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Abstract

We examine the extent to which vertical and horizontal market structure can together explain incomplete retail pass-through. To answer this question, we use scanner data from a large U.S. retailer to estimate product level pass-through for three different vertical structures: national brands, private label goods not manufactured by the retailer and private label goods manufactured by the retailer. Our findings emphasize that accounting for the interaction of vertical and horizontal structure is important in understanding how market structure affects pass-through, as a reduction in double-marginalization can raise pass-through directly but can also reduce it indirectly by increasing market share.

JEL classification: E30, E31, L11, L16
Bank classification: Inflation and prices; Transmission of monetary policy

Résumé

Les auteurs s'interrogent sur la mesure dans laquelle la structure verticale d'un marché et sa structure horizontale peuvent ensemble expliquer la transmission incomplète des coûts aux prix de détail. Pour répondre à cette question, ils estiment, à l'aide de données provenant d'un important détaillant américain recueillies par balayage optique, le degré de transmission des coûts selon les produits, pour trois structures verticales différentes : marques nationales, marques de distributeur non fabriquées par le détaillant et marques de distributeur fabriquées par lui. D'après les résultats de l'étude, il faut tenir compte de l'interaction des structures verticale et horizontale si l'on veut comprendre comment la structure d'un marché influe sur le degré de répercussion des coûts, du fait que la réduction de la double marginalisation peut aussi bien faire augmenter directement ce degré que le faire diminuer indirectement par l'élargissement des parts de marché.

Classification JEL : E30, E31, L11, L16
Classification de la Banque : Inflation et prix; Transmission de la politique monétaire

1. Introduction

Understanding pass-through – the transmission of costs to prices – is critical to closed and open economy macroeconomics, with implications for inflation and the real effects of monetary policy, exchange rate shocks, and shocks to individual cost components like wages and commodity prices. A large and growing literature decomposes the sources of incomplete pass-through into local non-traded costs, menu costs, and market power/markup adjustment (Goldberg and Hellerstein (2011), Nakamura and Zerom (2010)) or into individual retail and wholesale components (Gopinath et al. (2011), Nakamura (2008)). A separate literature has focused on explaining *variation* in pass-through across products and markets due to different market structure. Some studies analyze horizontal market structure, relating markups and pricing power to product market shares (Atkeson and Burstein (2008), Berman et al. (2011), Auer and Schoenle (2012)) and find that firms and products with larger market shares have lower cost pass-through. Others have analyzed vertical market structure – particularly the differences between arm's-length and intra-firm international trade transactions – finding that intra-firm prices seem to exhibit greater flexibility and higher rates of cost pass-through, consistent with a model where greater vertical integration leads to intermediate good pricing closer to marginal cost, reducing or eliminating the variable markups that can act as a buffer between costs an prices to diminish pass-through (Bernard et al. (2006), Neiman (2010), Neiman (2011), Hellerstein and Villas-Boas (2010)).

In this paper we contribute to these three literatures by examining cost pass-through for a large American supermarket chain. We estimate product level pass-through rates for thousands of products in over a hundred categories and assess how these pass-through rates vary with vertical structure and horizontal structure (product/firm market share) for narrowly defined products. Our analysis extends to two levels of cost pass-through – commodity prices to wholesale prices, and wholesale prices to retail prices – and three different vertical structures – national brands, private labels manufactured by other firms and private labels manufactured directly by the retail chain. These three structures can be thought of as representing decreasing degrees of double-marginalization and increasing control of the value chain from the retailer's point of view. National brand manufacturers charge a markup over the marginal costs of physical production as well as associated services like marketing and distribution, external manufacturers of private labels charge a markup over physical production, and the retailer sets the wholesale price of the private labels it manufactures directly equal to marginal cost. We develop a simple model that combined with our empirical analysis highlights the interactions between horizontal and vertical structure and their effects on different stages of cost pass-through. The interactions we uncover between horizontal and vertical market structure are novel to the pass-through literature and shed a new light on the recent decline in exchange rate pass-through for industrialized and emerging-market countries (Bailliu and

Bouakez (2004), Gagnon and Ihrig (2002), Frankel et al. (2005)) – while a rise of intra-firm transactions in international trade would seem to predict an increase in exchange-rate pass-through given a direct effect of reducing double-marginalization, if this rise accompanied (and was the product of) growing dominance by large multinationals it would have the opposite effect.[1]

Our main findings are consistent with much of the previous literature. For vertical market structure, we find that greater control of the value chain by the retailer results in higher commodity price pass-through into retail prices, which is consistent with a reduction in double-marginalization – commodity price to retail price pass-through over a 12 month horizon is 40% higher for retail manufactured goods and 10% higher for private label goods not manufactured by the retailer, compared to national brands in the same narrow product category. We also find a sizeable effect of horizontal market structure, as products and brands with larger market shares have lower cost pass-through, consistent with greater pricing power and higher markups. Horizontal and vertical market structure interactions are important, as vertical-integration that lowers prices and reduces double-marginalization, which raises pass-through, also typically increases market share, which lowers pass-through. Doubling the product (firm) market share within a narrow category reduces pass-through by 73% (38%). We find that on average the net effect of these two forces is an increase in pass-through for the private label products, but that, consistent with our model, the vertical-integration effect is much larger when we control for product and brand market shares – pass-through for retailer manufactured products is 40% higher than for national brands conditional on market share versus 30% unconditionally. We show that while horizontal structure has a similar effect on both the commodity-wholesale and wholesale-retail pass-through, the effect of vertical structure is more subtle. Most of the increase in pass-through from greater retail control of the value chain occurs at the commodity-wholesale level, with wholesale to retail pass-through typically decreasing in the retailer share of the value chain. This is consistent with the theory provided private label brands have lower wholesale prices and/or higher additional retail marginal cost, both of which are plausible (and the former verifiable with our data).

Our focus on cost pass-through in a domestic retail context is important for several reasons. First, in many countries such as the United States the majority of products consumed, the majority of products that make up the CPI, and the majority of product market competition comes from domestic sources. A focus on multi-product grocery retail highlights the ubiquity of double-marginalization and its potential interactions with market power to generate incomplete pass-through of cost shocks. Second, while some of the academic literature treats retailers as having little market power and therefore as unlikely to be a source of

[1] Intra-firm trade has been relatively stable in the US over the last decade but rising in Japan. Unfortunately there is no historical data on aggregate US intra-firm trade going further back.

variable markups, consolidation and entry of big box retailers into the supermarket industry has led to rising concentration at the retail level with implications for pricing behavior. Villas-Boas (2007) shows that for yogurt, prices behave "as if" wholesalers set prices equal to marginal costs and retailers had all of the pricing power, consistent with high bargaining power for retailers or non-linear pricing by the manufacturers that avoids the profit-reducing effects of double-marginalization. Thus our findings relate to a broader question of whether retail market power is important for generating incomplete pass-through and whether bargaining and non-marginal cost pricing schemes are able to reduce or eliminate the effects of double-marginalization on pass-through in this context. Third, a likely consequence of retail consolidation and concentration in the United States has been a steady growth in private labels, which now make up about 20% of national grocery sales and a similar share for our retailer. In Europe the private label share is over 35% and in Britain over 50%.[2] As private labels are often perceived as lower quality and/or better value relative to national brands, the recent growth of private label revenue during the Great Recession (Figure 1) also highlights the potential for cyclical shifts in the composition of groceries between national brands and private labels. Whether trend and cyclical shifts in private label shares matter for cost pass-through is an open question that we address with our data.

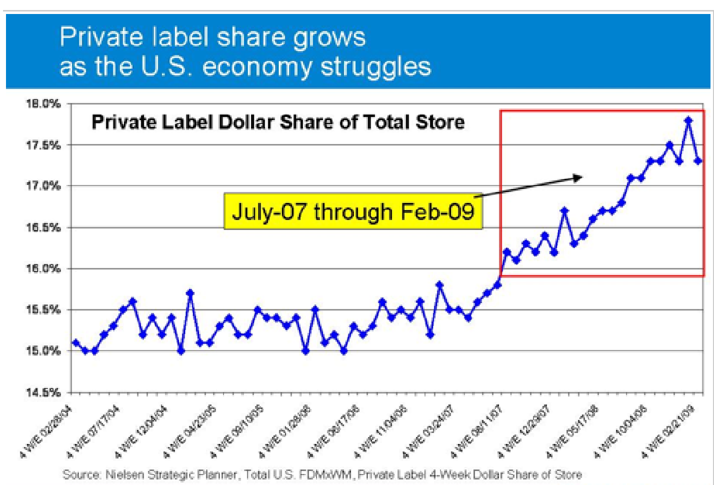


Figure 1: Share of private label goods over the years

Source: AC Nielsen Strategic Planner

Most of the recent literature analyzing the effect of market structure on pass-through has used trade micro data. Auer and Schoenle (2012) and Neiman (2010) use BLS trade micro data to estimate pass-through differences based on differences in horizontal and vertical market

[2]See IRISymphony "Retail Private Label Brands in Europe: Current and Emerging Trends" at: http://www.symphonyiri.eu/Insights/EuropeanWhitepapers/tabid/262/Default.aspx

structure respectively while Berman et al. (2011) use French export data.[3] Compared to this literature, our setting has several advantages. We have a precise measure of vertical structure compared to the self-reported intra-firm status of transactions in the BLS data[4] and our ability to identify private labels that are and are not manufactured by the retailer gives us an effective "continuum" in the degree of double-marginalization. A general issue in the trade literature is whether the reported intra-firm prices are really allocative "transaction" prices or rather tax-avoidance and accounting fictions (as suggested by Bernard et al. (2006) and Clausing (2003)) – while the BLS classifies intra-firm transactions into market-based, cost-based, other non-market based and unknown pricing methods, the precise definition of "price" is just as problematic as the definition of "intra-firm" for the trade data. While the wholesale prices for retailer manufactured goods recorded in our data may suffer from a similar problem (despite a lesser role for transfer pricing in a domestic context), we are able to examine pass-through from one allocative price to another (commodity to retail) and to examine wholesale prices of externally-manufactured private labels that represent a lesser degree of double-marginalization than national brands while still being allocative. Our data also enables us to directly measure market shares at the product and firm level, which is impossible in many of the trade micro data sets that do not record quantities and firm identities – this is critical both for direct measurement of the effects of market shares on pass-through and our analysis of the interaction between horizontal and vertical market structure. Finally, our products are precisely defined (unique Universal Product Codes) and we can classify them into competitive segments at a fairly broad level (product categories, e.g. yogurt, milk, flavored milk) and a very precise level (subsubclasses, e.g. 32 ounce mainstream white whole milk, 64 ounce 2% reduced fat organic milk).

Our study also relates to a large literature studying the determinants of retail and wholesale pass-through in a domestic context. Several studies have looked as pass-through from wholesale to retail prices (Gopinath et al. (2011), Nakamura (2008), Eichenbaum et al. (2011)), commodity prices to retail prices (Berck et al. (2009)), and commodity, wholesale and retail prices combined (Nakamura and Zerom (2010) for coffee, Goldberg and Hellerstein (2011) for beer). We build on this literature by considering both commodity to wholesale and wholesale to retail pass-through for a large number of products and categories and linking pass-through rates to different horizontal and vertical structures. Our focus on private labels as a source of different vertical retailer-manufacturer interactions in pricing adds another di-

[3]Other papers that use BLS trade micro data to study the determinants of pass-through include Gopinath and Rigobon (2008) who present general facts on pricing, Gopinath and Itskhoki (2010) who look at the relationship between price change frequency and long-run pass-through, Gopinath et al. (2010) who look at the effects of currency of pricing on pass-through, and Nakamura and Steinsson (2012) and Gagnon et al. (2011) who look at measurement of pass-through in the presence of product replacement bias.

[4]Gopinath and Rigobon (2008) suggest that firms probably use the Bureau of Economic Analysis definition which is a 10% ownership share.

mension to structural (Villas-Boas and Hellerstein (2006), Villas-Boas (2007),Villas-Boas and Zhao (2005), Kadiyali et al. (2000), Sudhir (2001)) and reduced form (Hastings (2004), Chevalier et al. (2003)) analysis of retailer pricing power and vertical relationships in retail. Hoch and Banerji (1993), Raju et al. (1995), Batra and Sinha (2000), Chintagunta et al. (2002) and Chintagunta and Bonfrer (2004) analyze the effect of private label introduction on strategic retailer-manufacturer interactions, focusing on the effect of private label introduction on the levels of market share, prices, markups and profits going to manufacturers and retailers. Our paper differs by analyzing the differential pass-through of commodity and commodity prices into retail prices of national brands and private labels that are manufactured or not manufactured by the retailer. We take as given the presence of store brands and do not analyze the effect of product entry (by private label or national brands) on the distribution of prices, markups and profits.

Balanced against these contributions, our study has several limitations. First, the time-series dimension of our data is relatively short (41 months) so our focus is on pass-through at modest durations (up to one year). Second, while the product dimension is very large, our results only apply to a single retailer. Third, we do not have complete data on the cost structure and do not attempt structural estimation of markups and marginal costs for thousands of products across a hundred categories, so differences in non-commodity marginal costs may drive some of our results despite our best attempts to control for product-level heterogeneity.

Our paper proceeds as follows. Section 2 presents a model that links horizontal and vertical structure to cost pass-through and encompasses both retailer-manufactured and externally-manufactured private labels to motivate our analysis. Section 3 describes the data. Section 4 presents our main empirical findings on pass-through and the frequency of price changes. Section 5 discusses the macro implications of our findings. Section 6 concludes.

2. Model

2.1. Basic setup

We consider a partial equilibrium model based on the insights of Dornbusch (1987) where large firms face CES demand for their product i and there is an outside good (interpreted either as competitors in the same market segment, or expenditures on other goods entirely) denoted z. Consumer utility is given by

$$C = \left(c_i^{\frac{\eta-1}{\eta}} + z^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{1}$$

This gives the standard cost-of-living index $P = \left(p_i^{1-\eta} + p_z^{1-\eta}\right)^{\frac{1}{1-\eta}}$. The price of z is taken as fixed for now.

Retailers in the model take their marginal cost as given. Retailers set the price for brand i as a markup over marginal cost of brand i following the conventional formula. We denote the wholesale cost paid by retailer i as w_i and we allow for an additional marginal cost of retailing θ_i^r. This additional cost is meant to capture the marginal costs of distribution (between receiving warehouses and retail stores, except in the cases of direct-store-delivery by manufacturers), holding inventory, advertising, along with standard inputs like land, capital, labor, and energy inputs. Although some of these costs can be thought of as fixed costs, at least in the short-run, many of them have at least a small marginal cost component. These additional marginal costs imply that even absent any market power or markup over marginal costs, the pass-through from wholesale to retail prices may be less than complete.

Formally, retailer i's price-setting rule is the standard markup over marginal cost based on the elasticity of demand ϵ_i,

$$p_i = \frac{\epsilon_i}{\epsilon_i - 1}(w_i + \theta_i^r). \tag{2}$$

The retailer of brand i takes p_z and the price of the other brand as given when setting the price (our earlier assumption), but takes account of the effect of its own price p_i on the overall price index P. This implies an elasticity of demand formula

$$-\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i} = \epsilon_i = (\eta(1 - S_i) + S_i) \tag{3}$$

where S_i is the market share of brand i. Small retailers with no market power face a demand elasticity equal to the elasticity of substitution parameter η (with $\eta > 1$ by assumption) while larger retailers with $S_i > 0$ have market power – they face a lower demand elasticity because raising their prices also raises the aggregate price index P and hence their demand falls more slowly in their own price. Brands with high market share have higher retail markups in this model.

Manufacturers set the wholesale price taking into account their own demand curve and elasticity, which depend indirectly on retail markups and pricing decisions. The final demand function is $q_i = \frac{p_i^{-\eta}}{P^{1-\eta}}Y$ where p is the retail prices and Y is total spending by consumers on product i and z. Manufacturer i has marginal cost $c + \theta_i^m$ where c is the price of commodity inputs and θ_i^m represents other marginal costs of the firm, and sets the wholesale price w_i such that $w_i = \frac{\mu_i}{\mu_i - 1}(c + \theta_i^m)$. The elasticity of demand facing manufacturers is given by

$$\mu = -\frac{\partial q_i}{\partial w_i}\frac{w_i}{q_i} = \left(\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i}\right)\left(\frac{\partial p_i}{\partial w_i}\frac{w_i}{p_i}\right) \tag{4}$$

The first part of this expression is just the demand elasticity (with respect to retail price) given by ϵ_i while the second part reflects the pass-through from wholesale to retail prices, i.e. the percent change in retail price p due to a percent change in the wholesale price w. The pass-through coefficient is given by

$$\frac{\partial p_i}{\partial w_i}\frac{w_i}{p_i} = \left(\frac{1}{1+\frac{\partial \epsilon_i}{\partial p_i}\frac{p_i}{\epsilon_i}\frac{1}{(\epsilon-1)}}\right)\frac{w_i}{w_i+\theta_i^r} = \left(\frac{\eta(1-S_i)+S_i}{\eta}\right)\frac{w_i}{w_i+\theta_i^r} \tag{5}$$

The first equality in the equation above holds for any demand system and shows how pass-through depends critically on the price elasticity of a price elasticity ($\frac{\partial \epsilon_i}{\partial p_i}\frac{p_i}{\epsilon_i}$) – sometimes called a markup elasticity or "super-elasticity" in the literature – as well as the marginal cost share of the "cost" being passed through ($\frac{w_i}{w_i+\theta_i^r}$). The second equality is specific to our setup (CES with large firms and price competition). Observe that pass-through from wholesale to retail prices in the model is incomplete (< 1) unless $\theta_i^r = 0$ and $S_i = 0$, i.e. there are no additional marginal costs and the firm has no market power and does not charge a markup over marginal cost. Pass-through for firm i is unambiguously decreasing in the market share of product i, S_i.

Based on equation 4, manufacturers face a lower demand elasticity than retailers ($\mu_i < \epsilon_i$) unless there is no market power and complete pass-through. The intuition for this result is that an increase in wholesale price leads to some reduction in the retail markup and is not fully passed-through to consumers in the retail prices – this makes quantity purchased less elastic to changes in wholesale prices than retail prices. This will also typically imply that pass-through from manufacturing cost to wholesale price will be lower than from wholesale cost to retail price, although this depends on the size of additional marginal cost components in retail.

With both retailers and manufacturing firms following their respective pricing rules and taking the prices of their competitors as given, the equilibrium retail price is

$$p_i = \frac{\epsilon_i}{\epsilon_i - 1}\left(\theta_i^r + \frac{\mu_i}{\mu_i - 1}[c + \theta_i^m]\right) \tag{6}$$

Combined with the retail demand functions, the system of equations for retail and wholesale prices has a unique equilibrium but no closed-form solution.

Equation 6 makes it clear that retail and manufacturer markups over marginal cost give rise to double marginalization. While incomplete pass-through in this model comes from the horizontal market structure – some firms are large enough to internalize their pricing decisions on the aggregate price index – double marginalization increases this effect as pass-through is incomplete at both the wholesale and retail levels.

Suppose that retailing and manufacturing firm i were to vertically integrate. This would imply a pricing rule given by

$$p_i^{VI} = \frac{\epsilon^{VI}}{\epsilon^{VI}-1}[c+\theta_i^r+\theta_i^m] \tag{7}$$

which eliminates the double marginalization in equation 6. This will result in lower retail prices and larger total profits:

$$\frac{1}{\epsilon^{VI}-1}[c+\theta_i^r+\theta_i^m]q_i^{VI} = \pi^{VI} > \pi^r+\pi^m = \left(\frac{1}{\epsilon-1}\left[\theta_i^r+\frac{\mu}{\mu-1}(\theta_i^m+c)\right]+\frac{1}{\mu-1}[c+\theta_i^m]\right)q_i \tag{8}$$

Although under vertical integration the total markup per unit sold is lower, the larger volume sold ($q_i^{VI} > q_i$) results in higher profits. This illustrates how double marginalization in this setup can lead to a deadweight loss with higher than optimal prices and lower consumer and producer surplus relative to a vertically integrated firm.

While the implications of vertical integration for pricing and profits are unambiguous, the implications for pass-through in this model are ambiguous. Commodity pass-through ($\frac{\partial p}{\partial c}\frac{c}{p}$) under vertical integration is given by

$$\left(\frac{\eta(1-S_i^{VI})+S_i^{VI}}{\eta}\right)\frac{c}{c+\theta_i^m+\theta_i^r} \tag{9}$$

while under arm's-length pricing the pass-through is

$$\underbrace{\left(\frac{\eta(1-S_i)+S_i}{\eta}\right)\frac{w_i}{w_i+\theta_i^r}}_{retail}\underbrace{\left(\frac{1}{1+\frac{\partial\mu_i}{\partial w_i}\frac{w_i}{\mu_i}\frac{1}{(\mu-1)}}\right)\frac{c}{c+\theta_i^m}}_{wholesale} = \left(\frac{\frac{\eta(1-S_i)+S_i}{\eta}}{1+\frac{\partial\mu_i}{\partial w_i}\frac{w_i}{\mu_i}\frac{1}{(\mu-1)}}\right)\frac{c}{c+\theta_i^m+\frac{\epsilon_i-1}{\epsilon_i}\theta_i^r} \tag{10}$$

The expression for arm's length pricing emphasizes four implications of the theory that guide our analysis. First, holding market share constant the presence of double-marginalization and doubly-incomplete pass-through reduces pass-through – the denominator $1+\frac{\partial\mu_i}{\partial w_i}\frac{w_i}{\mu_i}\frac{1}{(\mu-1)}$ in the arm's-length commodity price pass-through that arises due to incomplete pass-through of commodity prices to wholesale prices is strictly positive. We call this the "vertical" effect of vertical integration. Second, because vertical integration lowers prices and raises market shares ($S_i^{VI} > S_i$), vertical integration could also lead to lower pass-through than arm's-length pricing. We call this the "horizontal" effect of vertical integration. The overall effect of vertical integration on pass-through is then ambiguous and depends critically on the other model parameters. Simulations show that when η is low enough (implying large markups at retail and wholesale level) the increase in market share under vertical integration dominates the direct effect of removing incomplete commodity to wholesale price pass-through.

Although the overall effect is ambiguous unconditionally, the model implies that conditional on market share vertical integration should always lead to higher pass-through, and including market share as a control should increase the estimated effect of vertical integration on pass-through. Third, the greater the share of marginal costs born by the retailer relative to the manufacturer (e.g. the larger θ_i^r relative to θ_i^m) the greater the commodity price pass-through under arm's-length pricing. Mathematically this is reflected in the $\frac{\epsilon_i-1}{\epsilon_i}$ term that multiplies θ_i^r but not θ_i^m in the expression above; intuitively, this effect is because manufacturer "local" costs are subject to two markups while the retailer "local" costs are only subject to a single markup. To the extent that costs related to distribution and marketing are born by retailers, total markups and retail prices will be lower and pass-through will be higher. This channel reflects the ability of retailers to capture part of the gains from vertical-integration through private label goods that are manufactured externally – unlike the case of full vertical integration of manufacturing and retail, the manufacturers still charge a markup, but the markup is over a smaller share of the total marginal cost because the retailer takes over a larger share of costs related to marketing and distribution. Fourth, even when pass-through from commodity prices to retail prices is higher for private labels than national brands, pass-through from wholesale to retail prices may not be higher for two reasons: w_i for private labels may be lower conditional on market share, and θ_i^r may be higher for private labels conditional on market share (reflecting the shifting of distribution and marketing costs from manufacturer to retailer).

2.1.1. Multiple products and firms

We focus on the simplest partial equilibrium model since our goal is mainly to motivate the empirical analysis and provide intuition for the results. However the general insights are robust to other types of market interactions, and we briefly consider the role of multi-product firms and competition with multiple large firms instead of an outside good.

The main feature of the Dornbusch (1987) model is that large firms internalize the effects of their price-setting on the aggregate price index, which results in higher prices than in a setting where the aggregate price index is taken as fixed. When a firm sells multiple products, which is standard for both retailers and manufacturers in the food and non-durable sectors, raising the price on one product generates an externality on the demand for all other products – multi-product firms that internalize this demand externality will therefore set even higher optimal prices than single product firms and those that do not internalize the demand externality. Thus the products of a multi-product firm effectively face less competition than if they were produced by a single-product firm, resulting in higher markups and prices. Note that a major implication of this pricing model is that while the market share of an individual product matters, the market share of that firm's entire competing product line also matters, so that "market power" and pricing depend on both product and firm level market shares. In our setting multi-product manufacturers are dominant (including the retailer's private label division) so this is an important channel of market power on cost pass-through. We take this insight to the data in our empirical analysis and find that "brand" market share (defined as the market share of all products produced by the same firm within a given market segment) is just as important as product market share for determining pass-through. Note that multi-product retail is also potentially important for the pass-through measures we consider but we lack data on other retailers so cannot test whether local retail market share matters for retail pass-through.

Expanding our model to multiple firms is fairly straightforward but requires additional assumptions about the nature of the competitive equilibrium (price or quantity) and the presence of an outside good. Idiosyncratic cost shocks to single firms and products have a straightforward interpretation in terms of our model and in fact the distribution of other firms in the aggregated z sector is irrelevant to our main results here. Where the distribution of market shares of other firms and the outside good matter is for common cost shocks like a commodity or raw material cost shock. Absent an outside good and other marginal costs (e.g. θ^r and θ^m), prices are homogeneous of degree one (and market shares homogeneous of degree zero) in a common cost shock, regardless of the distribution of market shares and the degree of vertical integration of individual firms. The presence of other marginal costs can overturn this result even when the total cost ($c + \theta^m + \theta^r$) is the same across firms, because there can be differential pass-through for common-cost shocks. This differential pass-through ultimately depends on the share of the cost components that are subject to a markup for each firm, which given different market shares and degrees of retail integration can generate differential pass-through for a common shock – intuitively, markups/market share have to adjust to restore equilibrium in this case (see the last term in equation (10)). In the absence of an outside option, this leads to counter-intuitive results – for example, a common cost shock could lead to higher pass-through for firms with larger initial market shares, who consequently lose market share to the firms with lower initial market shares.[5] However, with even a modest outside option (an alternative option for spending that is not affected by the common shock) our simulations of the model typically find that the pattern of common cost pass-through mirrors the pattern of idiosyncratic cost pass-through.

[5]This is because the larger market share firms have a higher marked-up commodity cost share, e.g. $\frac{\frac{\epsilon}{\epsilon-1}\frac{\mu}{\mu-1}c}{p}$ is higher for firms with more market power (lower ϵ). Consequently in equilibrium these firms must have higher price increases, lower markups and lower market shares.

2.2. Choice of vertical structure

While there is a large literature on the boundaries of the firm and vertical relationships, in our context it seems clear that many of the predominant themes – contractability, moral hazard, and hold-up problems – are unlikely to be applicable. The typical product category in our data set features several national brands and either no private labels, private labels manufactured directly by the retailer and private labels that are manufactured by third parties. The decision of the retailer about which categories to enter (and how) is difficult to relate to these types of considerations. Instead, we believe that the most important factors governing the retailer's decision are the volume/scale of consumption in the product category as well as the extent of double-marginalization (inversely related to η, the CES elasticity of substitution parameter).

The importance of scale for vertical-integration relates to the boundary of firms, due to incomplete contracts (Antras (2003)) and heterogeneous firm, industry and country characteristics (Antras and Helpman (2004)). If firms have "core competencies" (in retail or manufacturing), expanding into other areas likely involves additional costs to the firm, relative to sourcing from outside the firm. Many of these costs are likely to have a fixed character, so larger firms will typically undertake a greater variety of tasks within the firm. There is also an important technological dimension related to minimum scales of production – when a retailer undertakes manufacturing of products exclusively destined for its own stores, it must be able to sell a sufficient volume to produce at a minimum of the average cost curve. National brands are able to sell in many stores, so are the naturally efficient producers for products that only sell in small volumes per retailer. By contrast, product categories with high volume in the grocery sector – such as bread and milk – are easier for the retailer to manufacture directly at an efficient scale. Note that the scale factor is likely to be particularly relevant for explaining why some categories feature retailer manufactured versus externally manufactured private labels.

Product categories with low demand elasticities (η) and hence high markups are also choice candidates for vertical integration, as the gains from vertical integration are directly related to the extent of double-marginalization and this depends critically on the final demand elasticities. The lower the demand elasticity and the higher the markup, the more a private label goods that succeeds in lowering prices – either through full vertical integration or transfer of some marginal costs from manufacturer to retailer – will gain market share and the more profitable it will be relative to a national brand. This effect will be bigger under full vertical integration where the benefit applies to the entire marginal cost ($c + \theta^i_m + \theta^i_r$ in the model) than under third-party private label manufacture, since the latter only avoids double marginalization on the (potentially small) share of costs that are transferred from the manufacturer to the retailer.

If we let r denote the share of non-commodity marginal costs ($\theta_m + \theta_r$) paid by the retailer we can order the total retail+manufacturer profits for product i under different vertical structures from highest to lowest, with full vertical-integration (VI):

$$\pi_{VI} = \frac{1}{\epsilon^{VI} - 1}[c + \theta^r + \theta^m]q^{VI} \tag{11}$$

partial integration/third-party manufacture (PI)

$$\begin{aligned}\pi^r_{PI} + \pi^m_{PI} = q^{PI}\{\frac{1}{\epsilon^{PI} - 1}\left[r^{PI}(\theta^r + \theta^m) + \frac{\mu}{\mu - 1}((1 - r^{PI})(\theta^r + \theta^m) + c)\right] \\ + \frac{1}{\mu^{PI} - 1}[c + (1 - r^{PI})(\theta^r + \theta^m)]\}\end{aligned} \tag{12}$$

and national brand (NB)

$$\begin{aligned}\pi^r_{NB} + \pi^m_{NB} = q^{NB}\{\frac{1}{\epsilon^{NB} - 1}\left[r^{NB}(\theta^r + \theta^m) + \frac{\mu}{\mu - 1}((1 - r^{NB})(\theta^r + \theta^m) + c)\right] \\ + \frac{1}{\mu^{NB} - 1}[c + (1 - r^{NB})(\theta^r + \theta^m)]\},\ with\ r^{NB} < r^{PI}\end{aligned} \tag{13}$$

The key to recognizing the scale effects is to note that the q expressions scale up one for one with the size/volume of the category. Combined with a positive fixed cost for partial-integration ($F^{PI} > 0$) and a larger fixed cost for full vertical-integration ($F^{VI} > F^{PI}$) there is a clear sorting pattern with the highest volume product categories being the most integrated, and potentially no private label entry in the smallest product categories. The elasticity effect is orthogonal to the scale effect – it affects the relative profitability (and conditional on entry, market share) of vertical integration, with the lowest elasticity categories providing the largest profit gains for full vertical integration.

Finally, we note that demand for different products may not be identical and exclusively driven by retail prices – advertising and product quality may differ across vertical structures and may potentially generate differences in market shares and markups even if marginal costs are identical. This allows national brands to have larger market shares despite typically charging higher prices than private labels. While private labels also have access to advertising technology, the gains in market share are restricted to gains within the retail chain, whereas national brand advertising and product quality investments can affect the entire national or global market. When these advertising and quality differences require a fixed cost, it is reasonable to think that many national brands with large aggregate volumes (relative to private labels) will engage extensively in this type of demand-boosting activity, allowing them to charge higher prices than private labels while potentially also having larger market shares (or larger than would be expected given their higher prices).

While product quality and advertising are often seen as fixed investments by firms and not as marginal costs, these demand-boosting activities could potentially affect marginal costs (e.g. national brands may potentially have higher non-commodity marginal cost $\theta_i^m + \theta_i^r$). In our empirical analysis, we are not able to directly observe these other marginal cost components. However, controlling for market share is sufficient to deal with heterogeneous demand from marketing/product quality that may confound inference on the effects of vertical integration on commodity pass-through. We also try to control for product heterogeneity as much as possible using the narrowest classifications in our data. However, without complete cost data (or the means to structurally estimate marginal costs for thousands of products and markets), we cannot rule out that the non-commodity marginal costs may differ for national brands, partially-integrated private label brands and fully vertically-integrated private label brands and that this may drive some of the commodity price to retail pass-through results.

2.3. Frequency of price adjustment

Our last theoretical observation draws on Gopinath and Itskhoki (2010) who document the important linkage between cost pass-through and the frequency of price adjustment for import prices. In a static setting with a menu cost (denoted by κ), firms face the decision of whether to deviate from their current price when faced with a cost shock. Firms have a profit-maximizing ideal price $p^*(c)$ that depends on the cost shock c, and a current price p^0 that will be set ex-ante based on the entire expected distribution of cost shocks and the menu cost. After the cost-shock is realized, firms compare

$$\pi(p^*(c), c) - \kappa \; vs. \; \pi(p^0, c) \tag{14}$$

and change their price if the left-hand side exceeds the right-hand side. A key determinant of the gains from changing the price – $\pi(p^*(c), c) - \pi(p^0, c)$ – is the desired pass-through of cost shock c, which effectively determines the optimal price $\pi(p^*(c), c)$. When the pass-through from our model above is very small, firms gain much less from changing their prices in response to a given cost shock – $\pi(p^*(c), c) - \pi(p^0, c)$ will be smaller for any c. This immediately implies the key finding of Gopinath and Itskhoki (2010) that long-term (desired) pass-through should be positively correlated with the frequency of price changes holding menu costs constant. For any given distribution of costs, the fraction of periods in which the firm will prefer to change its price (relative to the current price) is higher for firms with higher desired pass-through, i.e. firms with lower market shares or greater degrees of vertical integration. Although menu costs could potentially vary with horizontal and vertical structure and firms producing similar products might face different distributions of cost shocks, we see no obvious reasons why this would be the case and hence we examine whether our data are consistent with the ancillary prediction of the model for the frequency of price changes.

3. Data Description

3.1. Retailer data

Our retail data set consists of weekly store-level scanner data on the retail prices, wholesale costs, and quantity sold of individual UPCs. The data come from a large retailer and our sample covers operations in 250 stores across 19 states for the weeks between January 2004 and June 2007 (178 weeks total).[6] The data cover virtually all of the goods sold by each store, consisting of 200 product categories that span non-durable goods such as food and beverages, magazines, housekeeping supplies, and personal care products. Products are identified by Universal Product Category (UPC) barcodes that identify unique products but the data provided to us also contains coarser categorizations (including the product category measure mentioned above).[7]

As our goal is to analyze pass-through for similar nationally branded and private label goods, we restrict our attention to categories that contain both of these types of goods and to products that are sold frequently enough to avoid truncation and imputation of missing values. We distinguish private label goods from national brand goods by matching the UPC descriptions in our data with the names of private label brand lines. Within this list of private label goods, we distinguish those that are manufactured by the retailer from those that are branded but not manufactured using information from the manufacturing division web-site. We therefore categorize goods into three types: national brands (NB), private label products that are not manufactured by the retailer ('private label branded') and a private label good that is manufactured by the retailer ('private label manufactured'). Our retailer has a significant private label presence across a wide range of categories, spanning relatively unprocessed goods like meat, seafood and coffee to highly processed goods like cookies and cleaning products. There are 175 categories that contain both private label goods and national brand goods. In addition to excluding certain categories, the other main selection criteria we use is that a product must be sold in at least one store/week every month for the 41 months in the sample period. This excludes a substantial number of UPCs that enter or exit during the sample period as well as those that only appear in a few months of data. When we also exclude categories that have a very low private label presence among the remaining UPCs (below 1% of category revenue) we are left with our main sample of 155 product categories, 20 of which contain at least some retailer manufactured products (including dairy, cookies, soft drinks

[6] The data sharing agreement between this retailer and the research community is managed through the SIEPR-Giannini data center.

[7] For more in-depth description of the data set, see Gopinath et al. (2011), Eichenbaum et al. (2011) and Burstein and Jaimovich (2009).

and bread). Although our sample selection leaves us with only 18,941 out of 63,977 UPCs, this subsample represents over 2/3 of revenue.

Our data contain two measures of retail prices: a regular (or list) price and a sales price. The retail list price is calculated by dividing gross revenues by quantities sold. The sales price is calculated by dividing the net revenues (gross revenues net of promotions, coupons, and rebates) by quantities sold. Because of sales promotions, coupon usage, bulk discounts, and membership discounts that do not apply to every customer, it is often the case that different consumers pay different prices for a particular product in a given week. Using these measures, we calculate a national-level monthly (unweighted) price series for each item by averaging across stores and weeks in a month:

$$\overline{p}_{i,m} = \frac{\sum_{j=1}^{J_{i,m}} p_{i,j}}{N_{i,m}} \tag{15}$$

where *i* is product, *m* is the month, $J_{i,m}$ is the set of all store by week observations for product i during month m, and $N_{i,m}$ is the number of observations in set $J_{i,m}$.

Our measure of retailer cost comes from the scanner data and is the reported wholesale list price at which the retailer can purchase the product (i.e. the current replacement price). This is the measure of cost used in Eichenbaum et al. (2011), Gopinath et al. (2011), and Burstein and Jaimovich (2009). Note that this cost measure may or may not include associated distribution services since some national brand manufacturers engage in direct-store-delivery (DSD) while others ship to central warehouses owned and operated by the retailer. Furthermore, the extensive use of promotions and contracts means that this cost measure does not always correspond to the marginal cost of the retailer, which may not be constant in quantity given the existence of incentives based on quantity targets. Given the tight relationship between changes in this wholesale list price and the retail price, and the lack of other evidence on the use of manufacturer promotions/incentives as a mechanism of adjustment following manufacturer cost shocks, we follow the previous literature and treat this wholesale list price as a primary component of the retailer's marginal cost (w_i in the model) and as equivalent to a manufacturer/producer price. However, we add an important caveat to the previous literature by recognizing that the wholesale list price for products manufactured directly by the retailer may not be an allocative price – although we report pass-through results for these products using wholesale prices as a dependent or independent variable, we recognize that these prices may be accounting fictions rather than representative of the true marginal production costs ($\theta_m + c$) faced by the integrated retailer-manufacturer.

In addition to the price and cost measures provided by the retailer, we use the quantity measure to construct a product-level share of the retailer's revenue or what we call "market share." While this is not a true market share in that many of these products are sold by other competing retailers in local markets, differences in prices and within-retailer revenue shares are still informative about the implied demand or quality-shifters for a product – a product with high quality can sell more at a given price, and compared to a product with the same marginal cost will receive a higher markup by manufacturers and/or retailers. We construct this revenue share level by taking the total gross revenue from the product over the entire sample period (which necessarily includes an across-store margin). We also construct firm-level market shares to account for multi-product manufacturers (including our retailer). We do this using what is called the "manufacturer code" given by the first five digits of each UPC – these typically identify a unique manufacturer at the time of issuance, but changes in ownership through mergers and acquisitions take place without any change in the UPC. Our measure is thus more likely to be accurate within highly disaggregated product categories where a large manufacturer will not have multiple divisions (leading us to underestimate firm market share) and where ownership is likely to be uniform for UPCs sharing the same manufacturer code (as opposed to across broad categories where manufacturers are more likely to acquire or spinoff a division). While our measure is noisy, inspection of the UPC descriptions suggests that it provides a reasonably good match.

Finally, the retailer provides classification information that we use to construct appropriate comparison sets for goods. In assessing the effects of different market structures on pass-through defining the appropriate set of comparison goods is important both for defining the relevant competition and for isolating the effects of observed market structure on pass-through from the effects of unobserved heterogeneity in product characteristics – there is no reason to expect an increase in a meat commodity price to affect the marginal cost of a "steak" and a "frankfurter" product to the same degree, but comparing a nationally branded 6 pack of frankfurters with a private label 6 pack of similar dimensions is likely to be informative. The 155 product categories in the data are often too internally heterogeneous. Fortunately the retailer provides classification information down to a very disaggregate level, from category to class, subclass, and subsubclass. Subsubclass usually contains information on product volume but also modifiers like diet, organic, and flavors. To take a concrete example, a UPC with the description "Northern lights milk 2%" is in the "mainstream white milk" product category, "reduced fat 2%" class, and the "64 ounce reduced fat 2% milk" subclass and subsubclass, while a UPC described as "Hersheys chocolate milk" is in the "mainstream white milk" category, the "flavored milk/milk substitute" class, "chocolate flavored milk/milk substitutes" subclass and "quart chocolate milk/milk substitutes" subsubclass. Thus while in some cases the more disaggregated categories overlap or do not add additional information, typically at the subsubclass level products will be differentiated by product dimension, premium/non-premium dimension, diet/fat-free/health/organic modifiers, and flavor modifiers. We can thus define our comparison sets for pass-through regressions and for definitions of market share at different levels of aggregation – while our results turn out to be qualitatively robust from the category level on, the quantitative findings do depend on the level of disaggregation. We later report results using the most broad (category) and narrow (subsubclass) classifications to show this effect.[8] When a very narrow category does not contain both a national brand and a private label good, we aggregate up to the most disaggregated level that that contains both.

Table 3 presents some descriptive sample statistics from the retailer data. Private label goods that are manufactured by the retailer tend to have a higher revenue share and brand share within a comparison group, while also exhibiting lower prices (70% to 83%) and wholesale costs (50% to 90%) than national brands and higher markups(5% to 30%). The median prices and wholesale costs of retailer manufactured goods are also lower than those for retailer branded goods by 7 to 10%.

3.2. Commodity and wholesale cost indexes

We supplement our product-level data on retailer prices, costs, and quantities with two measures of "common shocks" that should shift the marginal cost of similar goods by a similar amount: (1) commodity prices and (2) wholesale cost index. Commodity prices, like exchange rates, are arguably exogenous sources of cost variation at the product level we can use to examine cost pass-through into both wholesale prices and retail prices. For retail price-commodity and wholesale price-commodity regressions, we collect weekly or monthly prices of raw materials (sugar, wheat, corn, meat, milk and coffee) from the Food and Agricultural Organization and the S&P Goldman Sachs Commodity Index and aggregate to the monthly level to be consistent with our price data.[9] Using commodity prices as cost measure ensures that a retail price/cost pass-through regression can be run with an allocative, market-based cost measure. We match product categories with commodities that are likely to be important ingredients (e.g. wheat with bread, milk with yogurt, meat with franks, corn with syrup and soft drinks via high-fructose corn syrup). The idea behind the wholesale cost index is that identifying the appropriate commodities and weights for a category is difficult, but shifts in category-level wholesale prices are likely to be informative of these changes. Unlike the idiosyncratic wholesale price changes, which may reflect individual product demand shocks, shocks to local factor prices, etc. the wholesale cost index for a product category is likely to capture the common cost shocks facing all manufacturers in an industry. We construct this index by using fixed revenue weights to aggregate the wholesale costs for each product in a

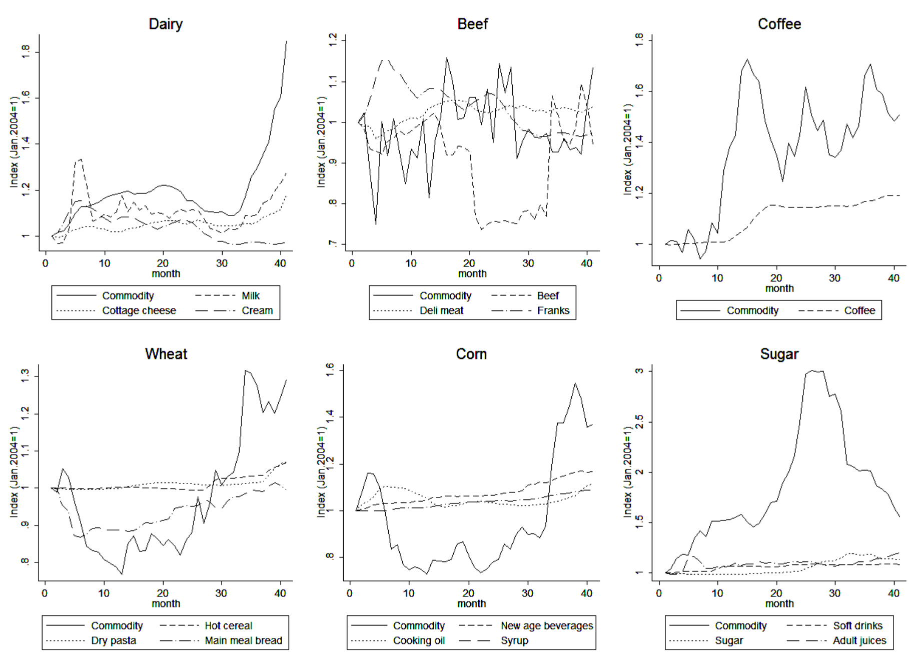
[8]Results using intermediate classifications are available by request.

[9]The commodity price series from the Food and Agricultural Organization is available at http://www.fao.org/es/esc/prices. There are several price series for some material depending on the country of origin and product characteristics. We use the export price of bovine meat produced in the U.S. as the meat commodity price and the dairy real price index.

category.

Figure 2 presents some time-series plots of the commodity indexes we use and the wholesale cost indexes of some associated categories. Commodity prices during this period are generally trending up, particularly in late 2006 and early 2007, but to varying degrees, and there are substantial periods of increase and decrease most commodities. Commodity price swings are much larger than those of the wholesale cost index, which should not be surprising given that commodity inputs are only a relatively small share of the costs of most products and products that use multiple commodity inputs will have a smoother material cost component over time than any individual component. We see clear co-movement between the commodity and wholesale indexes in some cases (milk and cottage cheese with dairy, coffee with coffee, bread with wheat, sugar with granulated sugar) while in other cases the co-movement appears to be relatively small or close to zero.

Figure 2: Retail and Commodity Price Movements



Note: The commodity price information is from the Food and Agricultural Organization of the United Nations and S&P Goldman Sachs commodity price index. In each plot, we generate a product category level regular price index from a sample of product categories that we use to run commodity-retail price regressions. Both data covers 41 months from January 2004 to May 2007.

3.3. Frequency of price changes

While our pass-through results aggregate across stores and weeks up to the monthly level, when measuring the frequency of price changes one is confronted with a standard problem of incomplete data. The scanner data set that we use only collects prices for a week/store if there are recorded transactions, so there are many missing observations.[10] Although a missing value need not imply a price adjustment, failure to correct for missing values could bias our measurement of price duration and sale frequency if missing values are correlated with price changes. Another issue, noted by Eichenbaum et al. (2011) in their description of the data set, is that there is potential measurement error in the weekly sale price because not all consumers purchase goods at the same price due to coupons, loyalty cards and promotions – a few consumers who do not take advantage of a promotion could create the appearance of a price change when there is no change in the underlying list and sale price. As in their paper, our estimates of the frequency of weekly price changes should be interpreted as an upper bound.

We adopt two different procedures to deal with missing values that are now standard in the literature (see Nakamura and Steinsson (2008) and Kehoe and Midrigan (2008)). They are described in detail in Table 1. The first procedure, referred to as 'spell1' combines spells on both sides of a missing spell provided the price before and after the missing spell is unchanged. Suppose we observe a price of $1 during weeks 2 to 3 and the price for weeks 4 to 6 missing, but we observe a price of $1 for week 7 followed by $1.5 for week 8 and $1.4 for week 9. The length of the ($1) spell is 2+1=3 weeks. The second procedure, 'spell2,' imputes the previously observed price to all missing values. In the example above, this means that we include weeks 4 to 6, resulting in a ($1) spell length of $2 + 3 + 1 = 6$. Table 2 shows that the 'spell2' procedure generates slightly longer durations than the 'spell1' procedure but the overall pattern is similar, with fairly similar and lengthy durations for regular prices and wholesale costs and much shorter durations for sales prices, consistent with Eichenbaum et al. (2011). Table 3 shows that using our preferred 'spell2' measure, retailer manufactured goods have the longest regular price durations (7-8 months), while exhibiting the shortest sales price durations (3.5 weeks median).

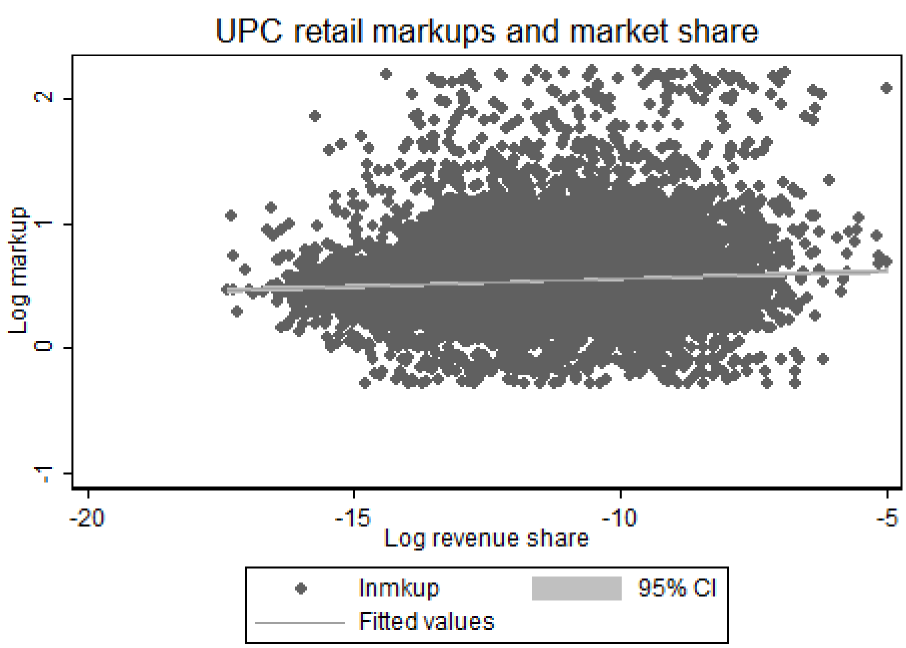
4. Market Share, Vertical Structure and Pass-Through

Before presenting our main pass-through results, we briefly provide some graphical evidence to corroborate two of the implications of our model – that higher market share is related to higher market power and hence higher markups, as in the Dornbusch (1987) framework, and

[10] This is less of a problem for our subsample since we exclude many goods that are only sporadically purchased, but is still potentially an issue.

that greater degrees of vertical integration are chosen for product categories that have higher volume and higher degrees of double-marginalization. Figure 3 presents a plot of the log within-category revenue share and the log retail markup (defined here as retail price over wholesale price) for the 18,941 products in our sample. While there is lots of variation along both dimensions for these products and lots of omitted factors relative to the model (e.g. the fundamental parameter η, the presence of other retail marginal costs θ^r and multi-product manufacturers) there is clear evidence of a significant and positive relationship between a product's market share and its retail markup. This implies some retail pricing power that is tied to the popularity of the product (otherwise the markup would be identical across products or unrelated to market share) and suggests that manufacturer markups may have a similar feature. It also corroborates the main feature of the Dornbusch (1987) model that greater market share effectively reduces the demand elasticity of these products leading to higher optimal markups, and our later analysis will show more formally that market share has a negative effect on pass-through as implied by the model.

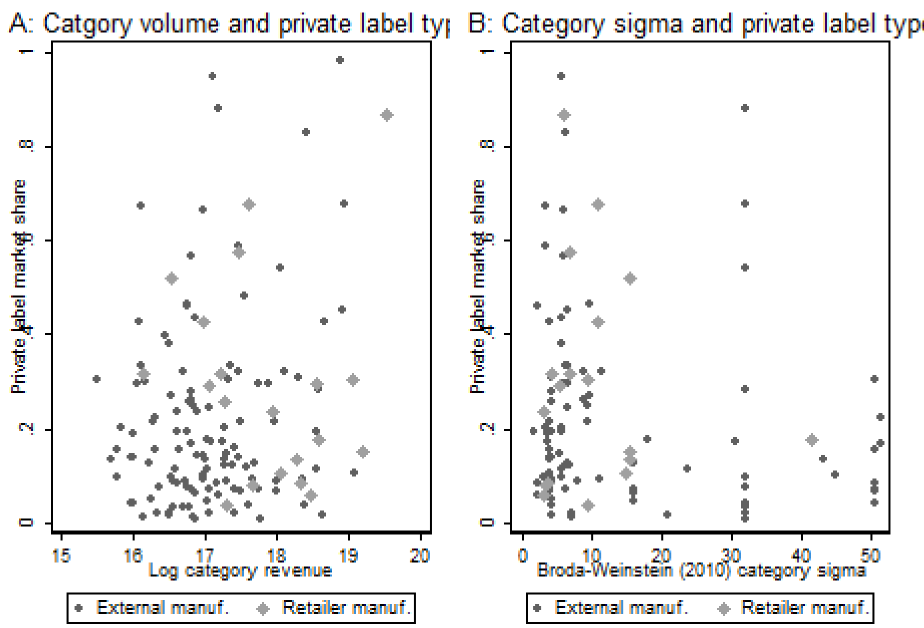
Figure 3: Market share and retail markups



Note: This figure shows the log within-category revenue share and the log retail markup (defined here as retail price over wholesale price) for the UPCs in our sample of 18,941 UPCs that appear every month during the sample period (41 months).

Although we abstract from the retailer's decision regarding which categories to enter, which mode of entry (direct manufacture or simply branding) to choose and how many products to introduce, Figure 4 provides some evidence in line with the model presented earlier. Aggregating up to the category level, we find that categories in which the retailer has some manufactured private labels tend to have a higher private label market share (an effect of deeper integration). Panel A shows that retailer-manufactured private labels tend to be in higher volume categories (measured by total category-level sales) which is consistent with a minimum efficient scale of production for products that are sold exclusively by the retailer or with a fixed cost for greater integration. Panel B links products to the demand elasticities calculated by Broda and Weinstein (2010) using Nielsen scanner data. While their elasticities are derived from a structural estimator under different preferences, it is interesting to note that (i) private labels gain a higher market share in categories with lower demand elasticities (and hence greater potential double-marginalization) and (ii) direct manufacture is more likely in these categories (consistent with greater profits from removing double-marginalization).

Figure 4: Choice of vertical structure



Note: Panel A and B show that categories that have manufactured private labels tend to be in higher volume categories and also tend to have lower demand elasticities.

4.1. Pass-through: empirical approach

We first describe our general empirical approach to estimating cost pass-through. Our preferred pass-through estimator is based on a "rolling-window" regression where we regress a change in price over horizon K against a change in cost over horizon K. That is, we estimate:

$$\Delta^K logP_{i,t} = \alpha_i + \beta_i^K \Delta^K logC_{i,t} + error_{i,t} \tag{16}$$

where i is the UPC, t is the month, P is the price measure which is the unweighted monthly average defined as (15), C is the cost measure, and Δ^K is the time-difference operator such that $\Delta^{12} logP_{i,t} \equiv logP_{i,t} - logP_{i,t-12}$. We perform this regression at different horizons with $K = 4, 8, 12$ for the 41 months in our sample, for each UPC separately. Our measure of pass-through is β^K, specific to a UPC and a horizon.

An alternate pass-through estimator that has been widely used in the literature (e.g. Gopinath and Itskhoki (2010), Neiman (2010), Nakamura and Zerom (2010)) uses distributed lags, as in:

$$\Delta logP_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_i^k \Delta logC_{i,t-k+1} + error_{i,t} \tag{17}$$

In this regression, we define a "long-term" pass-through for product i equivalent to the one from the rolling window regression as $\beta_i^K = \sum_{k=1}^{K} \beta_i^k$. We also use values of $K = 4, 8, 12$ for this regression. The results from the distributed lag regression are qualitatively similar to those from the rolling-window regression.[11]

We use four main combinations of prices and costs for our analysis: we regress retail prices on wholesale prices, wholesale prices on commodity prices, retail prices on commodity prices, and retail prices on a wholesale price index. Note that for the regressions using commodity prices we often have multiple pass-through coefficient for a UPC corresponding to multiple commodities – for example, we look at pass-through of both dairy and sugar prices into ice-cream prices, of both wheat and corn prices into breakfast cereal prices.

The overall magnitude of cost pass-through appears to be reasonable. Median pass-through from wholesale prices to retail prices is very high, ranging from 76% to 98% between 4 to 12 months, while pass-through from commodity prices to wholesale prices is much lower, ranging from 6.3% to 6.5% between 4 to 12 months. The combination of these effects generates pass-through from commodity to retail prices ranging from 4.1% to 8.3% between 4 to 12 months. Pass-through from the wholesale price index to retail prices is slightly higher than for commodity prices (7.3%-8.8%) suggesting that this may provide a slightly better measure

[11] We do not report and discuss our results using this alternative pass-through measure to save space, but they are contained in the appendix tables. We also experimented with quarterly/monthly seasonal dummies in the pass-through regressions but found that these had only minor effects on the estimated pass-through and omitted them because we have limited degrees of freedom given our short time-series.

of aggregate cost pressures facing UPCs in a particular category.

4.2. Pass-through and market structure

With product-level pass-through estimates in hand, we now address our central question – how do vertical and horizontal market structures affect product-level cost pass-through? Our preferred specification is a regression of the pass-through coefficient on dummies for UPCs that are manufactured or branded by the retailer together with controls for product and brand revenue share and dummies for each comparison group:

$$\ln \hat{\beta_i^K} = \alpha_{comparison} + \gamma_1 I[Retail\ Manufactured] + \gamma_2 I[Retail\ Branded] \\ + \gamma_3 Product\ RevShare_i + \gamma_4 Brand\ RevShare_i + \epsilon_i \tag{18}$$

In this regression, the dependent variable $\ln \hat{\beta_i^K}$ is the estimated pass-through coefficient of item i over horizon K. In the following tables we begin with only the dummies for private labels and progressively introduce category dummies, subsubclass dummies, and product and brand share controls, presenting the results for the 4 and 12 month rolling window pass-through results.[12] We focus on the results for the rolling-window pass-through regressions, leaving the results for the lagged pass-through regressions for the appendix. In this two-step estimation where the dependent variable in the second stage is a vector of estimated pass-through coefficients from the first stage, heteroskedasticity is a serious concern. Following the suggestion of Lewis and Linzer (2005), we use OLS with Eicker-White robust standard errors.[13] The measures of product and brand share are calculated within the "comparison group" we are considering – $\alpha_{comparison}$ is a set of dummies for each group. We use all products, categories, class, subclass, and subsubclass but only report results for all, categories and subsubclasses. Recall that we aggregate up comparison groups if there are no private labels in the group (e.g. we will aggregate up to "class" from "subsubclass" if there are no private labels in a particular "subsubclass" or "subclass"). When considering commodity price regressions, a "comparison group" is for a unique commodity as well, so "Quart chocolate milk/sugar" and "Quart chocolate milk/dairy" would be two separate comparison groups. Starting from our initial sample of 18,941 product-level pass-through coefficients, we drop products where there is no variation in the dependent or independent variable (resulting in

[12]We also used sales prices instead of the regular list prices as a dependent variable – the results are very similar for most specifications, with the exception of wholesale cost to sales price pass-through where the market share controls often come in positive and significant. These results are available from the authors by request.

[13]Note that while weighted least squares is often used this context, following the work of Saxonhouse (1976), Lewis and Linzer (2005) find that weighted least squares often performs poorly in their simulations leading to inefficient estimates and underestimated standard errors. They suggest a feasible GLS approach that results in standard errors of the right size, and under some circumstances (a high share of the total regression variance due to sampling error) greater efficiency, but they show that OLS with Eicker-White standard errors does not lead to over or under confidence.

$R^2 = 1$ or precisely estimated pass-through coefficients of zero) and trim the 1% tails of the pass-through distribution. Note that our use of log pass-through coefficients to help with interpretation means we discard products with negative estimated pass-throughs.[14]

Table 4 presents the results for pass-through of wholesale prices to retail prices, the second and final link in the cost pass-through chain. The results clearly indicate that private labels have lower pass-through that is 40% to 80% lower on this dimension, with generally lower pass-through for the retailer manufactured private labels than the other private labels. Product market share has a large and substantially negative effect on this channel of pass-through – a product with a 50% market share would have pass-through over 25% lower than a product with a 1% market share – but brand share has no additional effect.

Note that these effects of horizontal and market structure are exactly as predicted by the model provided that there are additional retail marginal costs ($\theta^r > 0$) and either (a)wholesale prices are lower for private labels and/or (b)the retail marginal costs are higher for private labels. This is because double-incomplete pass-through plays no role for wholesale to retail pass-through and only the retail market power (which we associate with the product market share) and the wholesale marginal cost share $\frac{w_i}{w_i+\theta_i^r}$ matter. Are these reasonable assumptions? While the size and nature of retail marginal costs over and above the wholesale cost is difficult to measure and substantiate, we know that assumption (a) is true so given any such costs our empirical result has a theoretical foundation. It is also seems reasonable to conclude that for private label goods, where the retailer takes over a larger share of distribution and marketing costs, the "retail" component of marginal costs may be larger than for nationally branded goods but we cannot substantiate this directly.[15] Note also that the absence of brand share effects here is also consistent with theory in that retailers receive the multi-product firm pricing externality for all products – what matters for them in terms of retail pricing is the product share and their overall share of the local market, not the share of particular manufacturers.

We next turn pass-through from commodity prices to wholesale prices, the first link in the cost pass-through chain. Note that the sample differs from the previous regressions as there are many UPCs that we do not link to any of our six commodity prices, and some UPCs can be linked to multiple commodities. We treat each pass-through separately, even for the same UPC, and compare it to similar UPCs (within a "comparison group") for the same com-

[14]We have also estimated regressions like equation 18 in levels, thereby using negative pass-through coefficients. The results are noisy and often not significant, but when we restrict to product categories featuring a positive pass-through from commodity prices to the wholesale price index (e.g. those with sufficient positive comovement as in 2) we get results that are qualitatively similar to those for log pass-through.

[15]One obvious channel is distribution given the fairly widespread use of direct-store-delivery by large national brand manufacturers, but if advertising and shelf-placement have some marginal cost component then "marketing" costs broadly understood may also have this feature. Another channel is related to our observation that sales are more frequent for the private label goods – to the extent that sales represent a price discrimination tool or a technology to boost demand and sales, but require some menu cost, more frequent sales will drive up θ^r.

modity. Table 5 presents the results. Here we find that private label UPCs show significantly higher pass-through rates compared to national brands. The effect is larger in most specifications for the retailer manufactured goods, consistent with the theory. Without controls the pass-through for retailer manufactured goods is up to 50% higher, which falls when including category controls but rises when using subsubclass controls. Our preferred specification (column (8)) finds that retailer manufactured goods have 42% higher pass-through while retailer branded goods have 29% higher pass-through.

One of our main results is that the use of market share controls *increases* the size of the retailer brand and manufactured dummies – consistent with the model, the effects of vertical structure are larger once we control for its indirect (and partly offsetting effect) operating through horizontal structure. Comparing private labels with national brands with similar market shares isolates the part of incomplete pass-through coming from double-marginalization from the part that comes from higher market share. We also find that the direct effect of market share for this link of cost pass-through is consistent with the theory – products with larger market share have lower cost pass-through – but that this operates primarily at the brand rather than the product level, though the product coefficient remains negative.

Finally, Table 6 presents our results for overall pass-through from commodity prices to retail prices, combining both of the previous links in the cost pass-through chain. These results provide a cleaner interpretation of the overall effects of vertical and horizontal market structure on pass-through, especially given the potential non-allocativeness of the wholesale price reported for retailer manufactured goods. Our findings are consistent with theory, in that pass-through rates are substantially higher for private label goods – 11% higher for retailer branded goods and 40% higher for retailer manufactured goods over a 12 month horizon in our preferred specification (column (8) of Panel A). Less double-marginalization increases pass-through, and this effect is larger when controlling for indirect effect of double-marginalization operating through market share. Market share also has the expected negative effect on pass-through for both product market share and brand market share, consistent with a multi-product firm version of the Dornbusch (1987) model. We also stress that the including controls for vertical structure affects estimates of the effects of market size on pass-through – since many of the products with larger market share are private labels, including private label dummies typically *increases* the negative effect of product market share on pass-through.[16] Note that the percent changes are fairly similar at four and twelve month horizons but that the absolute effect is bigger at longer horizons where pass-through is higher. Controlling for product heterogeneity also seems to be important and has fairly large effects on the private label dummy coefficients.

[16] Results available from the author by request.

Panel B of Table 6 presents results for pass-through from the wholesale price index to retail prices. This allows us to expand the sample though we only have one pass-through coefficient per UPC, and can potentially provide a better picture of common cost shocks at the category level. The results at the 12 month horizon are fairly consistent with the results for commodity prices, with 11% and 34% higher pass-through from retailer branded and manufactured goods respectively. At the 4 month horizon we find a much smaller effect on retailer manufactured goods, suggesting substantial delays in cost pass-through for these goods. The results for market share are similar for product market share but weaker for brand market share (negative but not statistically significant).

4.3. Price durations and sales

Finally, we examine whether price durations are related to long-term pass-through as in Gopinath and Itskhoki (2010), consistent with a fixed menu cost and larger profit loss from not adjusting prices of goods with high desired pass-through. Does the higher level of pass-through rates from commodity prices to retail prices for private label goods coincide with more flexible price movements for the private label goods? Our evidence here is somewhat mixed. Table 7 presents our results and shows that for regular prices, there is not much difference in price durations for retailer manufactured and branded goods – in fact the duration is slightly higher for retailer branded goods (3.6%). The effects of market share are also mixed, with a positive effect of product market share on duration and a negative effect of brand market share. Our pass-through results suggest that durations should be higher for goods with higher market share (and lower pass-through). Some of this ambiguity may arise because the source of cost shocks to retailers matters for the effect of the private label dummy on pass-through – the effect is negative for wholesale prices but positive for commodity prices, so the precise size and distribution of cost shocks arising from these two different sources may matter. We also cannot rule out that menu costs differ for private label and national brands, which would break the link posited in Gopinath and Itskhoki (2010).

When we turn to sales prices and wholesale costs, we find that sales price durations are 40% shorter for retail manufactured goods and 30% lower for retailer branded goods, while wholesale cost durations are 30% lower for retailer manufactured goods and 60% lower for retailer branded goods. An increase in market share on sales price duration reduces the price duration or increases the frequency of sales price changes. This is opposite to the theoretical link between pass-through rates and frequency of price changes in the model which shows an increase in market share lowers the pass-through rate which may also leads to higher duration given the duration of the cost. To understand this finding we turn to the recent literature arguing that sales price-setting mechanisms and motives are different from regular price setting mechanisms and motives by nature, which results in different cyclical properties

(Coibion et al. (2012), Anderson et al. (2012)). Interestingly, our finding is consistent with a story in which sales are not used for cost pass-through but rather as part of a price discrimination scheme by retailers. Guimaraes and Sheedy (2011) and Chevalier and Kashyap (2011) consider models where retailers face different types of consumers with different demand elasticities, with some consumers acting as price-sensitive "bargain-hunters" and others as less price-sensitive "loyals." Given that private label goods are typically cheaper than national brand goods, and the retailer manufactured ones are even cheaper than the externally-manufactured ones, the higher ratio of price-sensitive consumers who prefer private label brands may increase the incentive of the retailer to offer frequent sales.

5. Macroeconomic implications

While the rise in private label brands in the US market is part of a longer secular trend that is likely related to retail consolidation and may eventually lead to convergence with European levels of private label market share, Figure 1 hints that private label share may also be driven by demand-side considerations over the business-cycle, with households substituting towards "better value" private label alternatives to national brands.

To examine the cyclical sensitivity of private label market shares, we use the store-time panel dimension of our data, aggregating products across our product categories to form an aggregate store/month level private label market share from 2004 to 2007. We regress this measure of private label share on a local zipcode level measure of median household income from the 2000 Census and local (MSA or county level) measures of time-varying gas prices and unemployment rates; following Gicheva et al. (2010) we interpret a rise in gas prices as a negative disposable income shock to households given the very low price elasticity of gasoline.

Table 8 presents our results. The mean private label share for our sample stores is 0.24 (standard deviation 0.07). Most of the variation is cross-sectional, across stores. While private label shares vary over time during our sample period, this variation is small. The first column presents the cross-section from the first month of 2004, and reveals that our three variables explain 21% of the cross-sectional variation. For our retailer, private label goods seem to be inferior in the sense that lower income leads to substitution towards them and away from national brands. These effects are quite large – doubling local incomes lowers the private label share by 8 percentage points and doubling gas prices raises the private label share by 13.5 percentage points. One extra percentage point of unemployment raises the private label share by 0.43 percentage points. These effects are generally smaller when we use the time-series variation as well in column 2. When we control for store and month fixed effects, the impacts of unemployment and gas prices are smaller still but they remain statistically significant. Going from the lowest to highest county-level unemployment rate in our sample would raise the private label share by 4 percentage points (0.2 x 0.211) while going from the lowest to highest gas price raises private label share by 1 percentage point (1 log point x 0.01).

Given our earlier findings on the greater pass-through of private labels compared to national brands, our results suggest that the types of cyclical shifts in private label share we observe in the data – around 4 percentage points based on Figure 1 and Table 8 – could increase commodity to retail pass-through by about 1.2 percentage points (4 x 0.3) or about 14% (given a median commodity to retail pass-through of 8.3%). While this effect is not huge, it suggests that retail prices should be more sensitive to input costs during recessions and less sensitive during booms due to this demand channel, a novel implication to the best of our knowledge.

Moreover, the much larger trend and cross-sectional differences in private label market share observed in the US and Europe could have much bigger effects. These larger cross-sectional differences can also be observed in differences in intra-firm trade shares across countries, which can be similarly large. There have also likely been significant movements in the intra-firm trade share over time although there is limited aggregate data compared to private labels. While these larger swings in the share of vertically-integrated products could generate potentially large effects on pass-through given our (and other estimates), our findings also imply that the differences in horizontal structure that accompany these changes must also be taken into account. Indeed, it may be the case that an increase in intra-firm trade in the United States results from growing dominance by large multi-national corporations whose rising market share lowers exchange-rate pass-through and this effect dominates. Similarly, the high level of private label market share in some European countries may reflect a highly concentrated supermarket oligopoly and weak competition from national brands, which could imply lower pass-through of commodity and other cost shocks.

While cross-sectional heterogeneity matters for aggregate price rigidity and pass-through, an equally important issue is how the evolution of private label goods market share responds to broader macroeconomic forces. Before concluding, we briefly discuss some testable hypotheses about the macroeconomic forces that shape private label market share based on our empirical findings.

First, the longer-run evolution of market share for private label goods – rising in the United States and Canada, very high in some advanced European economies, and generally much lower in Asia and the developing world – is consistent with changes in technology, particularly scale effects associated with retail consolidation and advances in supply-chain management and marketing technologies. It is difficult to attribute the broad time-series and cross-country differences in the market share of private label goods to differences in consumer tastes, since income differences over time and across countries would tend to imply a smaller role for the lower quality, generic private label goods in the richer countries. The relatively small scale and limited managerial capacities of the retail sector in lower income countries is likely to be a major impediment to the introduction and growth of private label store brands. Low private label share in middle-income and developing countries may also be related to legal and regulatory policies that limit foreign direct investment or retail consolidation. These size constraints are likely to be relaxed as distribution, marketing, and managerial technology improves in these countries and the legal and regulatory policies converge towards what we observe in the rich, advanced economies. Regardless of the precise source of this ongoing evolution of private label market share, the implication of this supply-driven phenomenon is that manufacturers will lose market power resulting in higher cost pass-through and more frequent retail (and wholesale) price changes. There is a large trade literature documenting the decline in exchange pass-through for U.S. imports in the last few decades (Bailliu and Bouakez (2004), Gagnon and Ihrig (2002), Frankel et al. (2005)), a fact that is inconsistent with a rise in intra-firm transactions and the higher pass-through observed for intra-firm transactions (Neiman (2010)). We are not aware of any studies documenting the contribution of private label goods to the evolution of retail pass-through over the long-run or to cross-country differences.

Second, the inflationary aspect of commodity price pass-through into retail prices has received more attention during the recent period of volatility associated with the Great Recession. In general, the relevance of commodity prices as a reliable source of inflation forecasting is still under debate. While there are empirical studies that show the lack of a meaningful relationship between commodity price movements and core inflation since 1980s in the United States (for instance, Evans (May 2011)), other recent studies also suggest a prominent role for commodity prices in predicting a broad set of macroeconomic and financial variable (see Edelstein (2007)) and there is substantial micro evidence (cited earlier). The sharp increases in commodity prices – especially food and energy – account for most of the rising inflation in emerging market economies for a variety of reasons.[17] An obvious explanation for the greater inflationary pressure from commodity prices in developing countries is that the share of household expenditures on food and energy are greater in low-income countries. As countries get richer, the food and energy share in the consumption basket may fall, lowering the sensitivity of inflation to commodity prices. However, our findings suggest that as countries get richer the growth in private label brands may partly offset this effect by increasing commodity price pass-through within narrow food categories. Our findings also suggest that commodity price pass-through may be more counter-cyclical than otherwise due to the private label margin. Furthermore, even if firms prefer not to alter regular prices in response to rising commodity and energy prices due to reputation concerns or staggered contracts, pres-

[17]See http://www.imf.org/external/np/seminars/eng/2011/lic/index.htm for reports and discussion from the International Monetary Fund.

sure from consumers during bad states of the economy may incentivize firms to implement more frequent and deeper sales.[18] Given our finding that sales prices, not list prices, are more responsive to raw material prices, we conclude that inflationary pressure arising from raw material price hikes cannot be neglected.

6. Conclusion

We provide evidence on the effects of horizontal and vertical market structure on two links of the commodity to retail price pass-through chain. Our evidence is generally consistent with the previous literature – greater double-marginalization reduces pass-through (vertical effect) and firms with larger market shares have lower pass-through (horizontal effect). However, we stress that the interaction of these two effects is important; since reducing double-marginalization simultaneously increases pass-through directly while increasing market share, the positive effect of greater control of the value chain by the downstream party on pass-through is larger when conditioning on market share. We also show that accounting for multi-product firms is important for estimating the effects of horizontal market structure and that the effects of vertical integration on pass-through hold when considering two allocative prices in lieu of an intra-firm price. Finally, while the effects of vertical structure on commodity to retail price pass-through are quite large – 10% higher for retailer branded private labels and 40% higher for retailer manufactured brands – the cyclicality of the private label share appears quite modest. Thus the channel we study suggests that cost pass-through will be higher during recessions (with higher private label share) and lower during booms but this effect is modest given the observed cyclical fluctuations of private label revenue share around 3%.

Our findings suggest several avenues for future research. While the cyclical macro effects we identify are modest, longer-term trends in retail consolidation and market power generate much larger differences in private label shares, most notably in the large differences across countries. Several European countries have private label shares over 50%. While this would seem to suggest a much higher pass-through rate, our results on the interplay between horizontal and vertical structure highlight the danger of considering only one of these channels. If private label dominance in Europe is driven by huge market shares of the retailer brands, this anti-competitive effect could potentially reduce pass-through. Understanding how the forces we identify in this paper contribute to differences in commodity price pass-through across countries is thus a promising direction. Similarly, our results are likely to be relevant in an international context where existing studies have typically examined only horizontal or vertical structure in isolation. The rise of intra-firm transactions highlighted in Neiman

[18] See Coibion et al. (2012).

(2010) is undoubtedly an important part of the story, but the general trend of declining exchange rate pass-through into US import prices seems to pose a puzzle in this regard. This puzzle could potentially be resolved by recognizing that the rise of intra-firm transactions is connected to the growth and dominance of large multinational corporations that have sufficient market share that their pass-through is lower, as in Berman et al. (2011). While many of the existing trade micro data sets have limitations in terms of measuring horizontal market structure (lacking quantity data or multi-product firm identifiers) we believe this is another track worth pursuing. Vertical integration in an international context takes numerous forms, so being able to parse out the importance of distribution and marketing aspects of production from production aspects would also be interesting. Finally, we provide some preliminary evidence that private label sales frequency is higher than for national brands. We speculate that this may be a feature of menu cost technology and the nature of retailer-manufacturer contracts and promotions, or may be the result of optimal price discrimination by the retailer given heterogeneous consumers. Understanding the reason for this higher sales frequency, and its implications for price rigidity over the business cycle and over the long-term, is something we hope to pursue in future work.

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Table 1: Treatment of Missing Values

	•	•	•	X	X	•	•	•
Time	1	2	3	4	5	6	7	8
Price	2	1	1			1	1.5	1.4
Spell1	1	2	2			2	3	4
Spell2	1	2	2	2	2	2	3	4

Note: The dots represent the observations that are missing from the data set, while the crosses represent the observations in the data set. Spell1 counts value at t=6 as the same price spell as the spell before the missing values, but missing values are not counted as part of the spell. Spell2 is similar to Spell1, but differs in that Spell2 takes the missing values as part of the spell. Naturally, prices seem to be stickier using Spell2 than Spell1.

Table 2: Duration of prices and costs (weeks)

	Mean	Median
Spell1		
Regular Price	25.85	26.4
Sales Price	8.27	3.97
Wholesale Cost	23.39	21.48
Spell2		
Regular Price	30.24	31.82
Sales Price	10.13	5.16
Wholesale Cost	27.67	26.71

Note: The sample is restricted to UPCs that appear every month from January 2004 to May 2007 (41 months) and product categories that contain both national brands and private label goods. Depending on our measure of price spells, the regular price changes every 6-8 months. Our Spell2 measure of median sales price duration is comparable to Kehoe and Midrigan (2008) who report sales price durations of 3 weeks using a grocery store data set. Regular price spells are shorter than Nakamura and Steinsson (2008) (10 to 12 months)) and import data (Gopinath and Rigobon (2008) find a median price duration 10.6 months for imports and 12.8 months for exported goods), but longer than Kehoe and Midrigan (2008) that uses Dominick's supermarket data set.

Table 3: Summary Statistics: Private Label Goods, National Brands

Number of Private Label	Manufactured	674	
	Branded	2,314	
Number of National Brand	NB	15,953	
		Median	Mean
Number of Private Label in a subsubclass	Manufactured	5	10.6
	Branded	5	6.7
Number of National Brand in a subsubclass	NB	13	23.1
Number of Private Label in a category	Manufactured	64	64.3
	Branded	33	43.6
Number of National Brand in category	NB	188	237.9
RevShare of Private Label in a subsubclass	Manufactured	0.068	0.179
	Branded	0.046	0.119
RevShare of National Brand in a subsubclass	NB	0.028	0.105
RevShare of Private Label in a category	Manufactured	0.003	0.008
	Branded	0.003	0.009
RevShare of National Brand in a category	NB	0.001	0.005
Brand RevShare of Private Label in a subsubclass	Manufactured	0.624	0.629
	Branded	0.352	0.445
Brand RevShare of National Brand in a subsubclass	NB	0.29	0.353
Brand RevShare of Private Label in a category	Manufactured	0.286	0.358
	Branded	0.212	0.286
Brand RevShare of National Brand in a category	NB	0.04	0.128
Ratio of regular price (Private Label/National Brand) in a subsubclass	Manufactured	0.733	0.729
	Branded	0.787	0.837
Ratio of wholesale cost(Private Label/National Brand) in a subsubclass	Manufactured	0.518	0.58
	Branded	0.583	0.942
Ratio of markup(Private Label/National Brand) in a subsubclass	Manufactured	1.24	1.32
	Branded	1.23	1.29
Ratio of markup(Private Label/National Brand) in a category	Manufactured	1.05	1.20
	Branded	1.12	1.25
Duration of regular prices (weeks)	Manufactured	32.42	29.96
	Branded	31.99	30.62
	NB	31.05	30.15
Duration of wholesale cost(weeks)	Manufactured	24.37	26.86
	Branded	18.16	21.79
	NB	37.61	34.37
Duration of sales price (weeks)	Manufactured	3.45	6.58
	Branded	4.04	9.07
	NB	7.99	14.47

Note: The sample is restricted to UPCs that appear every month from January 2004 to May 2007 (41 months) and categories that contain both national brands and private label goods (minimum 1% revenue share). This leaves 155 product categories and 4,472 subsubclasses. For duration calculation we report measures using 'spell2.'

Table 4: Retail Price and Wholesale Cost Passthrough

Dependent Variable (Log Passthrough of Wholesale Cost to Regular Price)								
	4 months				12 months			
Median	0.764				0.983			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	-0.427***	-0.465***	-0.695***	-0.619***	-0.372***	-0.394***	-0.81***	-0.777***
s.e.	(0.053)	(0.061)	(0.077)	(0.08)	(0.061)	(0.071)	(0.089)	(0.092)
RetailBranded	-0.489***	-0.451***	-0.481**	-0.467***	-0.429***	-0.43***	-0.506***	-0.504***
s.e.	(0.032)	(0.038)	(0.046)	(0.046)	(0.038)	(0.038)	(0.048)	(0.048)
Product RevShare				-0.581***				-0.538***
s.e.				(0.107)				(0.111)
Brand RevShare				-0.072				0.032
s.e.				(0.061)				(0.064)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	10541	10541	10541	10541	10939	10939	10939	10939
R^2	0.0259	0.1393	0.3899	0.3934	0.0177	0.1136	0.376	0.3777

Note: The dependent variable is the logarithm of estimated product-level pass-through using the rolling window specification given by equation 16, where the dependent variable is the change in log average monthly retail regular price, the independent variable is change in the log average monthly wholesale price, and the sample comprises the 41 months from January 2004 to May 2007. The results reported here are for estimation of equation 18 where each observation corresponds to an individual product pass-through coefficient, and use heteroskedasticity robust standard errors.

Table 5: Wholesale Cost and Commodity Price

Dependent Variable (Log Passthrough of Commodity Price to Wholesale Cost)								
	4 lags				12 lags			
Median	0.063				0.065			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	0.505***	0.349***	0.272***	0.342***	0.329***	0.211***	0.347***	0.415***
s.e.	(0.048)	(0.051)	(0.081)	(0.081)	(0.046)	(0.045)	(0.067)	(0.068)
RetailBranded	0.291***	0.309***	0.222***	0.278***	0.206***	0.292***	0.264***	0.291***
s.e.	(0.047)	(0.045)	(0.059)	(0.059)	(0.042)	(0.042)	(0.055)	(0.055)
Product RevShare				-0.092				-0.115
s.e.				(0.103)				(0.102)
Brand RevShare				-0.615***				-0.513***
s.e.				(0.074)				(0.069)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	10326	10326	10326	10326	12757	12757	12757	12757
R^2	0.0106	0.3575	0.6483	0.6541	0.0044	0.28	0.5782	0.5825

Note: The dependent variable is the logarithm of estimated product-level pass-through using the rolling window specification given by equation 16, where the dependent variable is the change in log average monthly retail wholesale price, the independent variable is the change in the log commodity index for a linked commodity, and the sample comprises the 41 months from January 2004 to May 2007. The results reported here are for estimation of equation 18 where each individual observation is a product x commodity pass-through coefficient, and use heteroskedasticity robust standard errors. Because there are sometimes multiple commodities linked to an individual product, we include commodity dummies in this regression interacted with category or subsubclass dummies where applicable.

Table 6: Regular Price and Commodity Price/Wholesale Cost Index Passthroughs

Panel A: Dependent Variable (Log Passthrough of Commodity Prices to Regular Price)								
	4 lags				12 lags			
Median	0.041				0.083			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	0.258***	0.204***	0.262***	0.389***	0.369***	0.388***	0.306***	0.397***
s.e	(0.048)	(0.046)	(0.067)	(0.068)	(0.039)	(0.039)	(0.059)	(0.059)
RetailBranded	0.258***	0.109***	0.16***	0.194***	0.136***	0.028	0.119**	0.134***
s.e	(0.034)	(0.035)	(0.049)	(0.049)	(0.035)	(0.036)	(0.05)	(0.05)
Product RevShare				-0.868***				-0.713***
s.e.				(0.108)				(0.094)
Brand RevShare				-0.456***				-0.394***
s.e.				(0.076)				(0.059)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	9951	9951	9951	9951	12627	12627	12627	12627
R^2	0.0065	0.2228	0.4728	0.4904	0.0063	0.2061	0.4526	0.4614

Panel B: Dependent Variable (Log Passthrough of Wholesale Cost Index to Regular Price)								
	4 lags				12 lags			
Median	0.073				0.088			
RetailManufactured	0.073	-0.063	-0.043	-0.008	0.297**	0.216***	0.265***	0.341***
s.e	(0.065)	(0.063)	(0.081)	(0.083)	(0.076)	(0.07)	(0.098)	(0.099)
RetailBranded	-0.141***	0.144***	0.13***	0.124***	-0.263***	0.148***	0.103***	0.11***
s.e	(0.039)	(0.035)	(0.041)	(0.041)	(0.039)	(0.033)	(0.039)	(0.038)
Product RevShare				-0.664***				-0.794***
s.e.				(0.104)				(0.105)
Brand RevShare				0.062				-0.044
s.e.				(0.066)				(0.061)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	8805	8805	8805	8805	9653	9653	9653	9653
R^2	0.0019	0.2902	0.5059	0.5082	0.0077	0.3325	0.5404	0.5441

Note: The dependent variable is the logarithm of estimated product-level pass-through using the rolling window specification given by equation 16, where the dependent variable is the change in log average monthly retail wholesale price, the independent variable is the change in the log commodity index for a linked commodity or the category-level wholesale cost commodity index, and the sample comprises the 41 months from January 2004 to May 2007. The results reported here are for estimation of equation 18 where each individual observation is a product x commodity pass-through coefficient, and use heteroskedasticity robust standard errors. Because there are sometimes multiple commodities linked to an individual product, we include commodity dummies in this regression interacted with category or subsubclass dummies where applicable. For panel B, the wholesale cost index measures are calculated using the change in log average wholesale cost for every UPC in the category that appears in all 41 months, using fixed aggregate revenue weights to aggregate up to the category level.

Table 7: Duration of Prices changes (logs)

Dependent Variable (Log Duration of Regular Price)					(Log Duration of Sales Price))				(Log Duration of Wholesale Price)			
	Median	31.9 weeks			Median	6.49 weeks			Median	37.25 weeks		
RetailManufactured	0.043	0.032	0.041	0.037	-0.783***	-0.733***	-0.599***	-0.381***	-0.292***	-0.239***	-0.308***	-0.323***
s.e.	(0.023)	(0.024)	(0.028)	(0.029)	(0.049)	(0.047)	(0.054)	(0.053)	(0.028)	(0.027)	(0.032)	(0.032)
RetailBranded	0.021	0.044***	0.051***	0.052***	-0.487***	-0.404***	-0.356***	-0.299***	-0.525***	-0.531***	-0.574***	-0.578***
s.e.	(0.014)	(0.014)	(0.015)	(0.015)	(0.028)	(0.027)	(0.028)	(0.028)	(0.017)	(0.014)	(0.017)	(0.017)
Product RevShare				0.136***				-1.302***				0.065
s.e.				(0.044)				(0.08)				(0.047)
Brand RevShare				-0.021***				-0.569***				0.048**
s.e.				(0.022)				(0.04)				(0.024)
Category	N	Y	N	N	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y
Obs	14896	14896	14896	14896	14896	14896	14896	14896	14896	14896	14896	14896
R^2	0.0004	0.1617	0.3903	0.3936	0.0359	0.2126	0.5001	0.542	0.0608	0.3706	0.5897	0.5901

Note: The dependent variables are the log of regular, sales, and wholesale price duration using Spell2. The sample is over 41 months from January 2004 to May 2007.

Table 8: Dependent variable: store/month private-label market share

	(1)	(2)	(3)	Mean
Log median household income	-0.078^{***}	-0.081^{***}		10.90
s.e.	(0.014)	(0.002)		(0.343)
Log gas price	0.135^{*}	0.023^{***}	0.009^{***}	0.616
s.e.	(0.082)	(0.003)	(0.004)	(0.225)
Unemployment rate	0.428^{*}	0.266^{***}	0.211^{***}	0.049
s.e.	(0.227)	(0.039)	(0.030)	(0.017)
Months	Jan.2004	All	All	All
Store and month FE	No	No	Yes	
Obs				
R^2	0.21	0.21	0.96	

Robust standard errors and standard deviations in parentheses. Private label share is aggregated across of 124 product categories. There are 41 months and up to 250 stores per month. Private label share and unemployment rate are measured out of 1. Private label share has mean 0.24 and standard deviation of 0.07.

A Appendix: Results from the Long-Run Pass-Through Regressions

Table 9: Retail Price and Wholesale Cost Passthrough

Dependent Variable (Log Passthrough of Wholesale Cost to Regular Price)								
	4 months				12 months			
Median	0.481				0.981			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	-0.341***	-0.561***	-0.659***	-0.587***	-0.242***	-0.139	-0.34**	-0.236*
s.e	(0.069)	(0.079)	(0.096)	(0.099)	(0.095)	(0.105)	(0.137)	(0.14)
RetailBranded	-0.489***	-0.411***	-0.403***	-0.391***	-0.239***	-0.376***	-0.419***	-0.396***
s.e	(0.042)	(0.044)	(0.052)	(0.052)	(0.055)	(0.057)	(0.068)	(0.069)
Product RevShare				-0.551***				-0.303
s.e.				(0.149)				(0.203)
Brand RevShare				-0.063				-0.218**
s.e.				(0.075)				(0.104)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	10586	10586	10586	10586	9646	9646	9646	9646
R^2	0.0142	0.0933	0.3327	0.3344	0.0025	0.0949	0.3581	0.3591

Note: The dependent variable is the logarithm of estimated product-level pass-through using the lagged specification given by equation 17, where the dependent variable is the change in log average monthly retail regular price, the independent variable is change in the log average monthly wholesale price, and the sample comprises the 41 months from January 2004 to May 2007. The results reported here are for estimation of equation 18 where each observation corresponds to an individual product pass-through coefficient, and use heteroskedasticity robust standard errors.

Table 10: Wholesale Cost and Commodity Price Passthrough

Dependent Variable (Log Passthrough of Commodity price to Wholesale Cost)								
	4 months							
Median	0.03				0.063			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	0.692***	0.616***	0.664***	0.707***	0.355***	0.425***	0.439***	0.517***
s.e	(0.071)	(0.066)	(0.087)	(0.087)	(0.067)	(0.062)	(0.07)	(0.079)
RetailBranded	0.197***	0.279***	0.301***	0.325***	0.231***	0.207***	0.221***	0.246***
s.e	(0.047)	(0.046)	(0.053)	(0.053)	(0.045)	(0.043)	(0.048)	(0.048)
Product RevShare				0.099				-0.119
s.e.				(0.142)				(0.137)
Brand RevShare				-0.6***				-0.456***
s.e.				(0.07)				(0.068)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	13633	13633	13633	13633	14682	14682	14682	14682
R^2	0.0079	0.2509	0.5215	0.5252	0.0035	0.2628	0.5159	0.5185

Note: The dependent variable is the logarithm of estimated product-level pass-through using the lagged specification given by equation 17, where the dependent variable is the change in log average monthly retail wholesale price, the independent variable is the change in the log commodity index for a linked commodity, and the sample comprises the 41 months from January 2004 to May 2007. The results reported here are for estimation of equation 18 where each individual observation is a product x commodity pass-through coefficient, and use heteroskedasticity robust standard errors. Because there are sometimes multiple commodities linked to an individual product, we include commodity dummies in this regression interacted with category or subsubclass dummies where applicable.

Table 11: Regular Price and Commodity Price/Wholesale Cost Index Passthroughs

Panel A: Dependent Variable (Log Passthrough of Commodity Prices to Regular Price)								
	4 lags				12 lags			
Median	0.041				0.083			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	0.046	0.115*	0.126	0.204**	0.255***	0.358***	0.199**	0.284***
s.e	(0.064)	(0.063)	(0.084)	(0.084)	(0.063)	(0.063)	(0.085)	(0.085)
RetailBranded	0.272***	0.018	0.038	0.049	0.208***	0.051	0.034	0.051
s.e	(0.042)	(0.044)	(0.051)	(0.051)	(0.042)	(0.043)	(0.057)	(0.051)
Product RevShare				-0.667***				-0.342**
s.e.				(0.145)				(0.148)
Brand RevShare				-0.256***				-0.355***
s.e.				(0.073)				(0.074)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	13527	13527	13527	13527	14222	14222	14222	14222
R^2	0.0031	0.1458	0.3896	0.393	0.0027	0.136	0.3788	0.3814
Panel B: Dependent Variable (Log Passthrough of Wholesale Cost Index to Regular Price)								
	4 lags				12 lags			
Median	0.649				1.473			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	0.21***	0.077	0.053	0.169	0.113	-0.066	0.026	0.21*
s.e	(0.028)	(0.088)	(0.104)	(0.107)	(0.086)	(0.087)	(0.112)	(0.113)
RetailBranded	-0.03	0.233***	0.218***	0.239***	-0.181***	0.131***	0.106**	0.141***
s.e	(0.045)	(0.045)	(0.052)	(0.052)	(0.046)	(0.046)	(0.053)	(0.053)
Product RevShare				-0.599***				-0.714***
s.e.				(0.154)				(0.162)
Brand RevShare				0.205***				-0.431***
s.e.				(0.079)				(0.081)
Category	N	Y	N	N	N	Y	N	N
Subsubclass	N	N	Y	Y	N	N	Y	Y
Obs	10175	10175	10175	10175	10265	10265	10265	10265
R^2	0.0007	0.1985	0.4185	0.4211	0.0018	0.2234	0.4535	0.459

Note: The dependent variable is the logarithm of estimated product-level pass-through using the lagged specification given by equation 17, where the dependent variable is the change in log average monthly retail wholesale price, the independent variable is the change in the log commodity index for a linked commodity or the category-level wholesale cost commodity index, and the sample comprises the 41 months from January 2004 to May 2007. The results reported here are for estimation of equation 18 where each individual observation is a product x commodity pass-through coefficient, and use heteroskedasticity robust standard errors. Because there are sometimes multiple commodities linked to an individual product, we include commodity dummies in this regression interacted with category or subsubclass dummies where applicable. For panel B, the wholesale cost index measures are calculated using the change in log average wholesale cost for every UPC in the category that appears in all 41 months, using fixed aggregate revenue weights to aggregate up to the category level.