical strategy, the demand estimates are used to calculate the price-cost margins for a range of vertical supply models. In modeling the vertical relationship, we follow Villas-Boas (2007b) and Bonnet and Dubois (2010), who provide an in-depth discussion of vertical pricing models. In total, we end up with 11 models that we summarize in Table 2. We then test against each other to find the model providing price-cost margins that fit observed data best via the test proposed by Rivers and Vuong (2002).

Profits of multi-product retailers r are defined as

$$\Pi_r = Q \sum_{k \in \Theta_r} (p_k - w_k - c_k) s_k(p) - F_k \quad \forall \ r = 1 \ldots, R,$$

where Q denotes the market size. Profits are the sum of the per-product margin over all products s in retail portfolio Θ_r. The margin for product s at time t is given by retail price p_k, the wholesale price w_k, and the retail costs c_k. The market share s_k is a function of all retail prices, and retail prices might be a function of the wholesale prices depending on the timing of the game. Finally, there is a franchise fee F_k, which has to be paid from the retailer to the (multi-product) manufacturer m:

$$\Pi_m = Q \sum_{k \in \Theta_m} (w_k - \mu_k) s_k(p) + F_k,$$

where w_k and μ_k are the wholesale price and wholesale costs, respectively.

In case of linear pricing, there are no fixed fees and $F_k = 0$. Prices are the outcome of a Bertrand-Nash pricing game at the horizontal level and the assumption on

[10]See Train (2009) for a detailed derivation of the choice probabilities.

the timing in the vertical structure. Retailers set their prices given the pricing decision at the manufacturer level in all considered models, which is the standard assumption in studies investigating the grocery retailing industry. The first-order conditions from the maximization program of the retailers are:

$$\sum_{k\in\Theta_r} \frac{\partial s_k(p)}{\partial p_j} [p_k - w_k - c_k] + s_j(p) \;=\; 0 \;\forall\; j = 1, ..., J. \tag{2}$$

The first-order conditions from the maximization program of the manufacturers are:

$$\sum_{k\in\Theta_m} \sum_{l=1}^{J} \frac{\partial s_k(p)}{\partial p_l} \frac{\partial p_l}{\partial w_j} [w_k - \mu_k] + s_j(p) \;=\; 0 \; j = 1, ..., J,$$

where Θ_m denotes the manufacturer m's product portfolio. Retail prices are a function of wholesale prices in the Bertrand-Stackelberg Model. The additional term $\sum_{l=1}^{J} \frac{\partial p_l}{\partial w_j}$ disappears in the Vertical Bertrand-Nash Model.

In the framework of non-linear two-part tariff contracts with potential resale price maintenance, the manufacturer first simultaneously proposes take-it-or-leave-it offers to all retailers. Then, retailers simultaneously accept or reject offers, which are public information. Third, if all offers are accepted, retailers simultaneously set their prices. If one offer is rejected, then no contract is signed, and retailers earn the profits of their outside option. We can now formulate a maximization problem subject to the binding participation constraint that retailers' profits are at least as high as the profits from their outside option $\Pi_r \geq \overline{\Pi}_r \;\forall\; r = 1, ..., R$. We assume that $\overline{\Pi}_r$ is an exogenous constant which can be normalized to zero.

Consider first the maximization problem, where resale price maintenance cannot be used by the manufacturer:

$$\max_{\{p_k, w_k\}\in\Theta_m} \sum_{k\in\Theta_m} (p_k - \mu_k - c_k) s_k(p) + \sum_{k\notin\Theta_m} (p_k - w_k - c_k) s_k(p). \tag{3}$$

The manufacturer internalizes—through the franchise fees—the impact of its own pricing decisions on (i) its own products' entire channel margin $k \in \Theta_m$ and (ii) the retail margins of the competitors' products $k \notin \Theta_m$.

Next, we consider the implementation of resale price maintenance clauses in addition to the two-part tariffs. We consider two intuitive equilibria, which are most likely to arise (Rey and Vergé 2010). First, in the presence of an arbitrarily small non-contractible effort, the manufacturer chooses to leave retailers as residual claimants, by setting wholesale prices equal to the marginal cost of production ($w_k^* = \mu_k$). The first-order conditions of the maximization program in equation 3 can be expressed as:

$$\sum_{k=1,...,J} (p_k - \mu_k - c_k) \frac{\partial s_k(p)}{\partial p_j} + s_j(p) = 0 \;\;\forall\;\; j = 1, ..., J, \tag{4}$$

whereas retailers choose retail prices for their private label products and bear the marginal cost of production and distribution. The first-order conditions are the same as in equation 2, but only on the set of private label products $\forall\, j \in \tilde{\Theta}_r$. It seems noteworthy that—in the absence of private label products—two-part tariffs with resale price maintenance would allow the manufacturer to maximize the full profits of the integrated industry.

Second, we consider another resale price maintenance equilibrium—one where wholesale prices are such that the retailer's price-cost margin is zero: $p_k^*(w^*) - w_k^* - c_k = 0$. Retailers set prices to maximize profits corresponding to the downstream vertically integrated structure for each of the j products:

$$s_j(p) + \sum_{k \in \Theta_m} (p_k - \mu_k - c_k)\frac{\partial s_k}{\partial p_j} + \sum_{k=J'}^{J} (p_k - \mu_k - c_k)\frac{\partial s_k}{\partial p_j} = 0 \;\; \forall \;\; j = 1, ..., J,$$

where $J', ..., J$ are the private label products in the market. This additional term—implicitly contained in equation 4—highlights that the manufacturer internalizes retailers' strategic private label pricing. How retailers set prices, however, is different from the case of $w = \mu$. Instead of internalizing the effects of all products in the retail portfolio—national brands and private labels—retailers choose profit-maximizing prices by internalizing only their own private label products and not the effects of national brands.

4.3 Pass-through and Market Definition

In this section, we investigate how modeling the vertical supply chain impacts the relevant market size. To this extent, we first analyze how several contracting regimes affect the manufacturers' general capability to pass on upstream cost shocks to consumers. These pass-through rates are informative about the competitive constraints implied by the supply models. This exercise is the extension of Bonnet et al. (2013) because we analyze retailers' pricing incentives for private label products. We then show how pass-through rates from wholesale to retail prices affect the outcome of a SSNIP market definition analysis.

In order to investigate the differential cost pass-through rates across the models, we follow Bonnet et al. (2013) and Friberg and Romahn (2018). Having chosen the preferred pricing equilibrium according to our data, e.g., model 11, we can estimate a vector of marginal costs of production and distribution, which we denote by $C = (C_1, ..., C_j, ..., C_J)$. C is:

$$C = p - \Gamma - \gamma,$$

where p is a vector of observed retail prices. Γ and γ correspond, respectively, to the expressions of manufacturer and retail margins for the supply model simulated. In the simulation exercise, we first calculate new prices, margins, and market shares using the marginal costs from the preferred model, e.g., model 11, but with the first-order conditions from another model, e.g., model 1. The maximization program becomes:

$$\min_{(p^*_{jt})_{j=1,\dots,J}} ||p^* - \Gamma^*(p^*) - \gamma^*(p^*) - (1+\lambda) \times C||, \tag{5}$$

where $\lambda = 0$. To trace out the pass-through rates in supply models, we increase the vector of marginal costs by 10%, i.e., $\lambda = 0.1$, and solve for the new equilibrium. The cost pass-through rate is obtained as the ratio of the relative change in prices and the net relative change in marginal costs:

$$\phi = \frac{p^* - p}{\lambda \times p}. \tag{6}$$

Thus, a 10% increase in price in response to the 10% increase in marginal cost yields a pass-through rate of 1.0 or 100%.

In the next step, we analyze the role of pass-through rates across a range of supply models in the market definition analysis. We present in this section the empirical implementation of our theoretical insights for a market structure with one manufacturer brand and several retail private labels. In particular, we (i) impose a uniform price increase on all products inside the relevant market and (ii) keep the prices of outsiders unchanged. We discuss, however, how changing the assumptions impacts the results in appendix A.4.

Given the pricing assumptions, the SSNIP market definition algorithm is implemented as follows. We start the market definition procedure by evaluating the change in equilibrium profits after imposing a 10% price increase on all products owned by the manufacturer brand in all formats as an initial candidate. According to this definition, we assume that the manufacturer brand has the market power to raise prices for its products at all retail stores, which seems to be a reasonable assumption. Given that market shares are defined as a function of price, we can predict how market shares change in response to the price increase. Next, we calculate current joint profits before and after the price increase for the preferred equilibrium supply-side model. The intuition behind the test is as follows. Increased profits due to higher prices are countervailed by a loss in market shares, which are a function of the prices. In order to define markets, the SSNIP test simply assesses the sign of the profit change before and after the price increase to determine whether a hypothetical price increase is profitable. More precisely, if the sign of the profit change is positive, then we have found the relevant market; if it is negative, we select a broader subset of products. Our algorithm stops for the smallest possible set of products for which a price increase is profitable.

In the case of linear pricing LP and when the manufacturer brand's products mb are the insiders i in the candidate market, we get the following profits:

$$\Pi^{LP}_{mb} = Q \sum_{k \in \Theta_{mb}} ([1+x]w_k - \mu_k) s_k(p^*([1+x]w_k)), \tag{7}$$

where Θ_{mb} denotes the set manufacturer brand's products as insider products. The manufacturer's SSNIP profits in the case of resale price maintenance RPM are given by:

$$\Pi_{mb}^{RPM} = Q \sum_{k \in \Theta_{mb}} ([1+x]p_k - \mu_k - c_k)s_k([1+x]p). \tag{8}$$

When private labels are added to the set of insider products i in the candidate market, then we evaluate the following retail profits:

$$\Pi_{i|pl} = Q \sum_{k \in \Theta_{i|pl}} ([1+x]p_k - c_k)s_k([1+x]p), \tag{9}$$

where the profit function is the same in both contracting regimes LP and RPM. We calculate profits, described by equations (7) through (9), for a 10% hypothetical price increase (i.e., $x = 0.1$). The new hypothetical profits are then compared to the a scenario of no hypothetical price increase, where $x = 0$.

Resale price maintenance models imply implicitly a complete pass-through rate given that the retail price is increases. In the linear pricing models, however, the pass-through from the hypothetical wholesale price increase to retail prices of branded products mb are defined as:

$$\Phi = \frac{p^* - p}{x \times p}, \tag{10}$$

where we solve for new retail prices p^* with an optimization program that is equivalent to the one in equation 5:

$$\min_{(p^*_{mb})} ||p^* - \Gamma\left([1+x]w\right) - \gamma^*(p^*) - C||, \tag{11}$$

where the vector of retail prices p^* is given by $p^* = (p^*_{mb}, [1+x]p_{pl})$. We therefore assume that retail prices are raised by 10% when added to the inside market, while the prices of the outside products remain unchanged. Section A.4 presents our SSNIP test that loosens the pricing assumption of a symmetric price increase of 10% on all inside products. Notably, we allow private label prices to be a best response to the branded product price increase. Thus, instead of raising private label prices by 10%, they become part of the optimization problem p^*_{pl}.

We assume in all specifications that channel members equally split the channel costs.

Based on the generalized prediction in the theory section, we know that the relevant market size increases with the pass-through rates. We thus expect larger market definition outcomes in the resale price maintenance scenario (i.e., equation 8) than in the linear pricing scenario (i.e., equation 7).

5 Empirical Results

The results of the pricing regression are presented in section 4.1 before the demand-side results in section 4.2 and the results of the supply models, the pass-through rates, and the SSNIP tests in sections 4.3 and 4.4. Section 4.5 discusses how our empirical results can be generalized to a broad set of industries.

5.1 First-stage Pricing Regression

Our choice of instruments is standard. In order to control for price endogeneity, we use two types of instrument. The first is a cost-shifter for production costs varying over time (i.e., diesel prices). Cost variables tend to be good instruments because they might be correlated with prices and uncorrelated with unobserved demand-shifters. Second, we use the number of products sold by other retailers to account for endogeneity that varies over products. Given that we investigate competitive constraints between label types sold by retailers, we allow the instrument for retail costs to vary for private label products and for the manufacturer brand. Diesel prices seem to affect the prices of private labels and the manufacturer brand's products in a similar way, which explains the omission of such interaction terms for this other instrument.

Table A1 shows the results from the first stage. Cost-shifters are significant and have the expected positive sign indicating the positive correlation. Our set of instruments performs well, explaining 91% of the variation in product prices. The (partial) first-stage F-statistic of the excluded instruments is 11.91, which indicates that the instruments are not weak in the sense of Staiger and Stock (1997).[11]

5.2 Demand-Side Results

Results from the demand estimation are provided in Table 3. Column (1) estimates the baseline multinominal logit model including the price as well as brand-, retailer-, and package-size fixed effects. The sign of the price coefficient is negative as expected. Column (2) adds a control function, which is positive and significant, indicating that endogeneity is relevant in the model estimated. The magnitude of the price coefficient is lower—approximately by the factor of 20—implying that there might be some endogeneity problems tackled by our control function approach. The specification in column (3) estimates a model including a control variable for promotional activity. Despite being significant, the impact on the price coefficient is not too strong. Column (4) adds an indicator variable, which is equal to 1 if the brand purchased in period t is the same as the brand purchased in $t-1$. We split the variable into two categories: brand loyalty for the branded good and brand loyalty for the private label products. As expected, these variables are positive and significant, indicating that some form of switching inertia is present in the diaper market.

Given the indication of observed consumer heterogeneity in the descriptive statistics, we interact income with the fixed effects for package sizes and private label purchases in column (5). We see that the package size effects are positively correlated while the private

[11]We collected data on other cost-shifters (energy costs, oil prices, and wage index) as potential instruments. The combination of diesel prices and the competition proxy, however, yields the a (partial) first-stage F-statistic that is higher than any other combination of cost-shifters and competition proxy.

label effect is negatively correlated with income. The likelihood of buying smaller package sizes—compared to the omitted larger package size 3—increases with income. The interaction of the private labels with income indicates that lower-income customers have a higher likelihood of buying private labels. Column (6) then introduces the price-income interaction as well as a random price coefficient, and both effects are significant. Introducing price heterogeneity uncovers two important patterns: first, higher income customers are less price-sensitive; second, the significant random coefficient highlights that we account for unobserved consumer heterogeneity that also has an impact on utility. In order to introduce more flexibility into the model, we allow consumers to be heterogeneous regarding not only their price preferences but their brand valuation. To capture this, column (7) introduces random coefficients on the brand intercepts, which are all significant, implying heterogeneous purchasing patterns in this respect. The comparatively high change in the log-likelihood value suggests a major improvement in the model's precision, which is why we select model (7) for the subsequent steps of our analysis.

Table 4 presents information on the price elasticities of all brands, retail formats, and package sizes given the structural parameters estimated by model (7). Evidently, the own-price elasticities are all within the elastic region of the demand function and range from -6.15 to -12.41. More precisely, the own-price elasticities are lowest for the premium manufacturer brand label, ranging from -9.24 to -12.41 and highest for private label brands, ranging from -6.15 to -7.42. The standard manufacturer brand is located in-between these groups, with price elasticities ranging from -6.49 to -9.01. Conditional on controlling for income effects, the order of price elasticities is consistent with observed prices, where the premium brand label is most expensive per unit and per package. One explanation for the fact that buyers of premium label products are more price elastic than those of regular brands may be that premium product consumers find it easier to switch to cheaper options (e.g., from the premium to the standard brand label). Consumers of the lower-price alternatives, however, might be (income-) constrained to switch to the more-expensive products (e.g., from the regular to the premium brand label). This result is consistent with Bonnet and Bouamra-Mechemache (2016) who find that, in the milk market, private label buyers are less price-sensitive than consumers of branded products. Despite structural differences across brands, a specific pattern becomes evident: all brands are subject to a monotonic relationship with respect to package size. Elasticities are lowest for small packages (having the highest unit price), and highest for larger packages (with the lowest per unit price).

Table A2 aggregates the elasticities to the brand-format level. The own-price elasticities are on the diagonal, while cross-price elasticities are off-diagonal elements. This table provides information on what consumers switch to after a price increase of a certain brand. They can either switch to (i) the same brand in another format or (ii) another brand in the same format. We find two interesting patterns. First, consumers are more likely to switch to the same brand in another format, which is consistent with the state dependence observed in the data. Second, the table shows how brands from different formats are ranked with respect to their perceived closeness to the manufacturer brand. Private labels from drugstores are the closest substitutes followed by private labels from discounters and supermarkets. We will use this ranking to add products to the initial candidate market of all the manufacturer brand's products.

5.3 Profit Margins and Pass-through Rates

Table A3 presents the results of the non-nested test proposed by Rivers and Vuong (2002). The test selects model 11 as the preferred specification. Model 11 is a two-part tariff model with resale price maintenance clauses, where the wholesale price is equal to wholesale costs. Resale price maintenance is not *per se* legal in Germany. Bonnet and Dubois (2010) and Bonnet et al. (2013), however, point out that (i) the law might not be effectively enforced and (ii) firms often find ways to replicate this equilibrium with alternative—more sophisticated—contracting mechanisms that would not involve resale price maintenance. Furthermore, we find some anecdotal evidence that retailers do not have pricing power on diaper products, which are so called "must-stock" products used to attract consumers into stores.[12] This setup is similar to the one presented in Asker (2016) and Miller and Weinberg (2017), who find that distributors in the U.S. beer market are often induced to sell at prices set by brewers given the absence of legal sanctions for resale price maintenance.[13]

Table 5 lists estimated profit margins and channel costs for our preferred supply model. Profits are highest for the premium label followed by the regular brand. Evidently, the manufacturer brands is more expensive to produce than private labels, where highest costs are estimated for the premium label. As expected, the per-unit margin decreases with the package size, a pattern observed for all formats and labels.

Table 6 provides information on equilibrium prices for the selected models of vertical restraints along with estimated margins and alternative pass-through rates. First, we focus on the "preferred" models from the simulation scenario. Column (1) presents the results of model 11, which is selected by the Rivers-Vuong test. This is the equilibrium that we interpret as being consistent with observed prices. Based on the marginal cost estimates provided in column (1), we simulate new equilibrium prices and profit margins for models 1 and 10 in columns (2) and (3). Not surprisingly, manufacturer profits are highest in the model 11 scenario: The manufacturer maximizes industry profits by internalizing the cross-price elasticities of all products. In addition, retailers internalize the cross-price elasticities of all products in their store when setting prices for their private label products. Channel profits and prices, however, are highest in the double markup scenario, where both the retailers and the manufacturer make a margin on the branded products. Columns (4) and (5) introduce the results for the misspecification scenario. These are the cases where researchers or decision-makers mistakenly select a wrong contracting regime, although they are rejected by the Rivers-Vuong test. In such a case, we would infer the wrong levels of margins, marginal costs, and cost pass-through rates because the wrong equilibrium models would be associated to with the observed prices ($p = 19.33$).

Cost pass-through rates ϕ, from channel costs to retail prices, might vary across con-

[12]See http://www.welt.de/wirtschaft/article117203610/Das-lukrative-Geschaeft-mit-Babys-Po.html.
[13]Industry experts confirmed this practice in informal conversations.

tract types due to the varying levels of competitive constraints implied by the first-order conditions. The estimated pass-through rate for the preferred model 11 is 76.01% and therefore lies between the corresponding rates for models 1 and 10, which are 67.23% and 84.69% respectively. The intuition behind the different pass-through rates is that under the linear pricing regime firms face the double marginalization problem. Retailers set their prices conditional on the manufacturer decision leading to inefficient market outcomes, which limits the channel members' ability to pass-on cost increases to consumers (Goldberg and Verboven 2001, Bonnet et al. 2013). The elimination of the double markups, e.g., by the implementation of vertical restraints, enables firms to pass-on a higher percentage of the channel cost increase. The intuition for the difference between both resale price maintenance models is similar. The lower pass-through rate of model 10 compared to model 11 stems from the fact that the prices and margins of model 11 are closer to the competitive level and further from a monopoly than the prices and margins of model 10.

The results yields important insights for the analysis of competitive constraints that impact the market definition outcomes. In particular, we show that vertical restraints affect the capability of transmitting upstream supply shocks. The higher pass-through rates of both two-part tariff models compared to the linear pricing model is consistent with Goldberg and Verboven (2001). They find that double marginalization can serve to dampen pass-through. Furthermore, Bonnet et al. (2013) show that resale price maintenance between manufacturers and retailers increases the pass-through rate of a 10% cost shock by more than 10 percentage points relative to linear pricing contracts. Their findings in a market structure without private labels are in the ballpark of our results.

5.4 Market Power and SSNIP Test

We now turn to the presentation of our main market definition results, which we illustrate in Figure 3. The interested reader can find the details in Table A4. Figure 3(a) shows the relevant market according to our preferred model 11—the resale price maintenance model, where wholesale prices equal marginal cost. In this market definition scenario, we raise all retail prices of products inside the candidate market by 10%. Given that the initial 10% price increase for all products owned by the manufacturer brand is not profitable, we subsequently add private labels from different formats to the candidate market and then again raise all the inside products' prices by 10%. The market definition algorithm terminates after adding the private labels of drugstores and discounters. This result seems to be quite intuitive given that consumer tests have shown that consumers perceive discount and drugstore private labels as comparable in quality, but not private labels from supermarkets.

In Figures 3(b)–3(d), we investigate how market definition outcomes vary in counterfactual market structures based on the simulation exercise in Table 6's columns (2) and (3). This allows us to analyze variations in market definition outcomes holding marginal cost levels constant and simulating the equilibrium prices, margins, and market shares that are associated to the counterfactual vertical structure. Figure 3(b) shows the market definition results of the other resale price, in which retail margins are equal to zero. As above, we raise both the retail prices of branded the private label products inside the candidate market by 10%. The relevant market size, however, increases in the scenario of model 10 compared to the baseline scenario of model 11. The reason why both models lead to diverging outcomes is the difference in prices and profit margins in both market structures. The retailer internalizes more cross-price effects when the equilibrium is at $w = \mu$ compared to the equilibrium $p = w + c$. In the former case, the retailer internalizes the effects of all products in the store. In the latter case, the retailer internalizes only the effect of own private label products. This can be seen by the higher prices and higher manufacturer margins of model 10 in Table 6. In our set-up, this mechanism induces an earlier threshold for the profitability change. As a consequence, we find that there is a narrower market definition in model 11 compared to model 10.

Figure 3(c) shows the market definition outcome for the linear pricing contract with incomplete pass-through (model 1). Unlike in the SSNIP procedure with resale price maintenance, we impose a 10% wholesale price increase on the branded products' and solve for the branded products' new retail prices. Like in the scenarios before, private label prices are raised by 10%. Table A4 shows that the wholesale price pass-through rate Φ is quite similar to the channel cost pass-through rate ϕ. With linear pricing contracts, the relevant market includes the manufacturer brand's products only. The reason is that—compared to models 10 and 11—branded products now are subject to incomplete pass-through rates Φ, which describes retail price changes after wholesale price increases. Unlike in the resale price maintenance regimes, this implies that branded products' retail prices change only by 6.8% after the 10% wholesale price increase. As the retailer now absorbs part of its input price increase in order to prevent market share losses, the cost of the upstream price increase is lower than in the complete pass-through scenario. Thus, a hypothetical wholesale price increase for the same set of products is always more profitable in the incomplete pass-through scenario, which ultimately leads to definitions of smaller markets.

Next, we aim to show that it is indeed the pass-through rates Φ driving the results and not another effect, such as absolute levels of prices, margins and market shares. In Figure 3(d), we therefore take the linear pricing model of Figure 3(c), but we increase the pass-through rate to 100%. Evidently, we realize that the relevant market consists of more products in the scenario of higher pass-through rates. We therefore note that the variation in pass-through rates is an important driver for the results of the market definition test. Interestingly, the case described in Figure 3(d) is the one most often used in the counterfactual exercises of the Empirical Industrial Organization literature (Berry et al. 1995). These models neglect the vertical structure and implicitly assume that retail price changes are equal to wholesale price changes. However, most industries—such as grocery retailing—are characterized by strategic behavior at the downstream level.

Furthermore, in Figure 4 we investigate how market definition outcomes are impacted by supply model misspecification, which is based on Table 6's columns (4) and (5).[14]

[14]See also Table A5's columns (1)–(3).

This is the misspecification exercise scenario in which researchers erroneously associate the wrong vertical contract—and thus profit margins, marginal costs, and pass-through rates—to the observed market shares and price levels. Visual inspections of Figures 4(a) and 3(a) shows no impact on the market definition outcome when researchers assume the wrong resale price maintenance model (model 10 instead of model 11). This is due to the fact that the estimated costs and margins in both scenarios are quite similar and, more importantly, both scenarios share the same complete pass-through assumption.

Comparing Figure 4(b) to Figure 3(a) shows that the relevant market is defined more narrowly, when researchers erroneously assume that the observed prices and market shares are consistent with model 1. The reason again lies in the assumption of the incomplete pass-through rate. This can be also seen by comparing Figures 4(b) and 3(c), where we find qualitatively similar results. This stems from the fact that the quantitative measures of costs, margins, and pass-through rate are quite comparable. Figure 4(c) is the same scenario as in Figure 4(b), but with a assumed complete pass-through rate. It shows a slightly larger market definition than Figure 3(a), which can be explained by the wrongly associated marginal costs and margins. We see in Figure 3(d), however, that the scenario of complete pass-through and linear pricing leads to similar market definition outcomes as resale price maintenance, when profit structures are correctly assessed.

In Figure A1, we show the effect of relaxing the assumption of a uniform hypothetical price increase.[15] We focus on the two resale price maintenance models, but the logic is transferable to the linear pricing models. As in the resale price maintenance scenarios before, we increase the retail prices of manufacturer brands. Unlike before, we allow private label prices, instead of imposing a 10% price increase, to be a best-response to the imposed upstream price increase. Figure A1 shows that markets are defined more narrowly than the corresponding markets in 3. The effect is more pronounced in Figure A1(a) than in Figure A1(b), which accentuates the importance of carefully choosing the right modeling and pricing assumptions.

Finally, we conduct three robustness checks to see how a change in the market size—e.g., due to exogenous demand shocks—affects our results.[16] First, we reduce market size by adjusting the size of the outside option. In practice, we randomly drop 20% of the outside option purchases. We then re-estimate the demand parameters. Second, we introduce exogenous shocks (both positive and negative) to all purchases in the inside option holding demand parameters constant. In practice, we multiply the mean utility by 1.2 and 0.8 respectively. Table A6 in the paper shows that the results of the SSNIP test hardly change in response to the size adjustment of the outside option. Column (1) presents the market definition results when we reduce the consumers' outside option by 20%. The estimated market shares of the inside options increase relative to the outside option given that the demand system predicts higher valuation for the inside products. As a result, the magnitude of the profit change after a hypothetical price increase (on the subsets of inside products) changes slightly. The qualitative result of the market definition outcome, however, does not change. Columns (2) and (3) show the SSNIP results when

[15] See also Table A5's columns (4) and (5).

[16] We thank Pierre Dubois and an anonymous referee for this suggestion.

we exogenously adjust the utility of all inside products by 20% while holding demand parameters constant. We find minor deviations in the outcome. Finally, in column (4), we set the brand loyalty parameters of our main specification equal to zero. Subsequently, we calculate new elasticities and new margins. We then re-run the counterfactual exercises and find that the results do not change qualitatively.

Almost all of the market definition estimates are highly significant. One of the few exceptions is the outcome in the scenario of model 10 (RPM: $p = w + c$), which can be found in columns 2 of Table A4. The profitability increase is not statistically different from zero. We argue, however, that the market for our main specification (RPM: $w = \mu$) is precisely delineated and that the main line of argument (different profitability thresholds throughout different vertical contracts) holds.

6 Conclusion and Policy Implications

Our analysis aims at integrating vertical relationships into the market definition procedure. The strategy is as follows. We first derive a simple theory model in order to predict how pass-through rates affect upstream market definition outcomes. We then empirically quantify the results with price and market shares data from a rich and detailed representative consumer panel. Based on the demand substitution patterns from a flexible demand model, we infer firms' price-cost margins and marginal costs for a range of vertical supply models without additional firm-level cost data. We then test which model's inferred marginal cost estimates fit the observed cost-shifters best. Finally, we conduct the SSNIP test with observed prices and shares as well as profit margins and marginal costs from the best supply model to define the relevant market. The test is consistent with economic theory as it incorporates consumer substitution behavior, market power, and the pass-through rates of vertical contracts.

The insights from our theoretical model call for a careful investigation of how the SSNIP test is performed. We find that decision-makers should be advised to incorporate the specific market characteristics—in our case, both the strategic retail pricing and the vertical contract type—into their analysis. We find that, under reasonable conditions, the SSNIP test procedure leads to diverging upstream market definitions whenever the cost pass-through critically depends on the vertical restraints used in manufacturer-retailer relations. A model that ignores the pass-through rates would overestimate the cost of a hypothetical upstream price increase. When retailers act strategically, they are likely to absorb part of their input price increases. As retailers partially "protect" consumers from the input price increase, the demand loss—and thus profit loss–with incomplete pass-through is strictly lower than with complete pass-through. Thus, we find that higher cost pass-through rates lead to the definition of larger markets.

We then develop a SSNIP test for an industry where private labels comprise a key market characteristic. In our main specification, we compare a model of resale price maintenance (as an example for complete pass-through) to a simple linear model with incomplete pass-through rates. The empirical results suggest that higher cost pass-through rates indeed correspond to larger market definition outcomes. Our empirical results underline the importance of carefully modeling the vertical relations.

Although we focus on the comparison of resale price maintenance and linear pricing contracts, our general insights can be applied to manifold other vertical structures that incorporate the pass-through rates as a market characteristic. For instance, we model the type of fixed payments that corresponds to anecdotal evidence for the diaper market, which is full upstream bargaining power. However, our general finding—that market definition upstream depends on the pass-through rate from wholesale to retail prices—holds for a range of model specifications with retail buyer power. The same effect persists in more complex contracts, such as bargaining models, where retailers set retail prices after negotiating their wholesale prices with manufacturers.

Given that market definition will remain an essential tool for the future, our case study provides insights on how results are biased when researchers or practitioners assume wrong market structures and use wrong tools from their toolbox. Based on our theoretical model and empirical observations, we derive the following generalized policy implications. First, competition authorities should put more emphasis on modeling the entire vertical supply chain whenever they expect that incomplete pass-through by downstream retailers is an important market characteristic. In such markets structures, for instance, in vertical markets with successive oligopolies, we show that higher pass-through rates unambiguously lead to the definition of larger markets. Or put differently, the more incomplete the pass-through, the more biased the SSNIP test that neglects strategic retail pricing in the vertical supply chain. Second, we find that the probability of making mistakes in defining markets decreases with higher pass-through rates. Third, we highlight that competition authorities have to worry less about modeling vertical relations when the market structure implies complete pass-through—as it is the case in markets with resale price maintenance and perfect competition.

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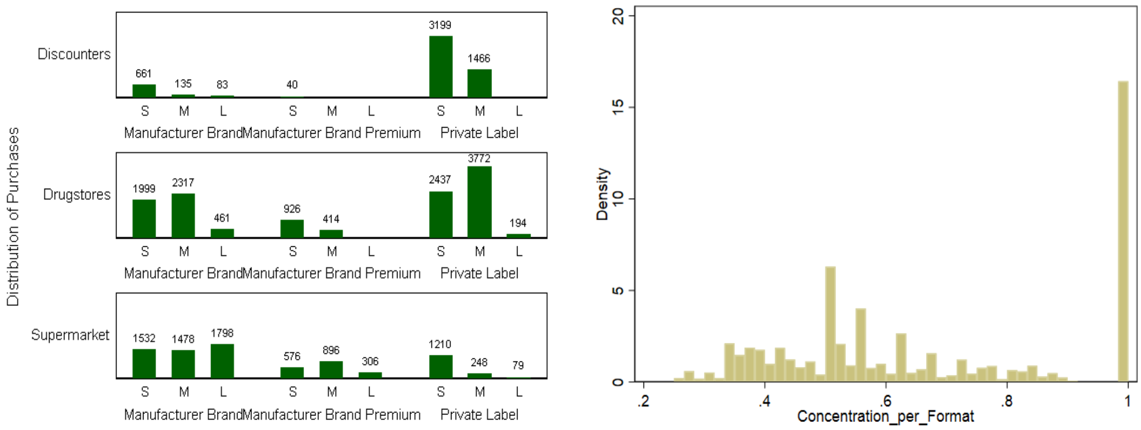
7 Figures and Tables

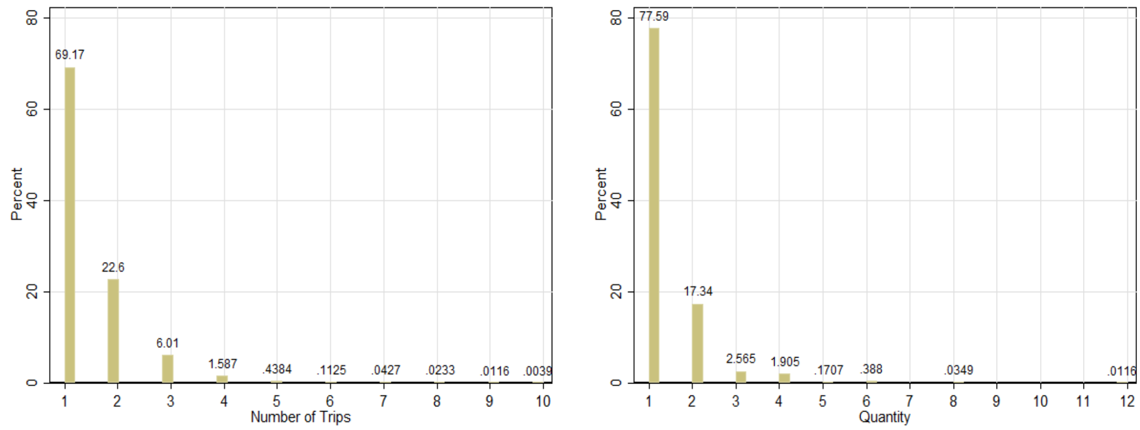
Figure 1: Descriptive Statistics over Formats



(a) Frequencies by Formats and Brand Type

(b) Concentration of Shopping over Formats

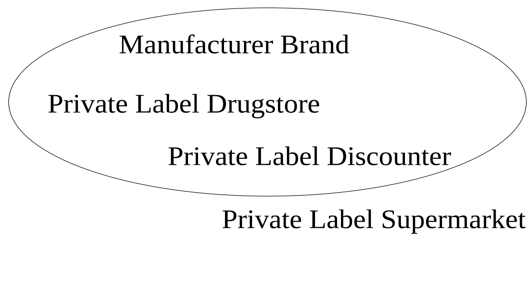
Figure 2: Number of Shopping Trips and Packages Purchased



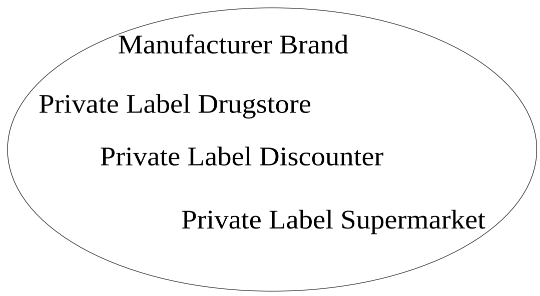
(a) Household Shopping Trips per Month

(b) Number of Packages per Shopping Trip

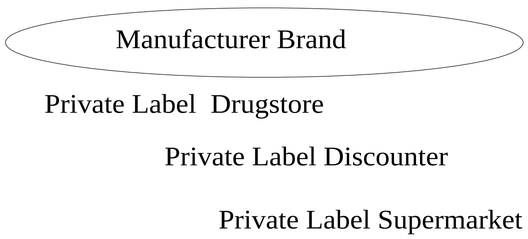
Figure 3: Market Definition Outcomes across Vertical Structures



(a) Model 11: RPM ($w = \mu$)



(b) Model 10: RPM ($p = w + c$)

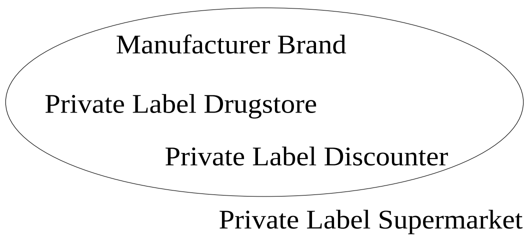


(c) Model 1: Linear Pricing (Incomplete PT)

(d) Model 1: Linear Pricing (Complete PT)

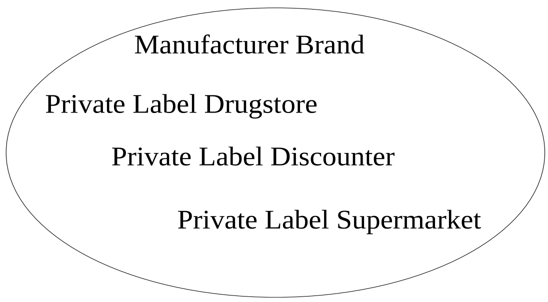
Notes: This figure graphically illustrates the market definition outcomes from the simulation exercise. Table A4 provides the quantitative results. RPM is the abbreviation for resale price maintenance and PT stands for pass-through.

Figure 4: Market Definition Outcomes across Vertical Structures



(a) Model 10: RPM ($p = w + c$)

(b) Model 1: Linear Pricing (Incomplete PT)



(c) Model 1: Linear Pricing (Complete PT)

Notes: This figure graphically illustrates the market definition outcomes from the misspecification exercise. Table A5 provides the quantitative results. RPM is the abbreviation for resale price maintenance, and PT stands for pass-through.

Table 1: Descriptive Statistics

			Price		Promotion		Income	
		Market Share	Mean	SD	Mean	SD	Mean	SD
Discounters	Σ	*0.21*						
Manuf. Brand	S	0.03	20.42	1.09	0.49	0.21	2,494.90	128.42
	M	0.01	19.00	1.06	0.21	0.11	2,440.08	233.98
	L	<0.01	16.43	1.41	0.85	0.15	2,489.23	197.02
Manuf. Brand Premium	S	<0.01	25.38	1.45	0.21	0.26	2,440.08	213.99
Private Label	S	0.12	15.71	0.82	0.04	0.04	2,338.06	179.22
	M	0.06	14.95	1.53	0.02	0.04	2,478.78	110.12
Drugstores	Σ	*0.48*						
Manuf. Brand	S	0.08	19.32	1.24	0.47	0.21	2,489.15	130.69
	M	0.09	18.14	0.76	0.55	0.14	2,516.39	112.59
	L	0.02	14.74	0.86	0.63	0.04	2,533.51	94.52
Manuf. Brand Premium	S	0.04	24.23	3.21	0.34	0.18	2,519.95	118.75
	M	0.02	20.46	1.78	0.66	0.14	2,525.82	121.54
Private Label	S	0.09	15.53	0.98	0.12	0.07	2,356.19	156.01
	M	0.14	14.45	0.95	0.19	0.20	2,356.19	136.38
	L	0.01	14.32	0.40	0.37	0.08	2,460.54	58.82
Supermarket	Σ	*0.31*						
Manuf. Brand	S	0.06	19.88	1.48	0.37	0.21	2,483.43	139.94
	M	0.06	19.59	1.20	0.81	0.07	2,555.36	112.01
	L	0.07	18.28	0.49	0.86	0.05	2,529.52	122.51
Manuf. Brand Premium	S	0.02	26.48	3.29	0.37	0.23	2,517.25	135.53
	M	0.03	23.40	1.99	0.79	0.10	2,550.98	111.37
	L	0.01	20.25	0.88	0.86	0.11	2,539.75	116.15
Private Label	S	0.05	16.54	1.36	0.04	0.05	2,126.66	190.97
	M	0.01	14.47	1.38	0.06	0.06	2,198.66	177.95
	L	<0.01	13.69	0.18	0.10	0.08	2,289.79	168.95

The table provides descriptive statistics separated by label, package size, and format. Package sizes are grouped into Small (S) with 28–50 diapers per package, Medium (M) with 56–96 units, and Large (L) with 102–136 units. Market shares—calculated for the market excluding the outside option, which has a market share of approximately 27%—are reported per label, format, and package size. Prices are provided in cents per diaper. Size describes the mean quantity per package of a label at a given format. Promotion reports the shares of purchases conducted within a promotional activity. Income is the household income measured in Euros and cents.

Table 2: Overview Supply Models

Model	Contract	Vertical Relation	Downstream Competition	Upstream Competition
1	Linear	Bertrand-Nash	Competition	Competition
2	Linear	Bertrand-Stackelberg	Competition	Competition
3	Linear	Bertrand-Nash	Collusion	Competition
4	Linear	Bertrand-Nash	Competition	Collusion
5	Linear	Bertrand-Nash	Collusion	Collusion
6	Linear	Bertrand-Stackelberg	Collusion	Competition
7	Linear	Bertrand-Stackelberg	Competition	Collusion
8	Linear	Bertrand-Stackelberg	Collusion	Collusion
9	Two-part tariff	No Resale price maintenance	Competition	Competition
10	Two-part tariff	Resale price maintenance ($p = w + c$)	Competition	Competition
11	Two-part tariff	Resale price maintenance ($w = \mu$)	Competition	Competition

Table 3: Demand Estimation Results

Coefficients	Specifications						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Price	-0.0202***	-0.4636***	-0.4145***	-0.449***	-0.447***	-0.475***	-0.457***
	(0.00461)	(0.0140)	(0.0187)	(0.0187)	(0.0187)	(0.0190)	(0.0193)
Control Function		0.4763***	0.4260***	0.4392***	0.4380***	0.4429***	0.4413***
		(0.0141)	(0.0190)	(0.0190)	(0.0190)	(0.0190)	(0.0191)
Promotion			0.1733***	0.03660	0.03643	0.04631	0.1399***
			(0.0440)	(0.0441)	(0.0441)	(0.0441)	(0.0450)
Brand Loyalty × Manufacturer Brand				1.3978***	1.3940***	1.1407***	0.4709***
				(0.0169)	(0.0169)	(0.0192)	(0.0212)
Brand Loyalty × Private Labels				0.9675***	0.9593***	0.9748***	0.2099***
				(0.0269)	(0.0270)	(0.0271)	(0.0282)
Package Size 1 × Income (in 1000)					0.0853***	0.0806***	0.0731***
					(0.0145)	(0.0151)	(0.0154)
Package Size 2 × Income (in 1000)					0.1580***	0.1522***	0.1451***
					(0.0233)	(0.0237)	(0.0242)
Private Label × Income (in 1000)					-0.1883***	-0.1956***	-0.3863***
					(0.0142)	(0.0145)	(0.0392)
Price × Income (in 1000)						0.0014	0.0031**
						(0.0014)	(0.0015)
Standard Deviation Price						0.0584***	0.0634***
						(0.0018)	(0.0022)
Random Brand Intercepts	No	No	No	No	No	No	Yes
Observation	34313	34313	34313	34313	34313	34313	34313
Log-Likelihood Value	-132202.83	-131634.29	-131626.54	-126938.87	-126822.7	-126821.33	-121387.93

*Standard errors in parentheses. Significant at 1% ***, significant at 5 % **, significant at 10% *. All specifications include fixed effects for brands, retailers, and package sizes.*

Table 4: Elasticities per Label and Retail Format

	Size	Own-price Elasticity Mean	SD
Discounters			
Manufacturer Brand	S	-8.46 (0.27)	0.56 (0.02)
	M	-8.13 (0.26)	0.49 (0.02)
	L	-7.13 (0.21)	0.59 (0.02)
Manufacturer Brand Premium	S	-10.61 (0.36)	0.47 (0.02)
Private Label	S	-6.78 (0.21)	0.28 (0.01)
	M	-6.21 (0.19)	0.58 (0.02)
Drugstores			
Manufacturer Brand	S	-8.04 (0.25)	0.58 (0.02)
	M	-7.90 (0.25)	0.54 (0.02)
	L	-6.33 (0.18)	0.30 (0.01)
Manufacturer Brand Premium	S	-10.56 (0.37)	1.44 (0.07)
	M	-8.94 (0.29)	0.79 (0.03)
Private Label	S	-7.08 (0.22)	0.55 (0.02)
	M	-6.40 (0.20)	0.47 (0.19)
	L	-6.23 (0.19)	0.15 (0.01)
Supermarkets			
Manufacturer Brand	S	-8.42 (0.26)	0.59 (0.03)
	M	-8.29 (0.27)	0.55 (0.03)
	L	-7.81 (0.24)	0.26 (0.01)
Manufacturer Brand Premium	S	-11.18 (0.39)	1.22 (0.05)
	M	-9.96 (0.33)	0.84 (0.04)
	L	-8.71 (0.28)	0.35 (0.01)
Private Label	S	-7.18 (0.23)	0.56 (0.02)
	M	-6.20 (0.19)	0.62 (0.02)
	L	-6.11 (0.18)	0.08 (0.00)

The table provides own-price elasticities separated by label, package size, and format. Package sizes are grouped into Small (S) with 28–50 diapers per package, Medium (M) with 56–96 units, and Large (L) with 102–136 units. Standard errors (in parentheses) are constructed via bootstrap with 100 draws from the estimated asymptotic normal distribution of the parameters.

Table 5: Profits and Costs per Label and Retail Format

		Margin (in %)	Cost (in %)	Margin (in Cents)	Cost (in Cents)
Discounters					
Manufacturer Brand	S	21.67 (3.25)	78.33 (3.09)	4.32 (0.48)	15.71 (0.54)
	M	23.48 (3.46)	76.52 (3.29)	4.46 (0.59)	14.58 (0.55)
	L	26.67 (3.96)	73.33 (3.77)	4.33 (0.58)	11.98 (0.54)
Manufacturer Brand Prem.	S	17.85 (2.98)	82.15 (2.84)	4.59 (0.69)	21.19 (0.65)
Private Label	S	15.76 (0.51)	84.24 (0.50)	2.45 (0.07)	13.09 (0.07)
	M	17.96 (0.68)	82.04 (0.68)	2.52 (0.09)	11.60 (0.09)
Drugstores					
Manufacturer Brand	S	22.01 (3.35)	77.99 (3.18)	4.20 (0.57)	14.91 (0.54)
	M	23.90 (3.52)	76.10 (3.35)	4.44 (0.58)	14.18 (0.55)
	L	29.30 (4.36)	70.70 (4.17)	4.24 (0.57)	10.26 (0.54)
Manufacturer Brand Prem.	S	17.94 (2.87)	82.06 (2.73)	4.55 (0.64)	21.32 (0.60)
	M	20.77 (3.44)	79.23 (3.28)	4.40 (0.66)	16.96 (0.62)
Private Label	S	11.21 (0.64)	88.79 (0.61)	1.84 (0.09)	14.58 (0.08)
	M	12.71 (0.62)	87.29 (0.60)	1.85 (0.08)	12.77 (0.08)
	L	9.78 (1.04)	90.22 (0.98)	1.39 (0.13)	12.88 (0.12)
Supermarket					
Manufacturer Brand	S	21.47 (3.24)	78.53 (3.08)	4.27 (0.57)	15.68 (0.54)
	M	22.85 (3.36)	77.15 (3.20)	4.49 (0.59)	15.27 (0.55)
	L	24.30 (3.59)	75.70 (3.41)	4.42 (0.58)	13.78 (0.55)
Manufacturer Brand Prem.	S	17.03 (2.71)	82.97 (2.57)	4.61 (0.65)	22.84 (0.61)
	M	18.72 (3.00)	81.28 (2.86)	4.46 (0.64)	19.55 (0.60)
	L	21.37 (3.53)	78.63 (3.37)	4.36 (0.65)	16.09 (0.61)
Private Label	S	14.61 (0.46)	85.39 (0.44)	2.40 (0.07)	14.11 (0.06)
	M	17.16 (0.49)	82.84 (0.48)	2.39 (0.65)	11.67 (0.62)
	L	17.39 (0.53)	82.61 (0.51)	2.38 (0.06)	11.30 (0.06)

The table provides profit and cost estimates separated by label, package size, and format. Package sizes are grouped into Small (S) with 28–50 diapers per package, Medium (M) with 56–96 units, and Large (L) with 102–136 units. Standard errors (in parentheses) are constructed via bootstrap with 100 draws from the estimated asymptotic normal distribution of the parameters.

Table 6: Overview Results of Supply Models

	Preferred Models (Simulation Exercise)			**Rejected Models** (Misspecification Exercise)	
	(1) Model 11	(2) Model 10	(3) Model 1	(4) Model 10	(5) Model 1
	Two-part $w = \mu$	Two-part $p = w + c$	Linear Pricing	Two-part $p = w + c$	Linear Pricing
Prices (in cents)	19.33	18.50	20.51	19.33	19.33
	(-)	(0.30)	(0.30)	(-)	(-)
Retail Margin (in cents)	2.52	2.38	2.45	2.52	2.52
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Manufacturer Margin (in cents)	7.85	4.39	5.40	6.75	5.57
	(0.35)	(0.30)	(0.30)	(0.31)	(0.33)
Channel Costs (in cents)	13.41	13.41	13.41	13.20	14.87
	(0.35)	(0.30)	(0.30)	(0.32)	(0.33)
Pass-through Rate ϕ (in %)	76.01	84.69	67.23	75.72	68.46
	(0.66)	(0.20)	(0.33)	(0.22)	(0.66)

Demand estimates from the model specification reported in column 7 of table 4 are the basis for all calculations. Column (1) presents the results from our preferred model 11 based on equations 2, 4, and 6. This is the market structure when observed prices and market shares are consistent with the marginal costs and profit margins backed-out by our preferred equilibrium model 11. In columns (2) and (3), we keep the marginal cost estimates from model 11. We then calculate prices, margins, and market shares for counterfactual equilibria that would arise in new vertical structures according to equation 5. The pass-through rate ϕ indicates the percentage retail price change after a 10% channel cost increase (cf. equation 6). The results in columns (4) and (5) are rejected by the Rivers-Vuong test. Here we use the observed prices ($p = 19.33$) and market shares to infer on margins, marginal costs, and cost pass-through by intentionally selecting a non-preferred vertical supply model. Standard errors (in parentheses) are constructed via bootstrap with 100 draws from the estimated asymptotic normal distribution of the parameters.

A Appendix

A.1 Simple Theory Model: Pass-through and Market Definition

The goal of appendix A.1 is to show how different pass-through rates across vertical contracts can impact market definition outcomes according to the SSNIP test. For this purpose, we compare the SSNIP market definition under two scenarios: (i) a linear double mark-up model and (ii) a resale-price maintenance model. By construction of the SSNIP test, in case (i) the wholesale price is raised by 10%, while in case (ii) the retail price is directly raised by 10%. Under standard assumptions the retail price change in case (i) is smaller because of incomplete cost pass through than in case (ii). It follows that demand change of a 10% price change is smaller in the former than in the latter case. Consequently, the 10% price change tends to be less profitable in the latter than in the former case.

When vertical restraints are such that the manufacturer sets the retail price (resale price maintenance), the wholesale price is used to extract the retailer's rents. Ignoring retailer marginal selling costs, the wholesale price equals the final retail price when all rents can be extracted by the manufacturer (see model 11). Consequently, manufacturer i's profit is given by

$$\pi_i^M = D_i(\overline{p})(p_i - c_i), \text{ with } p_i = w_i$$

where $\overline{p} = (p_1, ..., p_m)$ is the vector of all retail prices.[17] We suppose that this price vector is an equilibrium outcome of model 11. To conduct the SSNIP test, we consider a 10% price increase for manufacturer 1 with $\frac{\Delta w_1}{w_1} = \frac{\Delta p_1}{p_1} = 10\%$. The associated profit change for the manufacturer is given by

$$\frac{\Delta \pi_1^M}{\Delta p_1} = \frac{\Delta D_1}{\Delta p_1}(p_1 - c_1) + D_1(\overline{p}) + \Delta D_1(\overline{p}'), \tag{12}$$

where $\Delta D_1(\overline{p}') = D_1(\overline{p}') - D_1(\overline{p}) < 0$, $\Delta p_1 = p(1 + 10\%) > 0$, and $\overline{p}' := (p_1', ..., p_m')$ stands for the new price vector after the 10% price increase of firm i's product.[18] In the following we suppose a *ceteris paribus* analysis such that all other prices stay put; i.e., $\overline{p}' = (p_1 + \Delta p_1, ..., p_m)$. Quite generally, the price increase will reduce the demand of firm 1's product so that $\frac{\Delta D_1(\overline{p})}{\Delta p_1} < 0$. Thus, the larger the demand reduction, $\Delta D_1 < 0$, and the higher the channel initial profit margin, $(p_1 - c_1) > 0$, the more likely it is that the price increase will induce a fall in manufacturer 1's profit level.[19]

[17] To simplify, we suppose a single product per manufacturer and we also abstract from retailing production costs.

[18] In the standard SSNIP test, the prices of the other firms (that is, the firms outside the market) are kept constant. In our analysis the new price vector contains the new equilibrium so that all other prices adjust optimally to the price increase of product 1 (i.e., according to the best response functions of all other firms as implied by their first-order conditions).

[19] When we consider the optimal price responses of the competitors, $p_j' = p_j(p_1)$, for $j = 2, ..., m$, then the demand effect also depends on those price responses. As prices are strategic complements (i.e., $\frac{\Delta p_j}{\Delta p_1} > 0$) and goods are substitutes (i.e., $\frac{\Delta D_1(\overline{p}')}{\Delta p_j} > 0$), such responses tend to reduce the negative demand

We next turn to the linear case (model 1), where the manufacturer can only charge a linear wholesale price to retailer 1, w_1, which sells the good to final consumers at a price p_1. This model stands for the case when vertical restraints are being "ignored". The profit of manufacturer 1 is then given by

$$\pi_1^M = D_1(p_1(w_1), ..., p_m)(w_1 - c_1),$$

where we assume that w_1 only directly affects the optimal retail price charged by retailer 1, but has no strategic impact on the other products prices set by the retailers (that is, we presume that wholesale prices are not observable). Suppose that the price vector $\overline{p}(w_1) = (p_1(w_1), ..., p_m)$ is the corresponding initial equilibrium. To conduct the SSNIP test, we consider a 10% wholesale price increase for manufacturer 1 with $\frac{\Delta w_1}{w_1} = 10\%$. The associated profit change for the manufacturer is given by

$$\frac{\Delta \pi_1^M}{\Delta w_1} = \frac{\Delta D_1}{\Delta p_1}\frac{\Delta p_1}{\Delta w_1}(w_1 - c_1) + D_1(\overline{p}(w_1)) + \Delta D_1(\overline{p}'(w_1')), \tag{13}$$

where $\Delta D_1(\overline{p}'(w_1')) = D_1(\overline{p}'(w_1+\Delta w_1)) - D_1(\overline{p}(w_1)) < 0$ and $\overline{p}'(w_1') = \overline{p}'(w_1+\Delta w_1)$ is the new price vector after the 10% wholesale price increase of firm i's product.Quite generally, the wholesale price increase will increase the retail price (i.e., $\frac{\Delta p_1}{\Delta w_1} > 0$) and thus reduce the demand of firm 1's product so that $\frac{\Delta D_1}{\Delta p_1} < 0$. Thus, the higher the cost pass-through, $\frac{\Delta p_1}{\Delta w_1}$, the larger the demand reduction, $\Delta D_1 < 0$, and the higher the manufacturer's initial profit margin, $(w_1 - c_1)$, the more likely it is that the price increase will induce a decrease in manufacturer 1's profit level.

We now compare the profit changes (12) and (13) under vertical restraints and linear pricing respectively. The critical difference is the cost pass-through factor $\frac{\Delta p_i}{\Delta w_i}$, which only appears in the linear model specification (the corresponding value in (12) is one). This term is typically smaller than one.[20] We then get that a 10% price increase induces generally a smaller profit increase (or larger profit decrease) for the vertical restraints case than under the linear case (i.e., $\frac{\Delta \pi_1^M}{\Delta w_1} < \frac{\Delta \pi_1^M}{\Delta p_1}$ holds), because of the following reasoning.

If the cost pass-through is smaller in the linear setting than in the vertical restraints case (i.e., $\frac{\Delta p_1}{\Delta w_1} < 1$) and if the initial margin of the manufacturer is larger in the latter case than in the former (i.e., $p_1 - c_1 > w_1 - c_1$) and if the initial demand for good 1 is the same in both cases (i.e., $D_1(\overline{p}) = D_1(\overline{p}(w_1))$), then $\frac{\Delta \pi_1^M}{\Delta w_1} < \frac{\Delta \pi_1^M}{\Delta p_1}$ holds.

For the interpretation of the results, it should be noted that the models are estimated for the same market data $(p_1, ..., p_m)$ and $(D_1, ..., D_m)$, so that the initial market outcome must be the same. This implies $D_1(\overline{p}) = D_1(\overline{p}(w_1))$. Because demand is assumed to be

effect of a 10% price increase by manufacturer 1.

[20]This can be seen from considering the isolated retailer's maximization problem $\pi^R = D(p)(p - w)$. The first-order condition is $\frac{\partial D}{\partial p}(p - w) + D = 0$. Considering $p = p(w)$ and differentiating the first order condition with respect to w, we get $\frac{\partial^2 D}{\partial p^2}\frac{dp}{dw}(p - c) + 2\frac{\partial D}{\partial p}\frac{dp}{dw} - \frac{\partial D}{\partial p} = 0$ and thus $\frac{dp}{dw} = \frac{\frac{\partial D}{\partial p}}{\frac{\partial^2 D}{\partial p^2}(p-c)+2\frac{\partial D}{\partial p}}$. The second order condition implies $\frac{dp}{dw} > 0$. Moreover, $\frac{dp}{dw} < 1$ holds if the demand function is not too convex.

monotonically downward sloping (i.e., $\partial D_1/\partial p_1 < 0$ for all p_1) a larger price increase Δp_1 must induce a large demand reduction ΔD_1. Thus, for a cost pass-through below one under linear pricing, the first term on the right-hand side of (13) must be larger than the corresponding term in (12), whenever the initial margin is larger in the vertical restraints case (i.e., $p_1 - c_1 > w_1 - c_1$). Finally, the second term on the right-hand side of (13) must be larger than the corresponding term in (12), because the demand decrease is larger in the vertical restraints case (i.e., $\Delta D_1(\overline{p}') < \Delta D_1(\overline{p}'(w_1') < 0)$, while the initial demand for good 1 is the same.

A.2 Choice Set Construction

The data set contains information on the name of the brand, label (premium, regular or private label), retailer, the number and day of the shopping trips, and the actual transaction price (including any discounts and promotions). For the empirical analysis and inference, the GfK data set includes additional data on product characteristics like package size, promotions, and household income. We sample the time period from March 2009 to September 2010 for customers who purchases diapers (N=6,757 observations). This ensures that we exclude major trends over the years and panel attrition issues.

Possible choices for consumers—and thus products—are defined as $Retailer \times Brand \times PackageSize$ combinations. In other words, the same $Brand \times PackageSize$ combination (e.g., the small package size of the private label) sold by two heterogeneous retailers is treated as two different alternatives because consumers may perceive the same brand sold by another retailer differently. Thus, consumers may not only switch from brand A sold by retailer 1 to product B (either sold by retailer 1 or retailer 2), but also to brand A sold by retailer 2. Thus, the theoretical framework relating to vertical contracts is based on a monthly data set on retail prices, promotion, aggregated (to the product) market shares and product characteristics for 99 products produced by the manufacturer and the retailers. We add to the outside option, however, all cases where the frequency of that bundle is below 10 given that these products serve as a competitive fringe.[21] The remaining products define the market in the widest possible sense, which consists of 15 retailers in three formats (see Table 1).

We assume that every month consumers face a decision as to whether to buy diapers. Section 3.2 shows that this seems to be reasonable given that the vast majority of households conduct one shopping trip per month and purchase, on average, one diaper package per shopping trip. Nonetheless, we also see that some households conduct a second shopping trip (23%) and/or purchase a second package. We deal with that issue in two ways. First, if consumers purchase the same product twice in a month, we use the average monthly price and treat both purchases as a single unit of observation. If a household—allegedly with the same degree of individual heterogeneity within the same month—purchases a product twice at the same price, the random coefficient model predicts the same individual choice probability. Our aggregation choice therefore seems

[21] Previously, we defined that all brands with market shares < 2% and all retailers with shares < 1% are part of that competitive fringe in order to remove outliers and reduce the sampling error.

reasonable. This assumption is supported by the observation that price dispersion within product, household, and month is very low. Second, if households purchase two different products in a given month, we treat the purchases as independent from each other. In some cases, it might well be that purchases are not independent and consumers are obliged to conduct emergency purchases. However, we feel that this is a minor issue given that this kind of heterogeneity is captured by modeling varying package sizes over retail formats. Moreover, we exclude the newborn/early category. Finally, parents have—after an initial time period of unpredictable demand needs—a high degree of certainty of their monthly consumption needs.

If consumers decide not to buy an inside good then the outside option is chosen. Regarding a possible outside good, one may think of three options for the diaper market: excluded products, a potty or storage. The first option may include pharmacies, Internet purchases or a product offered by the competitive fringe. Since these products constitute a minor negligible share of the market, it seems reasonable to put them into the outside option. The second option is related to consumer exit given that children stop using diapers at some point. We assume, however, this to be exogenous. Finally, proving that people do not store diapers is more complicated, but summary statistics suggest that most consumers buy diapers once or twice a month. Given that diapers are voluminous and are therefore (i) difficult to transport out of the store and (ii) costly to store, we feel that storage is not a major issue.

A.3 Detailed Summary Statistics

In general, the statistics show that prices vary over retailers, brands, and package sizes (see Table 1). Average supermarket prices for branded products range from 18 cents per diaper to approximately 20 cents per diaper. The premium manufacturer brand prices range from around 20 to 26 cents per diaper. Branded products at drugstores range from around 15 to 19 cents. Surprisingly, discounters sell the manufacturer brand at the higher range of prices (the range is from 16 to 20 cents), which can be explained by discounters' heterogeneous pricing strategy. Discounters have, on average, the lowest prices for the total shopping basket, although thus does not necessarily hold for all products. One possible explanation for the higher prices of branded products is that discounters obfuscate consumers by taking advantage of the perception of low average prices to raise margins on selected products, such as branded diapers—an argument which is closely related to loss-leading strategies (see e.g., Chen and Rey 2012). Another explanation may be that discounters deliberately increase the pricing gap between branded products and private labels to stimulate sales of private labels. A significant variation in prices can also be found for private label products, where supermarkets—and also drugstores—offer the lowest prices for large packs (around 14 cents) and highest prices for small packs (around 16 cents). This pattern underlines the heterogeneous pricing strategies of retail formats regarding private labels and branded products. Another consistent pattern is noteworthy. Firms seem to engage in non-linear pricing. Small packs—defined as packages containing 28 to 50 diapers—are always the most expensive product category compared to the other categories, i.e., medium (56–96 units) and large (102–136), which are priced at lower levels.[22]

Table 1 further introduces summary statistics on promotional activities. Larger packs are more often sold as part if a promotion. Furthermore, medium packs are more often sold than small package sizes. Discounters and supermarkets rarely initiate promotions in order to stimulate demand for diapers, whereas private label promotions seem to be a strategic variable for drugstores. As expected, the manufacturer brand is an important brand in all formats.

Table 1 also shows summary statistics for household income at stores. Income does not vary much over retail formats, whereas private label consumers at drugstores and common supermarkets have slightly lower incomes than consumers of the manufacturer brand. The strongest effect can be seen within supermarkets where private label consumers have a monthly income that is roughly 250–300 Euros lower than consumers of the branded good. This difference is not that clear for discounters' customers. While the buyers of small private label packages have a lower income than the buyers of small branded products, the buyers of medium-sized private label packs have a slightly higher income than the buyers of the medium-sized manufacturer brand's products within the same retailer category.

Given that repeated purchases have shown to be important in grocery markets (see e.g., Dubé et al. 2008), we cannot reject that state dependence—most likely due to brand loyalty or risk aversion—plays a role, in particular, given that Rickert (2016) has shown that diaper consumers tend to be prone to purchasing the same brand repeatedly. This is consistent with our findings regarding income distribution, indicating that people sort themselves into customer groups for heterogeneous brands. Consequently, any demand estimation has to account for these market characteristics as well as demographic dependence.

Finally, Figure 1(b) shows a histogram of the average share customers spend per retailer. Evidently, the vast majority of consumers visit more than one format. Still, a small but substantial fraction above 15% concentrate their purchases in one retailing format. While considering that there are some non-switchers, both tables back up the presumption of vital substitution of consumers across products. This provides a first indicator that there may be competition of products across formats.

A.4 Market Definition with Asymmetric Insider Price Responses

In section 4.3, we assume (i) impose a uniform price increase on all products inside the relevant market and (ii) keep the prices of outsiders unchanged. The unclear wording from the wording of the U.S. Merger Guidelines, however, has led to a lively debate on whether to increase one price, some prices, or all prices in the candidate market. Whinston (2007) notes that theory cannot provide evidence of which approach is ultimately preferable given

[22] In order to keep estimation tractable, we have to implement some kind of grouping given that treating each observed package size as a distinct choice option would not be feasible. However, when grouping package sizes into classes, we implement an algorithm minimizing the price variance within those classes.

that the competitive constraints depends on the specific market structure. In markets with asymmetries—for instance, when private labels potentially compete with large national brands—a uniform price increase might lack an important economic force (Daljord et al. 2008). Thus, it might be a viable alternative assumption to assume asymmetric price increases in the market definition procedure.

Let us consider a market definition procedure that explicitly accounts for potential asymmetries of the manufacturer brand and the private labels. Remember that we start the market definition procedure by evaluating the change in equilibrium profits after imposing a 10% price increase on all products owned by the manufacturer brand in all formats as an initial candidate. When adding the private labels to the candidate market, we might allow for the fact that private labels raise their prices by less than 10%. That is, we calculate the best-response price increase of private labels in response to the uniform price increase of 10% an all branded products. Thus, the data decide by how much retailers raise the private label prices inside the candidate market. For instance, it may (or may not) be most profitable for retailers to respond with a 10% price increase. In such a case, the vertical supply models imply different levels of competitive constraints that determine the best-response for prices. The competitive constraint is same underlying driver for (i) the incomplete cost pass-through and (ii) the asymmetric price response of insiders and outsiders.

To understand the SSNIP test with asymmetric price response of private labels and the manufacturer brand, let us denote the retail price vector of insiders by (p_i), which can be decomposed into the inside manufacturer brand and the inside private labels: (p_{mb}, p_{pl}). Similarly, $w_i = w_{mb}$ describes the vector of insider wholesale prices, and $\bar{w}_{mb}$ denotes the case when insider wholesale prices are held fixed. As the outside products in our case are always private labels, there are no products with wholesale prices w_o outside the candidate relevant market. We assume that outsiders' prices $\bar{p}_o$ fixed and do not react.

The SSNIP test in linear pricing models implies raising the wholesale price of the manufacturer brand's products $\bar{w}_{mb}$ by 10% and estimating the optimal price response private labels inside the potential relevant market (p^*_{mb}, p^*_{pl}). Let us consider a change in the equilibrium system after a change of the insiders' wholesale prices, which is obtained by the minimization of a Euclidean norm $||\ .\ ||$ in $\mathbb{R}^J$ (see Bonnet et al. 2013):

$$\min_{(p^*_{pl}, p^*_{mb})} ||p^*(p^*_{mb}, p^*_{pl}, \bar{w}_{mb}) - \Gamma^*(p^*_{pl}, p^*_{mb}, \bar{w}_{mb}) - \gamma^*(p^*_{pl}, p^*_{mb}, \bar{w}_{mb}) - C||. \tag{14}$$

For the simulation of profits in the case of resale price maintenance, it is the insiders' retail price that is being raised, and thus the minimization problem becomes:

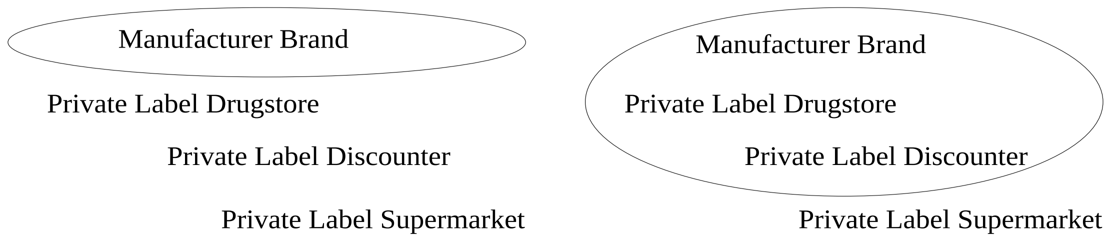
$$\min_{(p^*_{pl})} ||p^*(\bar{p}_{mb}, p^*_{pl}) - [\Gamma^* + \gamma^*](\bar{p}_{mb}, p^*_{pl}) - C|| \tag{15}$$

where $\bar{p}_{mb}$ denotes that retail prices are directly changed by the regulator. It seems evident from this equation that we explicitly consider asymmetries between the manufacturer brand and the private labels. The reason is that the amount by which retailers increase their prices depends on the best-response function to the 10% price increase on the manufacturer's products. This mechanism is methodologically equivalent to the umbrella effects in a merger analysis.

According to the simple economic intuition of the Bertrand-Nash pricing game, we expect this best response to be less than the monetary value of the manufacturer price increase. Imposing a uniform price increase on all products inside the candidate market, as opposed to an incomplete asymmetric price response from private labels, will lead to larger market definition outcomes. The underlying economic intuition is a higher market share loss associated with increasing average prices of products inside the candidate market. Higher market share losses imply that the profitability threshold increases, and more products need to be added to make the hypothetical price increase profitable.

A.5 Figures and Tables

Figure A1: Market Definition with Asymmetric Price Responses of Private Labels



(a) Model 11: RPM ($w = \mu$)

(b) Model 10: RPM ($p = w + c$)

Notes: This figure graphically illustrates the market definition outcomes when loosening the assumption of uniform pricing of products inside the relevant market. Table A5's columns (4) and (5) provide the quantitative results. RPM is the abbreviation for resale price maintenance.

Table A1: First-stage Regression Results

Price	Coefficient	Std. Err.	t-Value
Diesel Prices	0.01	0.01	1.85
Number of Products*MB	0.11	0.06	2.04
Number of Products*PL	0.15	0.03	4.56
R^2			90.91%
Excluded Instruments' F-statistic	$F(3, 1749)$		11.91
Observations			1,770

This table reports the first stage results. Prices are regressed on exogenous variables from the second stage and on instruments. Instruments are a cost-shifter for diesel and a proxy variable for competition allowing for heterogeneous effects of the manufacturer brand (MB) and the private labels (PL). The partial F-statistic of 11.91 indicates that the excluded instruments are not weak in the sense of Staiger and Stock (1997). All specifications include fixed effects for brands, retailers, and package sizes.

Table A2: Aggregated Own- and Cross-price Elasticities

	MB Disc	MB Drug	MB Sup	PL Disc	PL Drug	PL Sup
MB Disc	-7.62	1.04	0.61	0.30	0.46	0.19
	(0.30)	(0.15)	(0.10)	(0.05)	(0.06)	(0.02)
MB Drug	2.27	-4.03	2.44	1.25	1.93	0.78
	(0.38)	(0.62)	(0.41)	(0.21)	(0.26)	(0.09)
MB Sup	3.28	5.95	-5.02	1.78	2.74	1.12
	(0.55)	(0.85)	(0.69)	(0.29)	(0.37)	(0.13)
PL Disc	0.34	0.62	0.35	-4.80	2.69	1.09
	(0.09)	(0.16)	(0.10)	(0.24)	(0.17)	(0.06)
PL Drug	0.38	0.69	0.40	1.97	-3.78	1.22
	(0.10)	(0.18)	(0.11)	(0.15)	(0.22)	(0.07)
PL Sup	0.25	0.44	0.26	1.26	1.92	-6.04
	(0.06)	(0.11)	(0.07)	(0.09)	(0.12)	(0.19)

The table provides the own- and cross-price elasticities aggregated to the label type-format level. Standard errors (in parentheses) are constructed via bootstrap with 100 draws from the estimated asymptotic normal distribution of the parameters.

Table A3: Rivers-Vuong Test

H1 \ H2	2	3	4	5	6	7	8	9	10	11
1	15.42 (2.67)	11.78 (1.40)	13.72 (1.20)	7.02 (0.58)	14.76 (1.19)	11.13 (1.88)	5.84 (0.42)	20.58 (3.83)	14.81 (1.48)	-18.08 (3.23)
2		11.74 (1.39)	13.48 (1.18)	7.02 (0.58)	14.73 (1.18)	11.09 (1.87)	5.83 (0.42)	12.35 (2.02)	-8.25 (1.38)	-17.78 (3.36)
3			-11.00 (1.26)	4.88 (0.57)	10.02 (0.80)	-3.92 (1.04)	3.86 (0.37)	-11.72 (1.39)	-11.77 (1.40)	-11.89 (1.42)
4				6.91 (0.57)	14.21 (1.14)	10.30 (1.73)	5.79 (0.41)	-13.03 (1.15)	-13.55 (1.17)	-14.33 (1.26)
5					-4.43 (0.53)	-6.49 (0.53)	3.43 (0.41)	-7.00 (0.58)	-7.01 (0.58)	-7.04 (0.58)
6						-10.74 (0.93)	3.57 (0.42)	-14.71 (1.18)	-14.74 (1.19)	-14.84 (1.87)
7							5.51 (0.39)	-11.05 (1.86)	-11.10 (1.87)	-11.23 (1.90)
8								-5.82 (0.41)	-5.83 (0.41)	-5.84 (0.42)
9									-15.96 (3.37)	-19.23 (3.70)
10										-20.61 (3.67)

We implement the test for a size of $\alpha = 0.05$, where model v is presented in the columns and model v' in the rows. The null hypothesis that model v is asymptotically equivalent to v' is not rejected if $-1.64 < T_n < 1.64$. The null is rejected in favor of the assumption that model v is asymptotically better than model v' if $T_n < -1.64$. The Rivers-Vuong test is based on cost estimates identifying restrictions. The marginal cost function includes product-specific constants and time-fixed effects. As cost-shifters and marginal cost variables, we use diesel price index, paper index, and plastic index, each interacted with the label type. We also add a variable measuring the number of diapers inside a package interacted with the fixed effects for retail format. Standard Errors are computed with 100 bootstrap replications. See Rivers and Vuong (2002) and Bonnet and Dubois (2010) for more details.

Table A4: SSNIP Test. Simulation Exercise

	(1) Model 11	(2) Model 10	(3) Model 1	(4) Model 1
	RPM $w = \mu$	RPM $(p = w + c)$	Linear Pricing	Linear Pricing
Pass-through Rates Φ (in %)	100.00	100.00	67.55	100.00
	(-)	(-)	(0.20)	(-)
Profit Change				
Manufacturer Brand	-3.56	-4.02	2.74	-2.62
	(0.37)	(0.36)	(0.18)	(0.26)
... + Private Label Drugstore	-1.65	-2.30	3.44	-0.87
	(0.30)	(0.30)	(0.15)	(0.22)
... + Private Label Discounter	0.59	-0.17	4.51	1.20
	(0.23)	(0.24)	(0.11)	(0.16)
All Products	2.01	1.17	5.27	3.51
	(0.19)	(0.20)	(0.09)	(0.13)

The table reports the SSNIP results from the simulation exercise based on prices, marginal costs, and profit margins presented in Table 6's columns (1)–(3). The pass-through rate Φ indicates the percentage retail price change after a 10% wholesale price increase (cf. equation 10). The model of column (4) is the same as in column (3), but we increase the pass-through rate to 100%. Private label prices are raised by 10% in all cases. Standard errors (in parentheses) are constructed via bootstrap with 100 draws from the estimated asymptotic normal distribution of the parameters.

Table A5: SSNIP Test. Misspecification Excercise and Asymmetric Private Label Prices

	(1) Model 10	(2) Model 1	(3) Model 1	(4) Model 11	(5) Model 10
	RPM $p = w + c$	Linear Pricing	Linear Pricing	RPM $w = \mu$	RPM $p = w + c$
Pass-through Rates Φ (in %)	100.00	64.07	100.00	100.00	100.00
	(-)	(0.33)	(-)	(-)	(-)
$\Delta p_{pl}/\Delta p_{mb}$	100.00	100.00	100.00	78.05	85.29
	(-)	(-)	(-)	(0.66)	(0.20)
Profit Change					
Manufacturer Brand	-1.61	3.94	-6.41	-0.07	-1.84
	(0.32)	(0.19)	(0.43)	(0.54)	(0.31)
... + Private Label Drugstore	-0.18	4.30	(-5.17)	1.22	-0.45
	(0.26)	(0.15)	(0.39)	(0.46)	(0.26)
... + Private Label Discounter	1.74	5.20	-2.11	2.81	1.31
	(0.20)	(0.12)	(0.30)	(0.35)	(0.21)
All Products	2.98	5.82	(0.11)	3.82	2.42
	(0.16)	(0.09)	(0.23)	(0.28)	(0.17)

The table's SSNIP market definition outcomes can be split into two sets. The first set of results in columns (1)–(3) stems from the misspecification exercise based on prices, marginal costs, and profit margins presented in Table 6's columns (4) and (3). The pass-through rate Φ indicates the percentage retail price change of branded products after a 10% wholesale price increase (cf. equation 10). The model of column (3) is the same as in column (2), but we increase the pass-through rate to 100%. The second set of results are presented in columns (4) and (5). Here we allow for asymmetric private label price responses based on the simulation programs summarized by equations 14 and 15. $\Delta p_{pl}/\Delta p_{mb}$ reports the percentage change in private label prices in response to a 10% price increase of branded products. Standard errors (in parentheses) are constructed via bootstrap with 100 draws from the estimated asymptotic normal distribution of the parameters.

Table A6: SSNIP Test. Robustness Check for Model 11: RPM with $w = \mu$

	-20% Outside Good	$\|Utility\| \times$ 1.2	$\|Utility\| \times$ 0.8	No Loyalty
Manufacturer Brand	-1.96	-3.87	-3.62	-1.87
	(0.37)	(0.35)	(0.39)	(0.28)
... with PL from DRUG	-0.21	-1.36	-2.79	-0.69
	(0.30)	(0.29)	(0.30)	(0.22)
... with PL from DRUG+DISC	1.92	1.33	-0.18	0.04
	(0.22)	(0.23)	(0.22)	(0.17)
ALL	3.29	3.07	1.00	0.84
	(0.18)	(0.20)	(0.17)	(0.14)

Standard errors (in parentheses) are constructed via bootstrap with 100 draws from the estimated asymptotic normal distribution of the parameters.