Market Structure and Cost Pass-Through in Retail

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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 for 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.

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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 components of final prices 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 structures. 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 exhibit greater flexibility and higher exchange rate pass-through (Bernard et al. (2006), Neiman (2010), Neiman (2011), Hellerstein and Villas-Boas (2010)). This is consistent with a theoretical model where vertical integration leads to intermediate goods being priced at or closer to marginal cost, which reduces or eliminates the variable markups on intermediate goods that can act as a buffer between costs and prices.

In this paper we use data from a major American supermarket chain to estimate thousands of product level pass-through rates and assess their relation to the vertical and horizontal characteristics within narrowly defined categories. We are able to examine two steps in the cost pass-through chain – commodity prices to wholesale prices, and wholesale prices to retail prices. This is critical given uncertainty about whether retailer self-reported cost measures accurately reflect allocative marginal costs, particularly for intra-firm transactions, as we are able to examine pass-through from commodity prices to retail prices directly. We distinguish between three different vertical structures – national brands, private labels manufactured by other firms and private labels manufactured directly by the retailer – which represent decreasing degrees of double-marginalization and increasing control of the value chain by the retailer.[1] This distinction is also critical for our empirical analysis, as the magnitude of the vertical effect we identify is much larger and more robust for products directly manufactured by the retailer. We are also able to control for product heterogeneity at a fine level and measure both product and firm (brand) market shares, which is important for as-

[1]National brand manufacturers charge a markup over the marginal costs of physical production as well as associated services like marketing and distribution. Private label manufacturers charge a markup over physical production but typically do not undertake marketing or distribution activities. When the retailer manufactures the good directly, it presumably sets the wholesale price of the private labels it manufactures equal to the marginal manufacturing cost though how this is shows up in the retailer self-reported cost measure is unclear.

sessing the role of horizontal market power given the ubiquity of multi-product firms.

To motivate our empirical analysis we develop a simple model combining Spengler (1950) and Dornbusch (1987) that highlights the interaction between horizontal and vertical structure and its implications for pass-through of commodity to wholesale to retail prices. Our exploration of the interaction between horizontal and vertical market structure is novel to the empirical pass-through literature to the best of our knowledge and has both a micro and a macro implication. The micro implication is that ceteris paribus vertical integration raises market share by lowering price; in a model where market share lowers pass-through, this generates a countervailing force that partly offsets the direct impact of vertical integration which is to increase pass-through (conditional on market share). This generates a classic omitted variable bias in regressions that omit either vertical or horizontal variables, biasing the included variable towards zero. The macro implication relates to the observation that vertical integration in general and private labels in particular are often associated with increased market power for integrating firm. For example, European countries with more concentrated retail sectors have higher private label shares, and we find some suggestive evidence that the net effect lowers pass-through of commodity prices to retail prices. This has some bearing on findings about general trends in cost pass-through to consumer prices. In a domestic context, Weinhagen (2002) uses BLS aggregate data to show that between 1974-1989 and 1990-2001, pass-through from crude/intermediate goods prices to finished goods/CPI prices fell, while pass-through from finished goods prices to CPI increased. In international trade, Bailliu and Bouakez (2004), Gagnon and Ihrig (2002), and Frankel et al. (2005) have documented the decline in exchange rate pass-through to import prices for industrialized and emerging-market countries in recent years, and some have hypothesized that changes in market structure have played some role in this decline. A decline in pass-through would be be at odds with an increased reliance on intra-firm trade if the results of Neiman (2010) are taken in isolation, but if the rise in intra-firm trade is driven by rising horizontal market power of multinationals this effect could dominate any changes in vertical structure.[2]

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. As a check on whether our retailer is representative we show that similar results are obtained using data from multiple retailers in a smaller number

[2]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.

of product categories.

Our results confirm that horizontal and vertical market structure interactions are important, as vertical-integration lowers double-marginalization, which can raise pass-through, but also lowers price and hence typically increases market share, which can lower pass-through. We find that doubling the product market share within a narrow category reduces pass-through by 73%, and doubling the brand share reduces it by 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 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 when there are additional retail marginal costs and private labels either have lower wholesale prices than comparable national brands or higher retail marginal cost – both of these are plausible and the former is directly verifiable in 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 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%.[3] As private labels are often perceived as lower quality and/or better value relative to national brands, the recent growth of private labels 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 private label shares matter for cost pass-through is an open question that we are the first to address directly using several data sources.

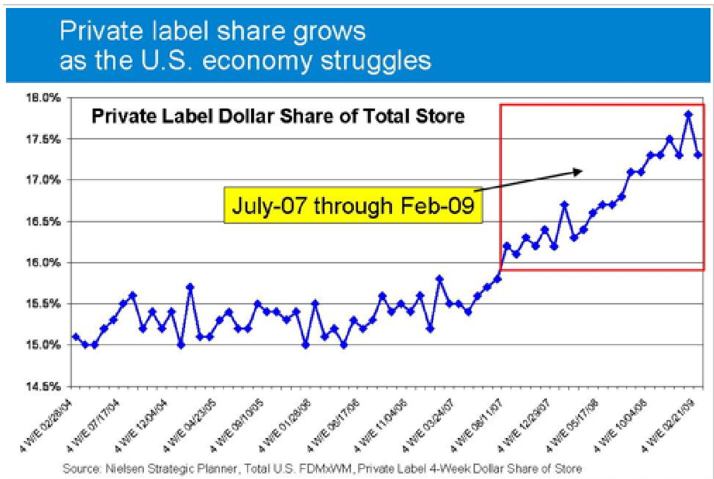


Figure 1: Share of private label goods over the years

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 structure respectively while Berman et al. (2011) use French export data.[4] 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[5] 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"

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

[4]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.

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

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. 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 being otherwise similar (though still potentially non-allocative). Our data also enable 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). This is important since differences in the share of marginal costs subject to a cost-shifter (e.g. a commodity price or exchange rate) can be another source of incomplete and variable pass-through across products.

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 dimension 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 distinguishing between private labels that are manufactured or not manufactured by the retailer and by focusing on the differential pass-through of commodity and wholesale prices to retail prices across many different product categories due to market structure.

Balanced against these contributions, our study has several limitations. First, the time-series dimension of our data is relatively short for our main sample (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 main results only apply to a single retailer. We use supplemental IRI Symphony data that covers multiple US retailers and a longer time period (but a smaller number of product categories) to verify that our main results hold. Third, we do not have complete data on the cost structure so differences in non-commodity marginal costs may drive some of our results despite what we think are the best controls for product and consumer heterogeneity available (e.g. similar sized cartons of 2% organic milk sold by the same retailer).

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 our main data set. Section 4 presents our main empirical findings on pass-through, some robustness checks, and a replication of our main findings on a multiple-retailer dataset. Section 5 discusses the macro implications of our findings with respect to the US business cycle and a cross-section of European countries with differing private label market shares. Section 6 concludes.

2. Model

2.1. Basic setup

We first describe pass-through with horizontal and vertical market power in the simplest partial equilibrium setting with only one retailer and manufacturer that take the cost of competitors as given. Our treatment is similar to the classic double-marginalization problem analyzed in Spengler (1950), which is similar to a Cournot Oligopoly with a Stackelberg leader. The retailer in the model takes its marginal cost as given. The retailer sets the price for brand i as a markup over marginal cost following the conventional formula. We denote the wholesale cost paid by retailer i as w_i and 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, some of them will likely have a 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 would 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:

$$p_i = \frac{\epsilon_i}{\epsilon_i - 1}(w_i + \theta_i^r), \; where \; \epsilon_i \equiv -\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i}. \tag{1}$$

The manufacturer sets the wholesale price taking into account its own demand curve and elasticity, which depend indirectly on retail markups and pricing decisions. 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

$$w_i = \frac{\mu_i}{\mu_i - 1}(c + \theta_i^m) \tag{2}$$

The elasticity of demand facing manufacturers μ_i is given by

$$\mu = -\frac{\partial q_i}{\partial w_i}\frac{w_i}{q_i} = -\left(\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i}\right)\left(\frac{\partial p_i}{\partial w_i}\frac{w_i}{p_i}\right) \tag{3}$$

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

$$\frac{\partial p_i}{\partial w_i}\frac{w_i}{p_i} = \left(\frac{1}{1 + \frac{\partial \epsilon_i}{\partial p_i}\frac{p_i}{\epsilon_i}\frac{1}{(\epsilon - 1)}}\right)\frac{w_i}{w_i + \theta_i^r} \tag{4}$$

The first equality in this equation 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 ($\frac{w_i}{w_i + \theta_i^r}$).[6] Pass-through from wholesale to retail prices in the model is incomplete (< 1) unless there are no additional marginal costs ($\theta_i^r = 0$), there are no markups over marginal cost ($\epsilon \to \infty$) or the markup is invariant ($\frac{\partial \epsilon_i}{\partial p_i}\frac{p_i}{\epsilon_i} = 0$, the case with CES preferences).

Based on equation 3, manufacturers face a lower demand elasticity than retailers ($\mu_i < \epsilon_i$) when retail pass-through is below one. In this case the manufacturer markup and the retailer markup are strategic substitutes. The intuition is that an increase in wholesale price is not fully passed-through to consumers because retailers adjust their markups downward when their costs increase (or have to pay other costs that do not change), making the quantity purchased less elastic to changes in wholesale prices than retail prices. This also implies that

[6]Note that this issue arises in analysis of exchange-rate pass-through as well, often through the form of imported intermediate inputs whose prices are affected when the exchange rate changes (e.g.Gopinath and Itskhoki (2010)) when analyzing at the dock prices and non-traded costs when analyzing exchange-rate pass-through to consumer prices of imported goods.

pass-through from manufacturing cost ($c + \theta_m$) to wholesale price will typically be lower than from wholesale cost to retail price, though the presence of non-commodity retail and manufacturing marginal costs (θ_r and θ_m) can potentially overturn this when they vary across products.

With both retailing and manufacturing firms following their respective pricing rules, the equilibrium retail price is

$$p_i = \frac{\epsilon_i}{\epsilon_i - 1}\left(\theta_i^r + \frac{\mu_i}{\mu_i - 1}[c + \theta_i^m]\right) \tag{5}$$

Equation 5 makes it explicit that retail and manufacturer markups over marginal cost give rise to double marginalization. Combined with a particular retail demand function, the system of equations for retail and wholesale prices will typically have a unique equilibrium but no closed-form solution.

Now consider the case where the retailer and manufacturer described above decide to vertically integrate. This would imply a pricing rule given by

$$p_i^{VI} = \frac{\epsilon^{VI}}{\epsilon^{VI} - 1}[c + \theta_i^r + \theta_i^m] \tag{6}$$

which eliminates the double marginalization in equation 5 – the integrated firm internalizes the negative pricing externality. This has the implication that the integrated firm will feature lower retail prices and larger total profits:

$$\frac{1}{\epsilon^{VI} - 1}[c + \theta_i^r + \theta_i^m]q_i^{VI} = \pi^{VI} > \pi^r + \pi^m = \left(\frac{1}{\epsilon - 1}\left[\theta_i^r + \frac{\mu}{\mu - 1}(\theta_i^m + c)\right] + \frac{1}{\mu - 1}[c + \theta_i^m]\right) q_i \tag{7}$$

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.[7]

While the implications of vertical integration for pricing and profits are unambiguous, the implications for pass-through in this model are ambiguous. The rise in volume ($p^{VI}q^{VI} > pq$) generated by vertical integration is central to our analysis as in some commonly used demand systems this rise in market share will generate an increase in horizontal market power and thereby decrease pass-through. Commodity pass-through ($\frac{\partial p}{\partial c}\frac{c}{p}$) under vertical integration is given by:

$$\left(\frac{1}{1 + \frac{\partial \epsilon^{VI}}{\partial p^{VI}}\frac{p^{VI}}{\epsilon^{VI}}\frac{1}{\epsilon^{VI} - 1}}\right)\frac{c}{c + \theta_i^m + \theta_i^r} \tag{8}$$

while under arm's-length pricing it is given by the combined retail and wholesale commodity

[7]Note that under the additional assumption that pass-through is increasing in cost (which applies to the functional form we assume in the next section) we will have $\epsilon^{VI} < \mu < \epsilon$.

price pass-through:

$$\underbrace{\left(\frac{1}{1+\frac{\partial \epsilon}{\partial p}\frac{p}{\epsilon}\frac{1}{(\epsilon-1)}}\right)\frac{w_i}{w_i+\theta_i^r}}_{retail}\underbrace{\left(\frac{1}{1+\frac{\partial \mu_i}{\partial w_i}\frac{w_i}{\mu_i}\frac{1}{(\mu-1)}}\right)\frac{c}{c+\theta_i^m}}_{wholesale}=\frac{1}{1+\frac{\partial \epsilon}{\partial p}\frac{p}{\epsilon}\frac{1}{(\epsilon-1)}}\frac{1}{1+\frac{\partial \mu_i}{\partial w_i}\frac{w_i}{\mu_i}\frac{1}{(\mu-1)}}\frac{c}{c+\theta_i^m+\frac{\mu_i-1}{\mu_i}\theta_i^r} \tag{9}$$

The arm's-length pass-through equation reveals that markup adjustment by manufacturers ($\frac{\partial \mu_i}{\partial w_i}\frac{w_i}{\mu_i}$) can provide an additional source of incomplete pass-through compared to the vertically integrated case; holding retail pass-through constant, this would tend to lower pass-through for the arm's-length case compared to the vertically integrated case. This first force for higher pass-through ("markup adjustment channel") is only relevant when demand elasticities are variable but the economic intuition is fairly simple as the term is completely absent in the vertically integrated case but less than one when the elasticity μ is finite and increasing in price ($\frac{\partial \mu_i}{\partial w_i}\frac{w_i}{\mu_i}>0$).

Offsetting this first force is the term $\frac{\mu_i-1}{\mu_i}$ in the denominator of the arm's-length pass-through equation. This second force ("cost channel") only arises when there are retail marginal costs, but in this case the level of the manufacturer's markup directly raises pass-through since it increases $w=\frac{\mu}{\mu-1}(c+\theta_m)$ and hence the share of the retailer's marginal cost affected by the shock ($\frac{w}{w+\theta_r}$). Pass-through is rising in the commodity share of total costs – $\frac{c}{c+\theta_m+\theta_r\frac{\mu-1}{\mu}}$ – which in the presence of retail costs is amplified by the degree of double-marginalization. For the vertically-integrated case this is absent (effectively $\mu\to\infty$) which results in lower pass-through. This term also provides insight into how shifting aspects of production between manufacturers and retailers could affect pass-through in the arm's-length case. If private labels are equivalent to a shift from θ_m and θ_r to $\theta_m-\delta$ and $\theta_r+\delta$, this raises commodity to wholesale pass-through more than it lowers wholesale to retail pass-through and the net effect is to increase pass-through. Thus while this channel lowers commodity pass-through for retailer manufactured private labels, it always raises it for externally manufactured private labels. Note that in both cases the wholesale to retail pass-through is lower due to this channel.

A third force ("market power channel") is central to our empirical analysis and highlights the interaction between the horizontal and vertical effects of the model – vertical integration affects prices and market shares, which can potentially generate feedback effects on the markup and markup elasticity. Under many demand systems (including the one we investigate in greater detail in the quantitative results below) firms with larger market shares will face lower demand elasticities and hence feature higher markups, which could in turn raise the markup elasticity ($\frac{\partial \epsilon}{\partial p}\frac{p}{\epsilon}$ and $\frac{\partial \mu_i}{\partial w_i}\frac{w_i}{\mu_i}$) and lower pass-through. Thus while vertical integration or a shift in costs from the manufacturer to the retailer (e.g. going from θ_m and θ_r to $\theta_m-\delta$ and $\theta_r+\delta$) can raise pass-through through the first two forces described above, by raising market share they generate a countervailing force that lowers pass-through.

What determines which of these forces will dominate? We explore this with some quantitative simulations in the next section, but first conclude with a few general observations. The first force we identify (markup adjustment) will be stronger when the markup elasticities are high and markups are highly variable. The second force (cost share) will be stronger when either retail marginal costs (θ_r) and/or the manufacturer markup level (μ) are high. The third force (market power) will be strongest when vertical integration delivers the largest increase in market share and the markup elasticity is most sensitive to market share.

Note that in the case of shifting costs from manufacturer to retailer (e.g. the non-manufactured private label goods where the only difference is the share of total marginal costs paid by the retailer) the first force is absent and the second force strictly increases pass-through. The third force still partly offsets the second, but as an indirect consequence of the second it only generates a second order countervailing effect, and the net effect of shifting from θ_m and θ_r to $\theta_m-\delta$ and $\theta_r+\delta$ increases pass-through unambiguously. In the case of full vertical integration all three forces play a role, and the cost channel can be strong enough to outweigh the markup adjustment channel even when the market power channel is absent.

2.2. Quantitative analysis

To provide some additional insight we consider a particular version of the previous model along the lines of Dornbusch (1987). Consumer utility is CES and given by

$$C = \left(d_i^{\frac{1}{\eta}} q_i^{\frac{\eta-1}{\eta}} + z^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}} \tag{10}$$

where η is the CES elasticity of substitution, d_i denotes the "quality" of the good (a factor that shifts demand given price) and good z is an "outside good" or the rest of the market, whose price the retailer takes as given. We get the standard CES cost-of-living index $P = \left(d_i p_i^{1-\eta} + p_z^{1-\eta}\right)^{\frac{1}{1-\eta}}$.

The key assumption that allows variable elasticity is that while the retailer of brand i takes p_z and the price of the other brand as given when setting the price, it takes account of the effect of its own price p_i on the overall price index P. This implies a simple elasticity of demand formula:

$$-\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i} = \epsilon_i = (\eta(1-S_i)+S_i) \tag{11}$$

where the elasticity of demand ϵ_i is decreasing in the market share (S_i) of the firm. Thus firms with more horizontal market power (larger market shares) face less elastic demand and set higher markups. This yields a simple formula for retail pass-through:

$$\frac{\partial p_i}{\partial w_i}\frac{w_i}{p_i} = \left(\frac{\eta(1-S_i)+S_i}{\eta}\right)\frac{w_i}{w_i+\theta_i^r} \tag{12}$$

where we see that a retailer with no market power ($S_i = 0$) only has incomplete pass-through from the presence of local retail costs, but that a retailer with positive market power ($S_i > 0$) has incomplete pass-through due to markup adjustments after a cost shock. Hence this model not only features variable markups that increase in market share, it features a markup elasticity that is increasing in market share (and hence pass-through that is decreasing in market share).

While this model has no explicit solution, we provide some illustrative simulations. We hold set $\eta = 4$, $c = 1$, $\theta_m + \theta_r = 12$ and analyze the effects of a 0.1% increase in the commodity price c to 1.001 in all of our simulations. We picked these parameters to roughly match a few data moments from our data (i.e. low commodity pass-through suggests $\theta_r + \theta_m$ are high relative to c, higher pass-through from wholesale to retail implies higher θ_m than θ_r, the ratio of retail to wholesale costs in our data together with assumptions on θ_r pin down the elasticity η, etc.) though our goal here is only to illustrate the quantitative impact of the different forces in the model. We consider three broad scenarios based on different prices of the outside good z, setting p_z equal to 50, 25, and 10. For each scenario we calculate five cases:

1. National brand (NB): the arm's-length pricing case (equation 5) where $\frac{\theta_r}{\theta_r+\theta_m} = \frac{1}{6}$ and $d_i = 4$
2. Private-label not vertically-integrated (PL-NVI): the arm's-length case where $\frac{\theta_r}{\theta_r+\theta_m} = \frac{1}{2}$ and $d_i = 4$ (so compared to the first case the retailer has a higher share of the non-commodity cost)
3. Private-label vertically-integrated (PL-VI): pricing based on equation 6 and $d_i = 4$
4. Constant-market share PL-NVI: similar to case 2, but we vary d_i such that the initial market share is exactly equal to case (1)
5. Constant-market share PL-VI: similar to case 3, but we vary d_i such that the initial market share is exactly equal to case (1)

The PL-NVI case captures the idea that private labels that are externally manufactured represent a shifting of some activities (marketing and distribution) to the retailer from the manufacturer, without eliminating the need for these activities or eliminating the ability of the manufacturer to charge a markup over marginal cost. Recall that the three forces in the model are (1)full integration removes markup adjustment by manufacturers (raises pass-through), (2)the presence of retail costs lower's pass-through for the vertically integrated case relative to arm's-length, particularly when the retailer share of retail plus manufacturing marginal costs is higher (the PL-NVI case), and (3)both types of private labels lead to lower prices, higher market shares, higher markups, and lower pass-through when the markup elasticity is increasing in the markup. For the constant-market share cases listed above, the idea is to shut-down the third force in our model (the feedback from vertical integration to horizontal market power due to price reductions and market share increases) to isolate the combined effect of the first two forces.

Table 1 presents the results and reports the price, market share, wholesale to retail pass-through and commodity to retail pass-through for all three broad scenarios and the five cases within each scenario. Scenario 1 illustrates a case where market shares are high because the outside good z is expensive. In this scenario, the first force dominates the second and third forces, so pass-through is increasing from NB to PL-NVI to PL-VI. Holding constant market share (by lowering d for the PL-NVI and PL-VI cases below 4) we see that this effect is even bigger, an illustration of how not conditioning on market share could lead to downward biased estimates of the effect of vertical structure on pass-through. Note also that while commodity to retail pass-through is higher for the PL cases, wholesale to retail pass-through is actually lower than for national brands. The reason for this is clear from equation 12 where even conditional on market share pass-through will be lower when w is lower, which is precisely the case when w contains a lower share of the total marginal costs (the PL-NVI case) or there is no markup on retail inputs (the PL-VI case).[8] This also means that commodity to wholesale pass-through is higher for the PL-NVI and PL-VI cases which can be easily backed out from the two estimates reported in the table.

Scenario 2 illustrates the case with intermediate cost of outside good z, so firms start with lower market share. In this case the first force still dominates the second force, but the combined effect of the second and third force yield lower unconditional pass-through for the PL-VI case than the NB case. Pass-through is still higher for the PL-NVI case because in this case the second force works for higher pass-through and the third force is only second order. Note that conditional on market share, pass-through is higher for PL-VI than PL-NVI and NB, confirming that the first force dominates the second. Finally, Scenario 3 illustrates the case with a low cost of the outside good z, so market share and markups are smaller and less variable. In this case the second force dominates the first force so that even conditional on market share, PL-VI goods have lower pass-through than NB or PL-NVI goods.

The intuition for the differences between the scenarios is that the first force (markup adjustment channel) depends on the markup elasticity, which is increasing in the initial market share and increasing in the gap between the atomistic firm elasticity (η) and the large firm elasticity (set to 1 in this case though this can be generalized). Otherwise the third force (mar-

[8]For these simulations we assume that the retailer sets $w = \theta_m + c$.

ket share channel) always lowers pass-through for the PL-VI and PL-NVI case. The second force (cost channel) always raises pass-through for PL-NVI compared to NB but lowers it for PL-VI compared to NB – the strength of this channel also depends on η, as raising η raises the elasticity for every term and lowers the degree of double-marginalization ($\frac{\mu}{\mu-1}$) which is what generates the cost channel. Thus raising η reinforces the markup adjustment channel and weakens the cost channel, making scenario 1 more likely.

We take four lessons from this simple model that are relevant for our empirical analysis:

- In our setting, unconditional commodity pass-through can be higher or lower for national brands compared to vertically integrated goods (while externally manufactured private labels should always have higher pass-through). Econometrically, we would expect the effect of the "private label" treatment to be quite heterogeneous across categories given the differing strength of the forces we identify.
- Conditioning on market share could raise the commodity pass-through of private labels relative to national brands, because vertical integration/private labels should lead to higher market share which can lower pass-through. Econometrically, omitting market share introduces an omitted variable bias that biases towards zero the positive effect of vertical integration/private labels; similarly omitting vertical structure could bias towards zero the (negative) estimates of the effect of market share.
- Pass-through from wholesale to retail prices should be lower for private labels (vertically integrated or otherwise), though market share should still have a negative effect on pass-through at this level.
- Differences in quality/demand (d) or marginal cost shares ($c, \theta_m + \theta_r$) could confound estimation, so looking at similar goods (sold to similar customers, e.g. in the same store) is important. Differences in quality d get absorbed into market shares in our model, so the model's prediction about the direction of omitted variable bias from ignoring market shares relies on the quality of private label goods being similar (or not too far below) that of national brands.

2.2.1. 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 overall, and that consistent with theory it operates primarily at the manufacturer level (wholesale price setting) rather than at the retail level. Multi-product retailers effectively face this positive externality across all of their goods, so only individual market shares should matter to them, along with their local retail market share, which is not observable in our data set.

Expanding our model to multiple firms is fairly straightforward but requires additional assumptions about the nature of the competitive equilibrium (Bertrand vs. Cournot, timing of price-setting by multiple firms) and the presence of an outside good. While our analysis applies to a firm specific shock (holding p_z the price of other goods constant), a common shock across firms – like a commodity cost shock – will lead to higher pass-through than an idiosyncratic cost shock. When the price level of the competition p_z is correlated with c, it allows the firm to pass on more of the increase in c to consumers. In a more general setting, the entire distribution of other firms could matter for the category level pass-through of common cost shocks. For example, Auer and Schoenle (2012) show that the entire distribution of firms can help predict pass-through differences across sectors, trade partners and sector-trade partner pairs. We abstract from these considerations in our empirical analysis by comparing pass-through rates across products with different vertical structures and market shares within narrow categories (conditioning on category fixed effects) rather than trying to explain differences in pass-through across categories. While our simple model's predictions still map qualitatively into the empirics when extended to multiple firms, a quantitative assessment would require information on the precise market structure (with multiple multi-product retailers and manufacturers) and the entire correlation structure of cost shocks.

2.3. 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 (whose manufacturers can sell to multiple retailers). We later present some evidence that categories with vertically integrated private labels are typically larger than those with externally manufactured private levels, and provide further evidence of a correlation between private label market share and supermarket concentration ratios across European countries.

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 ($c + \theta_m^i + \theta_r^i$ 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):

$$\pi_{VI} = \frac{1}{\epsilon^{VI} - 1}[c + \theta^r + \theta^m]q^{VI} \tag{13}$$

partial integration/third-party manufacture (PI)

$$\begin{aligned}\pi_{PI}^r + \pi_{PI}^m = q^{PI}\{\frac{1}{\epsilon^{PI} - 1}\left[r^{PI}(\theta^r + \theta^m) + \frac{\mu}{\mu - 1}((1 - r^{PI})(\theta^r + \theta^m) + c)\right] \\ + \frac{1}{\mu^{PI} - 1}[c + (1 - r^{PI})(\theta^r + \theta^m)]\}\end{aligned} \tag{14}$$

and national brand (NB)

$$\begin{aligned}\pi_{NB}^r + \pi_{NB}^m = q^{NB}\{\frac{1}{\epsilon^{NB} - 1}\left[r^{NB}(\theta^r + \theta^m) + \frac{\mu}{\mu - 1}((1 - r^{NB})(\theta^r + \theta^m) + c)\right] \\ + \frac{1}{\mu^{NB} - 1}[c + (1 - r^{NB})(\theta^r + \theta^m)]\},\ with\ r^{NB} < r^{PI}\end{aligned} \tag{15}$$

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. 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, but it cannot control for differences in pass-through arising from different commodity (or wholesale) cost shares. While we control for product heterogeneity as much as possible using the narrowest classification in our data, without complete cost data or structural estimates of marginal cost for each of our products we cannot rule out that the non-commodity marginal costs may differ for national brands and private labels. However, if the cost shares are similar for vertically integrated and externally manufactured private labels, which seems reasonable given the comparable "quality" and advertising for these goods, a comparison of these two types of goods will provide evidence that is more robust to this critique.

2.4. 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

$$\pi(p^*(c), c) - \kappa \; vs. \; \pi(p^0, c) \tag{16}$$

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).[9] 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).[10]

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.

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

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

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 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:

$$\overline{p}_{i,m} = \frac{\sum_{j=1}^{J_{i,m}} p_{i,j}}{N_{i,m}} \tag{17}$$

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 for another reason – 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. This is one reason why our setup, which allows us to examine pass-through from commodity prices to retail prices, bypassing wholesale costs completely, is potentially advantageous for identifying the effects of vertical integration on pass-through.

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 sell 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.[11] 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 4 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.[12] Using commodity prices as cost measure ensures that a retail price/cost pass-through regression can be run with an allocative, market-based

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

[12]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.

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 category.

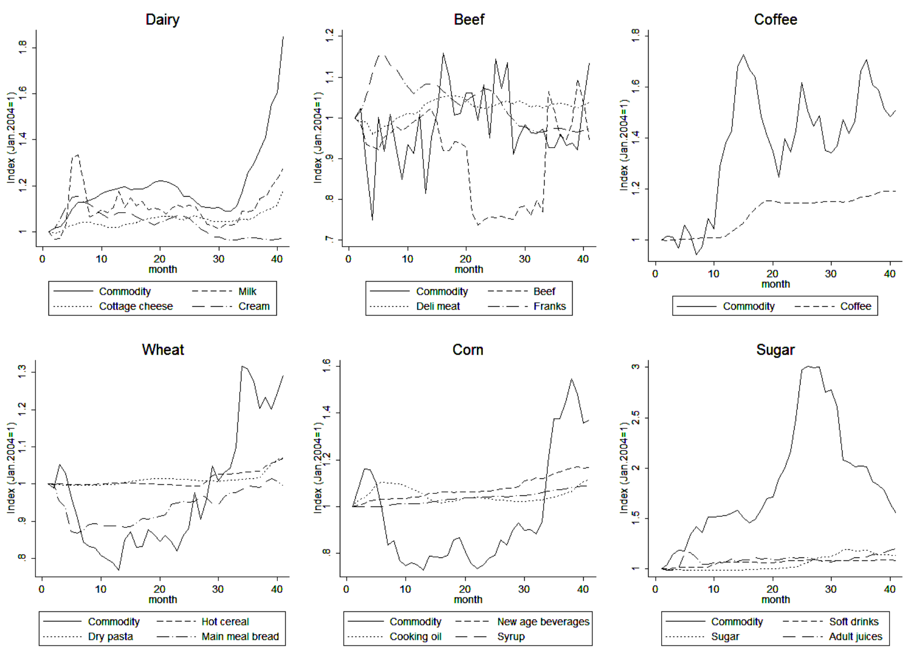
Figure 2 presents some time-series plots of the commodity indexes we use and the wholesale cost indexes of some associated categories. Commodity prices during this period are generally trending up, particularly in late 2006 and early 2007, but to varying degrees, and there are substantial periods of increase and decrease for 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.

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.[13] 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

[13] 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.

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.

upper bound.

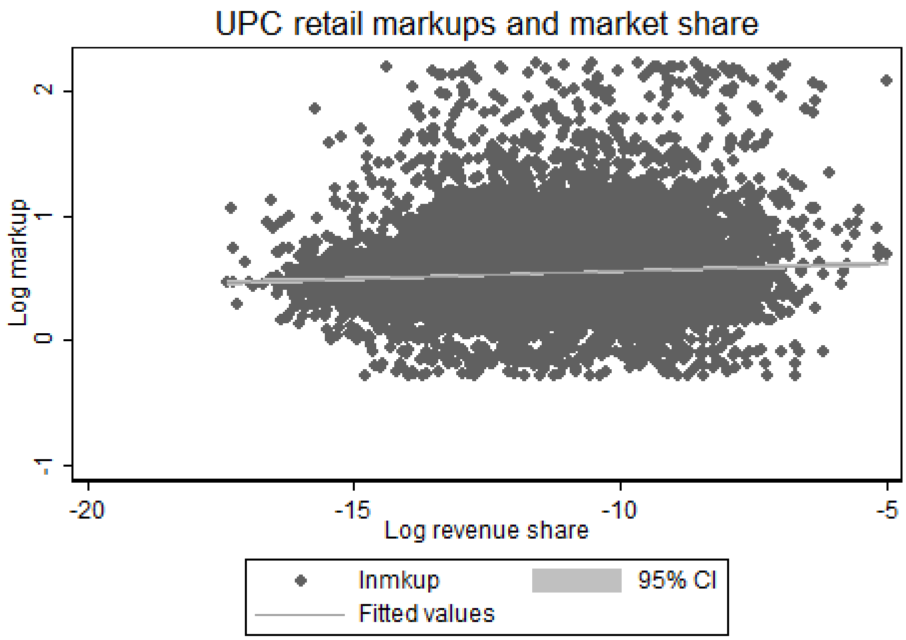
We adopt two different procedures to deal with missing values that are now standard in the literature (see Nakamura and Steinsson (2008) and Kehoe and Midrigan (2008)). They are described in detail in Table 2. The first procedure, referred to as 'spell1' combines spells on both sides of a missing spell 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 3 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 4 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 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.

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 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).

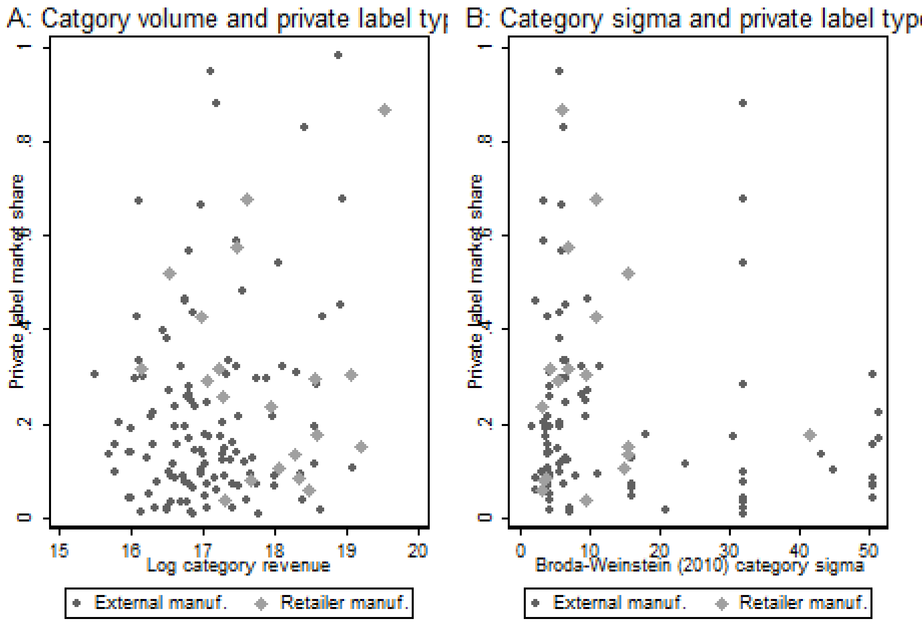
4.1. Pass-through: empirical approach

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:

$$\Delta^K logP_{i,t} = \alpha_i + \beta_i^K \Delta^K logC_{i,t} + error_{i,t} \tag{18}$$

where i is the UPC, t is the month, P is the price measure which is the unweighted monthly average defined in equation 17, 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 for each UPC separately at different horizons with $K = 4, 8, 12$ for the 41 months in our sample. We choose $K = 12$ or annual windows for our baseline results as our aim is to capture longer-term pass-through, and most products in our sample change prices at least once per year – price-stickiness is more of an issue when looking over shorter horizons. Our measure of pass-through is β^K, specific to a UPC and a horizon.

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.

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:

$$\Delta logP_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_i^k \Delta logC_{i,t-k+1} + error_{i,t} \tag{19}$$

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.[14]

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

[14]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.

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 but very heterogeneous across products and categories. Overall commodity pass-through to products is low, which leads to a substantial number of negative pass-through estimates in our sample. Similar results have been obtained in other studies of commodity pass-through (Dube and Gupta (2008), Kanishka Misra and Singh (2010)) and in studies of the transmission of exchange rate changes to at the dock and consumer prices of imported products (Berger et al. (2011)). Figure 5 presents the distribution of pass-through estimates using either the rolling window or lagged specification at the twelve month horizon across UPCs.[15] This reveals very low pass-through from commodity prices to retail or wholesale prices (with many negatives but a positive median) and generally much higher pass-through from wholesale costs or the wholesale price index to retail prices (with some negatives but a substantially higher median).[16] When we restrict to products with positive pass-through, we find median pass-through from wholesale prices to retail prices around 70%, while pass-through from commodity prices to wholesale prices is much lower at about 5%. The combination of these effects generates pass-through from commodity to retail prices of a comparable magnitude to the pass-through from commodity to wholesale prices.[17] Pass-through from the wholesale price index to retail prices is much higher than for commodity prices suggesting that this may provide a better measure of aggregate cost pressures facing UPCs in a particular category, although this measure is arguably less exogenous than commodity prices in the sense that it could be driven by shocks to demand for individual products that have a large weight in a category.

4.2. Pass-through and market structure

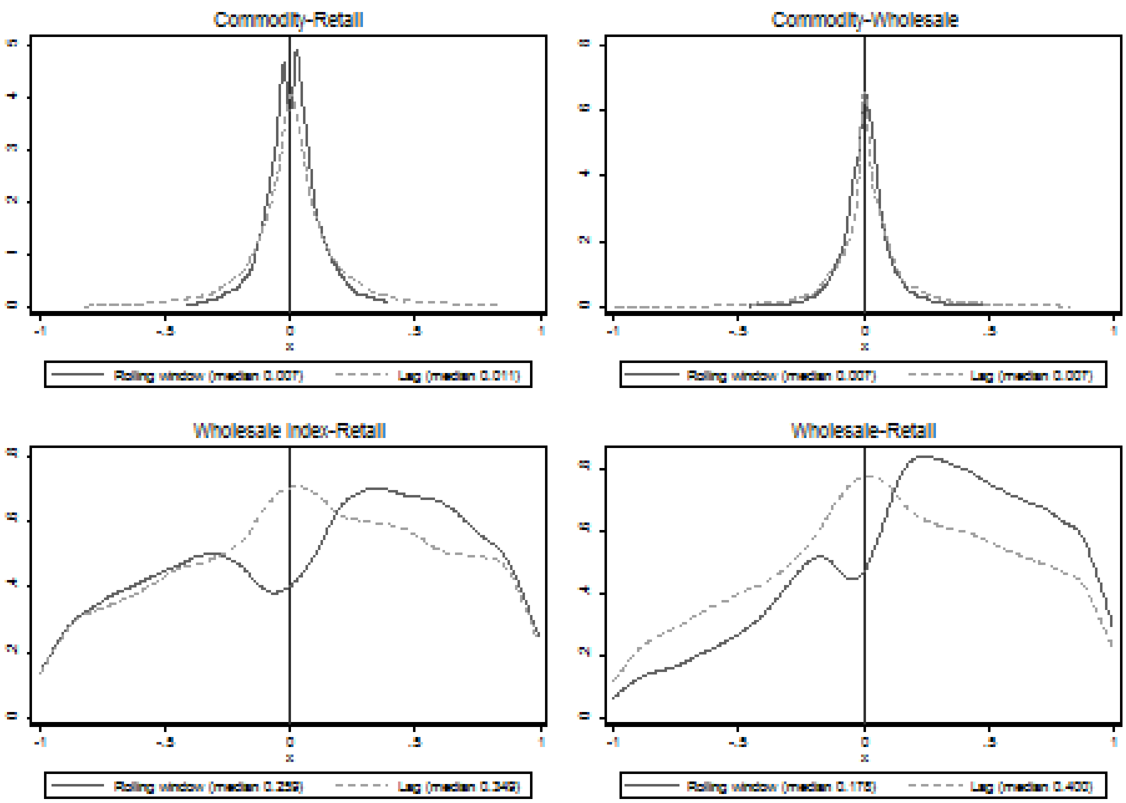
With product-level pass-through estimates in hand, we now address our central question – how do vertical and horizontal market structures affect product-level cost pass-through? Our preferred specification is a regression of the pass-through coefficient on dummies for UPCs that are manufactured or branded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

[15] Note that for commodity pass-through we sometimes have multiple commodities per UPC.

[16] For commodity to retail price pass-through 31% are positive and statistically significant at the 5% level and 25% are negative and significant. For wholesale price to retail price pass-through 48% of the coefficients are positive and statistically significant at the 5% level and 13% are negative and significant.

[17] We address the robustness of our results to the use of negative pass-through estimates in section 4.3. We have also explored specifications that allow positive and negative commodity price changes to have different effects, i.e. asymmetric pass-through. While we find that pass-through of negative cost changes is typically smaller in magnitude than pass-through of positive cost changes (similar to Kanishka Misra and Singh (2010) who look at pass-through in liquid milk), allowing for asymmetric pass-through has little impact on our main results.

Figure 5: Distribution of first-stage pass-through estimates for 12 month horizon



revenue share and dummies for each comparison group:

$$\begin{aligned}\ln \hat{\beta_i^K} = \alpha_{comparison} + \gamma_1 I[Retail\ Manufactured] + \gamma_2 I[Retail\ Branded] \\ + \gamma_3 Product\ RevShare_i + \gamma_4 Brand\ RevShare_i + \epsilon_i\end{aligned} \tag{20}$$

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 focus on the twelve month rolling window pass-through specification (equation 18) and begin with category dummies. We include the vertical (private label) variables in column 1, the horizontal (revenue share) variables in column 2, and then both sets of variables combined in column 3 – the changes from columns 1 and 2 to column 3 reveal the "omitted variable bias" caused by considering only vertical and horizontal market structure in isolation and ignoring the interaction effects we emphasize in the model. In columns 4 through 6 we use subsubclass dummies, which should make the products very comparable, and consider the same three specifications. In column 7 we add the median (across stores and periods) price as a control variable – to the extent that the effect of vertical integration is operating through prices we would expect this to lower the coefficient on the private label dummies. In column 8 we report results for the 4 month rolling window using the specification in column 6 – in general are results are quite similar using different horizons.[18] In this two-step estimation, the dependent variable in the second stage is a vector of estimated pass-through coefficients from the first stage, which makes heteroskedasticity is a serious concern. Following the suggestion of Lewis and Linzer (2005), we use OLS with Eicker-White robust standard errors.[19] We later report results using alternate specifications including a one-step procedure.

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 using category and subsubclass dummies. 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 $R^2 = 1$ or precisely estimated pass-through coefficients of zero) and trim the 1% tails of the pass-through distribution.

Table 5 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

[18]See Table 8 where we present some results for the lagged pass-through specification and using sales prices instead of regular/list prices.

[19]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.

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.[20] 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 commodity. Table 6 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 (7)) 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.

[20]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.

Finally, Table 7 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 (7) 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. 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.

Panel B of Table 7 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. The results for market share are similar for product market share but generally insignificant for brand market share.

Qualitatively our results are in line with our model, in that vertical structure has the expected (differential) effect on different stages of cost transmission, neglecting either the vertical or horizontal characteristic of products biases the coefficients on the other characteristic towards zero due to the interaction effect. Overall our findings suggest that on average the products in our sample behave similarly to the model under the parameters in Scenario 1 in Table 1. We also note that given our parameter estimates, at the individual product level the vertical effect of private labels dominates the horizontal effect, particularly for the retailer manufactured private labels – given the average differences in market shares of private labels and national brands in the data (see Table 4) the average private label product has higher pass-through compared to the average national brand in the same category or subsubclass. However, our results also emphasize that a rise in private labels will have a much weaker effect on pass-through when it replaces competing products with small market shares than when it gains market share at the expense of large national brands.

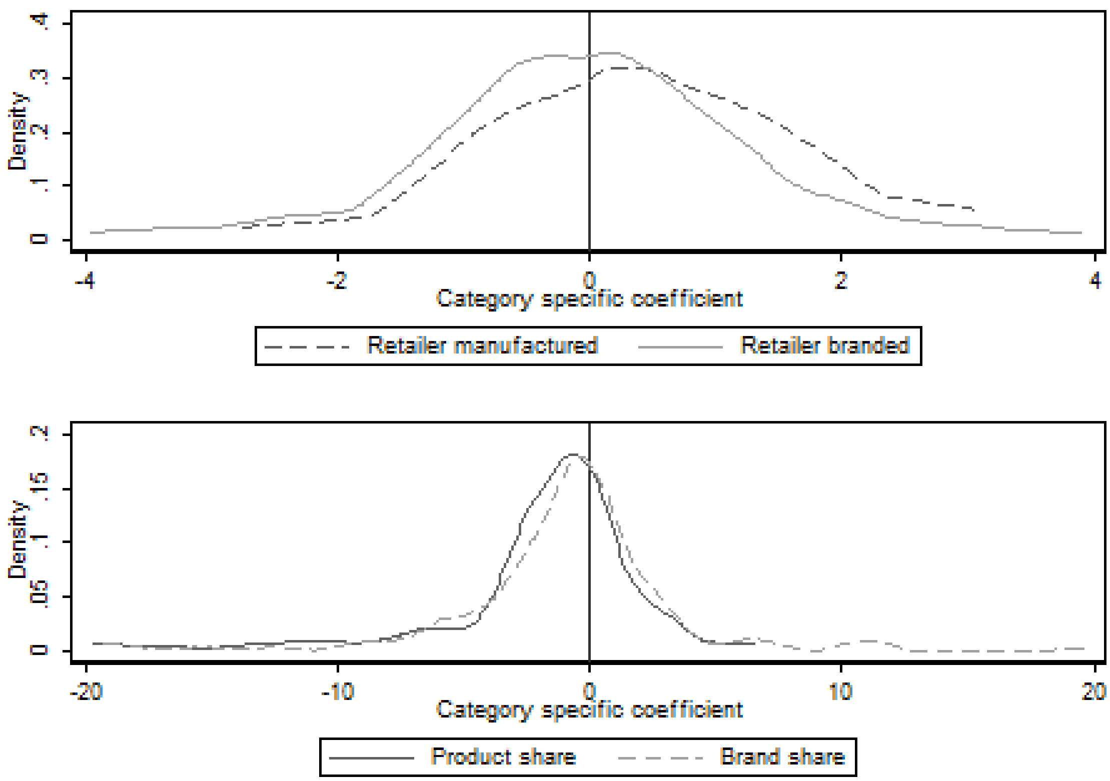
4.3. Robustness

While on average the results conform to those of the model under Scenario 1 in Table 1, there is considerable heterogeneity across categories. Figure 6 presents the distribution of estimates for the two private label dummies and the two revenue share variables from the specification in column 6 of table 7 (the 12-month rolling window commodity to regular price regression including subsubclass dummies, both private label dummies and both revenue share variables) when these are estimated category by category. While the distributions clearly indicate a general tendency for higher pass-through for private labels and lower pass-through for higher revenue shares, they also indicate that there is significant heterogeneity across product categories. This likely explains why the marketing literature often finds mixed or conflicting results regarding private labels. It also suggests that either the basic model we propose may be overly simple, or that for some product categories the commodity cost share may be lower for private labels, resulting in lower pass-through for externally manufactured private labels even conditional on market shares.[21]

In Table 8 we present some alternative samples and specifications that stick close to our main results. In the first three columns we use the sales price (the actual average transaction price including coupons, rebates, loyalty discounts, etc.) instead of the regular price as the dependent variable in the pass-through regressions. The average (across stores and weeks) monthly sales price is much more variable than our regular price, often jumping around when there are substantial sales in enough stores, but still tends to co-move with the regular price. Unless (a) retailers and/or manufacturers use the depth and frequency of sales (reflected in our monthly average sale price measure) to pass-through cost shocks to consumers and (b) this behavior varies systematically with vertical and horizontal market power, we would expect the results to be similar. Our results suggest that this not a major issue for our retailer – although the point estimate on non-manufactured private labels is a bit higher than the one on retailer manufactured private labels in column 1 (but not in column 3), the results are generally in line with our findings using the regular/list price. Columns 4 through 7 present the results when pass-through is estimated as in equation 19, using the monthly change in price and twelve lags of the change in the cost variable. The results are qualitatively very similar, with higher pass-through for private labels and lower pass-through for products with

[21] Note that in our model externally manufactured private labels can never have lower pass-through conditional on market share, unless the cost shares are different. Unconditionally they could have lower pass-through if they are much higher quality (have much higher market shares conditional on price). Our model predicts that for retailer manufactured private labels the pass-through could be higher or lower than for national brands depending on the characteristics of the market.

Figure 6: Coefficients by category



larger market shares. Columns 8 and 9 follow the same specifications as before but we use data only from a single store in Southern California (though we use national revenue share variables). This significantly lowers the number of products in our sample since we now require that our products be sold at least once in every month in a single store and we throw out many products not sold in this store, but avoids the concern that our aggregated measure of product level wholesale costs may be contaminated by measurement error since we use the actual wholesale cost reported by the store. The results broadly similar with some evidence for higher commodity price pass-through for retailer manufactured private labels and lower pass-through for products with higher brand shares, as well as lower wholesale cost pass-through for externally manufactured private labels.

In Table 9 we explore a different concern – are our results driven by the two-stage estimation procedure, which treats the second-stage dependent variable as data (when it is an estimate) and drops negative pass-through coefficients?[22] While it is difficult to interpret negative pass-through coefficients in the context of standard pricing models, in the empirical literature they are quite common at the product level. For example, Dube and Gupta (2008) find negative pass-through coefficients for over 10% of products when estimating wholesale cost to retail price pass-through for eleven product categories, Kanishka Misra and Singh (2010) find negative wholesale to retail pass-through for liquid milk in up to one third of estimated coefficients, and Berger et al. (2011) find negative pass-through from exchange rates to import or consumer prices for about half of the products they study. In our case, due to the low (expected) pass-through from most commodity prices to retail prices they make up a large share of our sample.

To address this concern we instead consider all products (including those with negative individual pass-through) in the subset of categories that have positive pass-through at the category level. That is, we first regress a category retail price index on the commodity indexes we initially match using the 12-month rolling window pass-through regression, and then restrict the analysis to categories with a positive and statistically significant relationship with the commodity prices. This allows for many individual products with negative pass-through and leaves us with about 7,000 product/category matches using the 1% significance level.[23] We then follow Neiman (2010) and estimate a one-step regression where the coefficients of interest are the interactions between a product's vertical and horizontal variables and the change in the cost variable:

$$\begin{aligned}\Delta^{12}\ln p_{it} = \alpha_t + \alpha_i + \beta_j \Delta^{12}\ln c_{jt} + (\gamma_1 I[Retail\ Manufactured] + \gamma_2 I[Retail\ Branded] \\ + \gamma_3 Product\ RevShare_i + \gamma_4 Brand\ RevShare_i) * \Delta^{12}\ln c_{1t} + \epsilon_{it}\end{aligned} \tag{21}$$

where i and t are individual products and months, j is a product category or subclass by commodity pair, and c_{jt} is a monthly commodity price associated with the UPC. By including UPC and month fixed effects we allow for product specific linear price trends and common shocks, and we allow pass-through to vary for each category/subclass by commodity pairing j. The γ coefficients of interest are the interactions of changes in commodity prices with market share variables and dummies for private labels. We report heteroskedasticity robust standard errors, but where possible we verify that the results hold up using Driscoll and Kraay (1998) standard errors that allow for arbitrary cross-sectional dependence of the

[22] Note that the first issue is primarily about statistical significance since the two-step OLS estimator is consistent but less efficient than a one-step estimator, or a two-step estimator that weights the first-step estimates using the first-stage estimated variance-covariance matrix. As previously stated in our main results we use OLS with heteroskedasticity robust standard errors rather than weighted least squares based on the results of Lewis and Linzer (2005).

[23] The results we present are robust to using a 5% significance cutoff for category-commodity pass-through, which increases the sample by roughly 1500.

error terms and autoregressive error terms up to order 12.[24] While our two-step procedure omits products with negative (or zero) pass-through which could bias estimation, our one-step procedure selects based on categories and not products so should not bias us towards finding relatively higher or lower pass-through for private labels or products with larger market shares within categories.[25]

Table 9 presents the results, which are consistent with our main finding – the retailer manufactured private label manufactured goods on average have a higher level of pass-through than national brands and externally manufactured private labels – but generally indicate a zero effect of retailer branded private labels on commodity to retail price pass-through. This is similar to some of our two-stage specifications, e.g. Table 7 columns 1 and 3 and Table 8 column 4. These results highlight the importance of distinguishing between the two types of private labels. We are able to reproduce the basic patterns from our earlier regressions for different levels of pass-through, with private labels featuring higher pass-through from commodity to wholesale prices but lower pass-through from wholesale to retail prices. Note that the magnitude of the coefficients varies more here across stages because the coefficients reflect level and not percentage differences in pass-through and pass-through is much lower for commodity prices than wholesale prices. Our results for the market share variables in Table 9 are less consistent with our previous results, with a zero or even positive effect for product market share, and a consistently positive effect for brand share.[26] Note that this implies that the combined effect of horizontal and vertical structure results in even higher pass-through for retailer manufactured private labels.

4.4. Extension to Multi-Retailer Data

Another limitation of our main results is that the pricing behavior we observe may be specific to our particular retailer. To address this concern, we extend the analysis of product level commodity pass-through and market structure to a rich data set that contains multiple retail chains. We use the weekly scanner data from Symphony IRI, a market research agency.[27] The data contain weekly scanner price and quantity information covering a panel of stores in 50 metropolitan areas ("markets") in the U.S. in 31 product categories defined similarly to the ones in our retailer data, e.g. beer, yogurt. The data cover the period from January 2001 to December 2011 with multiple retail chains in each market. We restrict our attention to 12

[24]When using many dummies and variables, our software had trouble with matrix inversion and failed to calculate the Driscoll and Kraay (1998) standard errors in many cases.

[25]The composition of products with negative pass-through is fairly similar (4.3% vs. 4.8% for retailer manufactured private labels, 11.2% vs. 9.2% for externally manufactured private labels, 0.46% vs. 0.50% for average product category share and 14.3% vs. 15.1% for average brand category share).

[26]We have investigated this discrepancy and find that while part of it comes from the use of levels rather than logs, most of it is driven by products with negative estimated pass-through.

[27]See Bronnenberg et al. (2008) for a detailed discussion of the data.

food product categories that we can match to a commodity ingredient to estimate commodity-retail price pass-through.[28] The price and quantity information are available at the UPC level. While brand information is included (e.g. Kellogg's, Coca-Cola), all private-label UPCs have the same brand identification so that the identity of the retailer cannot be recovered from the labeling information. While we were previously able to separately identify private label goods manufactured by the retailer and those that were branded by the retailer but externally manufactured, this information is not available for the IRI marketing data set and our inability to identify particular chains makes it impossible. The IRI data also do not contain any cost measures and does not contain a more disaggregated classification than category.

Retailers report the total dollar value of weekly sales for each UPC as well as total quantity sold, along with a flag for goods on sale. In this case we calculate the average regular/list price by dividing weekly revenue by weekly quantity sold when there is no sale. When there is a sales flag, we assume the regular price for that week is equal to the pre-sale price when the pre-sale price is equal to the post-sale price. Using the regular price series, we calculate a store-level monthly (unweighted) price series for each item by averaging across weeks in a month:

$$\overline{p}_{i,s,m} = \frac{\sum_{j=1}^{J_{i,m}} p_{i,s,j}}{N_{i,m}} \tag{22}$$

where all the subscripts are defined as in equation 17 except s, which denotes the store. The main difference of using the multi-retailer data is the way we calculate the market share of each product. We construct two different measures of market share: first is the more "traditional" market share, which is the revenue share of a UPC within a category where we aggregate across all products in a category sold in all markets and stores in our sample. The second market share measure is more analogous to the one we used previously, e.g. the revenue share of a particular product within a category for a particular store. We can thus test whether our results are sensitive to using store revenue shares or market shares.

With these measures on hand, we run commodity prices to regular price pass-through regressions for each product in each store, as in equation 18. The average pass-through from commodity to retail prices using the IRI data is 11% (ranging from 5% to 20% depending on the product category) which is higher than for our retailer (median of 4.1% to 8.3% depending on the specification) but the set of products is different and there is significantly more time variation. Given our measures of product-store level pass-through, we estimate how vertical and horizontal market structure affects product store-level pass-through by running the second-stage regression:

[28] The 12 product categories we use are beer, carbonated soft drink, coffee, cold cereal, hotdog, margarine and butter, mayonnaise, milk, mustard and ketchup, peanut butter, saltine crackers, soup and yogurt.

$$\ln \hat{\beta_{i,s}^{K}} = \alpha_{comparison} + \gamma I[PrivateLabel] + \gamma_3 Product\ RevShare_i + \theta_{c,h,k} + \epsilon_i \quad (23)$$

where $\theta_{c,h,k}$ refers to the fixed effect for each category (c), retail chain (h) and city (k). The results are reported in Table 10. Our findings using the multi-retailer IRI data are consistent with the findings from the single retail chain we analyze in depth, with private label goods exhibiting significantly higher pass-through rates – about 40% higher for private label goods when using chain fixed effects, which is similar in magnitude to our findings for retailer manufactured private label goods in Table 7. We also find a negative effect of market share on pass-through that is of a similar magnitude to the results in Table 7 using category fixed effects.

4.5. 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 11 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

5.1. Cyclicality

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 12 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 12 – could increase commodity to retail pass-through by about 1.2 percent (4 x 0.3). While this effect strikes as quite small (absent other estimates of the cyclicality of commodity price pass-through), 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. We explore some of these cross-sectional in the next subsection.

5.2. Cross-country commodity pass-through and private labels

While the market share of private label goods does not vary enough over the business cycle to have substantial implications for the cyclicality of pass-through, the market share of private label goods varies significantly over longer horizons and across countries. Around 2009 the private label market share for supermarkets varies from as high as 46% in Switzerland or 42% in the United Kingdom to as low as 15% in Italy, 10% in Iceland and Romania and 4% in Bulgaria.[29] For the 18 European countries we could match with comparable market share data (we use the CR5, the market share of the five largest supermarket chains) the correlation of private label shares with market concentration is 0.50 (s.e. 0.04). Our micro estimates indicate that the net effect of a higher private label share could go either way when private labels are also associated with greater market power as appears to be the case in Europe, particularly since most private label goods in Europe are not manufactured directly by the retailer.

To explore whether this has any implications for pass-through we use data from the Eurostat Food supply chain monitor, which collects monthly consumer prices, producer prices, and agricultural commodity prices for 32 European countries in 17 categories between January 2005 and March 2013. Some of the categories are composites of others, and we focus on 11 distinct (non-overlapping categories) – beef, bread and cereals, cheese, eggs, fruit, milk,

[29]Sources: Nielsen, IGD, Business Review (Romania), USDA FAS (Bulgaria).

oils and fats, pork, poultry, confectionery, and vegetables. Note that the database tries to match the most important commodity to each category. We found private label market share data for 22 countries at the country level for the year 2009, so our final sample consists of 22 countries in up to 11 categories. We also estimate commodity to producer price pass-through regressions but due to lack of data we can only include 7 countries and 10 categories for these regressions.

To examine whether the private label shares are correlated with the strength of pass-through we pool the countries (i) and categories (j) and run the following regression:

$$\Delta^T \ln p_{ijt} = \alpha_t + \alpha_{ij} + \beta_j \Delta^T \ln c_{ijt} + \gamma \Delta^T \ln c_{ijt} * plshare_i + \epsilon_{ijt} \tag{24}$$

where t is month and T is the horizon over which we are differencing. We consider a twelve month horizon for comparability with our earlier micro results as well as one month changes. This specification allows average inflation within a category to vary by country and allows for common time-varying price shocks across countries/categories. It also allows for differential pass-through rates across categories (β_j varies with j). Our focus is on estimating the common "average" effect of the country private label share on commodity to retail price pass-through (the coefficient γ). The results are presented in Table 13. We use Driscoll and Kraay (1998) standard errors that allow for arbitrarily correlated error terms in the cross-section and autoregressive errors up to twelve lags.

Our results show that private label share is associated with lower pass-through of commodity prices to consumer prices across the European countries in our sample for the period and categories we study (Panel A). A one standard deviation increase in the private label share from 0 to 0.1 would lower the pass-through from 0.044 for the mean category to 0.028 for the twelve month pass-through and from 0.102 to 0.077 for the one month pass-through. The higher commodity pass-through over shorter (1 month) than longer (12 month) horizons is different than our results for the US retailer, but it is important to keep in mind that the consumer prices here are indexes/aggregates across different products and retailers – overall commodity pass-through is still quite low. Similar to our micro results, the effects appear to be heterogeneous across categories – while no categories have a significant and positive coefficient on the interaction of commodity price and private label share, only four categories (bread and cereals, fruit, milk, and vegetables) had a negative and significant coefficient at the 5% level, indicating that the country-level private label share was negatively associated with pass-through across countries. Turning to producer prices, we see a positive association of private label share with pass-through from commodity to producer prices. Taken together, these results are consistent with story in which European countries with highly concentrated retail sectors have a large role for private label goods resulting in low market power for producers (high pass-through of their cost shocks) and high market power for retailers (low pass-through to final consumers). We view these results as suggestive but hope to more fully explore the cross-country implications of vertical and horizontal structure in retail in future work as more micro data becomes available.

5.3. Discussion

Our results for the macro implications of retail market structure have many parallels to the international trade literature on vertical integration and pricing. While the available data do not reveal significant changes at business cycle frequencies, when we look across countries and over longer horizons there have been significant changes in the vertical organization of relationships between sellers and buyers. While our micro-level findings and those of Neiman (2010) suggest that a rise in vertical integration could raise pass-through by reducing double-marginalization created by the market power of upstream firms, our results for market share and those from a separate international trade literature imply that interactions between vertical and horizontal market structure are critical. If rising private label penetration and rising intra-firm trade are associated with greater market power for downstream firms, which appears to be the case for retail, it is not obvious theoretically or empirically whether pass-through will increase or decrease. Indeed the rise in intra-firm trade in the United States appears to coincide with a decrease in the pass-through of exchange rates to import prices, and the rise in private labels that accompanies greater market power for retailers appears to be associated with lower pass-through of commodity prices across European countries.

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. 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 relative to retailers, which our results indicate could have ambiguous effects on pass-through and potentially the frequency of price adjustment because vertical integration driven by the growing horizontal market power of retailers generates countervailing effects.

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. 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.[30] 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, unless this is accompanied by rising horizontal market power. Our findings also suggest that commodity price pass-through may be more counter-cyclical than otherwise due to the private label margin but this effect is small. 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, pressure from consumers during bad states of the economy may incentivize firms to implement more frequent and deeper sales.[31]

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

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

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

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 which is about 4 percentage points.

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 around 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 (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. We would like to explore why this is the case and its implications for price rigidity over the business cycle and over the long-term.

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Table 1: Model simulations

Case	Price	Share	$\frac{\partial p}{\partial w}\frac{w}{p}$	$\frac{\partial p}{\partial c}\frac{c}{p}$
Scenario 1: $p_z = 50$				
NB	79.59	0.554	0.559	0.021
PL-NVI	76.57	0.582	0.484	0.024
PL-VI	45.70	0.868	0.302	0.027
Constant market share				
PL-NVI	60.63	0.554	0.484	0.030
PL-VI	22.71	0.554	0.495	0.045
Scenario 2: $p_z = 25$				
NB	43.52	0.431	0.627	0.037
PL-NVI	41.06	0.475	0.490	0.044
PL-VI	28.74	0.725	0.386	0.035
Constant market share				
PL-NVI	35.88	0.431	0.497	0.050
PL-VI	20.62	0.431	0.573	0.052
Scenario 3: $p_z = 10$				
NB	26.60	0.175	0.777	0.070
PL-NVI	24.68	0.210	0.551	0.079
PL-VI	19.63	0.346	0.627	0.057
Constant market share				
PL-NVI	23.82	0.175	0.561	0.083
PL-VI	18.25	0.175	0.735	0.067

Note: All simulations use $eta = 4$, $c = 1$, and $\theta_r + \theta_m = 12$.The first three cases in each scenario use $d = 4$ while the constant market share cases vary d to match the market share of the NB case under that scenario. Under NB there is arm's-length pricing but $\theta_r = 2$ and $\theta_m = 10$, while under PL-NVI there is arm's-length pricing but $\theta_r = \theta_m = 6$. Under PL-VI there is full vertical integration. The pass-through is calculated based on a 0.1% increase in the commodity price, i.e. c increases to 1.001.

Table 2: 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 3: Duration of prices and costs (weeks)

Spell1		
	Mean	Median
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 4: 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 5: Retail Price and Wholesale Cost Passthrough

Dependent Variable (Log Passthrough of Wholesale Cost to Regular Price)								
Window	12 months							4 months
Median	0.695							0.569
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	-0.394***		-0.404***	-0.810***		-0.799***	-0.815***	-0.632***
	(0.071)		(0.074)	(0.089)		(0.095)	(0.096)	(0.084)
RetailBranded	-0.437***		-0.443***	-0.506***		-0.511***	-0.523***	-0.472***
	(0.038)		(0.039)	(0.048)		(0.049)	(0.049)	(0.047)
Product RevShare		-3.439***	-3.680***		-0.519***	-0.543***	-0.526***	-0.643***
		(0.824)	(0.818)		(0.106)	(0.105)	(0.106)	(0.100)
Brand RevShare		-0.118*	0.123*		-0.311***	0.100	0.101	-0.013
		(0.068)	(0.068)		(0.088)	(0.090)	(0.090)	(0.088)
Log(Med. Price)							-0.050	
							(0.035)	
Obs.	10939	10939	10939	10939	10939	10939	10939	10541
$\bar{R}^2$	0.102	0.088	0.104	0.237	0.212	0.239	0.239	0.253
Category	Y	Y	Y	N	N	N	N	N
Subsubclass	N	N	N	Y	Y	Y	Y	Y

Note: The dependent variable is the logarithm of estimated product-level pass-through using the rolling window specification given by equation 18, 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 20 where each observation corresponds to an individual product pass-through coefficient, and use heteroskedasticity robust standard errors.

Table 6: Wholesale Cost and Commodity Price

Dependent Variable (Log Passthrough of Commodity Price to Wholesale Cost)								
Window	12 months							4 months
Median	0.047							0.037
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	0.211***		0.318***	0.347***		0.416***	0.392***	0.392***
	(0.045)		(0.046)	(0.067)		(0.068)	(0.069)	(0.082)
RetailBranded	0.292***		0.343***	0.264***		0.288***	0.271***	0.300***
	(0.042)		(0.043)	(0.055)		(0.056)	(0.056)	(0.061)
Product RevShare		-1.960	-1.817		-0.452***	-0.454***	-0.440***	-0.372***
		(1.366)	(1.293)		(0.096)	(0.095)	(0.095)	(0.099)
Brand RevShare		-0.512***	-0.668***		-0.129	-0.290***	-0.280***	-0.687***
		(0.074)	(0.075)		(0.088)	(0.089)	(0.090)	(0.110)
Log(Med. Price)							-0.072**	
							(0.035)	
Obs.	12757	12757	12757	12757	12757	12757	12757	10326
$\bar{R}^2$	0.270	0.270	0.276	0.470	0.468	0.472	0.472	0.548
Category	Y	Y	Y	N	N	N	N	N
Subsubclass	N	N	N	Y	Y	Y	Y	Y

Note: The dependent variable is the logarithm of estimated product-level pass-through using the rolling window specification given by equation 18, 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 20 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 7: Regular Price and Commodity Price/Wholesale Cost Index Passthroughs

Panel A: Dependent Variable (Log Passthrough of Commodity Prices to Regular Price)								
Window	12 months							4 months
Median	0.064							0.050
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RetailManufactured	0.389***		0.456***	0.306***		0.416***	0.350***	0.418***
	(0.039)		(0.040)	(0.059)		(0.061)	(0.062)	(0.071)
RetailBranded	0.028		0.055	0.120**		0.150***	0.100**	0.205***
	(0.036)		(0.036)	(0.050)		(0.050)	(0.051)	(0.049)
Product RevShare		-5.373***	-5.234***		-0.928***	-0.918***	-0.873***	-1.113***
		(1.061)	(1.055)		(0.087)	(0.086)	(0.086)	(0.104)
Brand RevShare		-0.273***	-0.393***		-0.285***	-0.431***	-0.414***	-0.473***
		(0.058)	(0.058)		(0.085)	(0.087)	(0.085)	(0.094)
Log(Med. Price)							-0.208***	
							(0.044)	
Obs.	12627	12627	12627	12627	12627	12627	12627	9951
$\bar{R}^2$	0.195	0.195	0.202	0.303	0.309	0.313	0.316	0.324
Category	Y	Y	Y	N	N	N	N	N
Subsubclass	N	N	N	Y	Y	Y	Y	Y

Panel B: Dependent Variable (Log Passthrough of Wholesale Index to Regular Price)								
Window	12 months							4 months
Median	1.006							0.783
RetailManufactured	0.216***		0.254***	0.265***		0.320***	0.289***	-0.055
	(0.070)		(0.072)	(0.098)		(0.102)	(0.103)	(0.085)
RetailBranded	0.148***		0.156***	0.103***		0.105***	0.077*	0.111***
	(0.033)		(0.033)	(0.040)		(0.039)	(0.041)	(0.041)
Product RevShare		-2.916***	-2.712***		-0.855***	-0.840***	-0.793***	-0.686***
		(0.844)	(0.830)		(0.100)	(0.099)	(0.098)	(0.096)
Brand RevShare		0.035	-0.073		0.153*	0.021	0.022	0.195**
		(0.065)	(0.066)		(0.079)	(0.081)	(0.081)	(0.087)
Log(Med. Price)							-0.113***	
							(0.043)	
Obs.	9653	9653	9653	9653	9653	9653	9653	8805
$\bar{R}^2$	0.323	0.322	0.324	0.429	0.432	0.433	0.434	0.381
Category	Y	Y	Y	N	N	N	N	N
Subsubclass	N	N	N	Y	Y	Y	Y	Y

Note: The dependent variable is the logarithm of estimated product-level pass-through using the rolling window specification given by equation 18, 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 20 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 8: Robustness

	Dependent Variable (Log 12-month Passthrough)								
	Sales price			Lagged specification				One California store	
Pass-through dep. var.	Retail	Retail	Retail	Retail	Whole.	Retail	Retail	Retail	Retail
Pass-through ind. var.	Comm.	Whole.	Wh. index	Comm.	Comm.	Whole.	Wh. index	Whole.	Comm.
Median PT	0.092	0.821	1.406	0.083	0.063	0.981	1.473	0.654	0.058
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RetailManufactured	0.169***	-0.505***	0.259***	0.279***	0.557***	-0.203	0.201	0.276	1.145***
	(0.053)	(0.091)	(0.077)	(0.091)	(0.101)	(0.155)	(0.122)	(0.578)	(0.277)
RetailBranded	0.248***	-0.246***	0.244***	0.049	0.261***	-0.390***	0.135**	-0.860***	0.221
	(0.035)	(0.051)	(0.033)	(0.055)	(0.056)	(0.079)	(0.058)	(0.227)	(0.182)
Product RevShare	-0.284***	-0.125	-0.287***	-0.575***	-0.328***	-0.396**	-0.990***	0.723	0.972
	(0.074)	(0.108)	(0.090)	(0.113)	(0.123)	(0.172)	(0.144)	(0.685)	(0.629)
Brand RevShare	-0.221***	-0.118	0.048	-0.250**	-0.546***	-0.290*	-0.287**	-0.588	-0.925***
	(0.083)	(0.101)	(0.084)	(0.116)	(0.113)	(0.167)	(0.123)	(0.616)	(0.368)
Obs.	11278	9596	8789	14222	14682	9646	10265	2338	3172
$\bar{R}^2$	0.282	0.281	0.523	0.226	0.406	0.184	0.458	0.491	0.471
Subsubclass	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: In columns 1-3 and 8-9, the dependent variable is the logarithm of estimated product-level pass-through using the rolling window specification given by equation 18, where the dependent variable is the 12-month change in log average monthly (pass-through dep. var.) and the independent variable is the 12-month change in log average monthly (pass-through ind. var.), and the pass-through sample comprises the 41 months from January 2004 to May 2007. In columns 4-6, the product-level pass-through is estimated as in equation 19 where the dependent variable is the one-month change in log average monthly (pass-through dep.var.) and the independent variables are contemporaneous and 1 through 11 lagged one-month changes in log average monthly (pass-through ind. var.), and we calculate long-term pass-through as the sum of the 12 coefficients. The results reported here are for estimation of equation 20 where each observation corresponds to an individual product pass-through coefficient. All regressions include subsubclass fixed effects and use heteroskedasticity robust standard errors.

Table 9: One-step estimation

Pass-through	Commodity-Retail		Commodity-Wholesale		Wholesale-Retail	
	(1)	(2)	(3)	(4)	(5)	(6)
RetailManufactured	0.0268***	0.0175***	0.0320***	0.0163***	-0.4284***	-0.5266***
	(0.0058)	(0.0065)	(0.0053)	(0.0063)	(0.0785)	(0.0728)
	[0.0025]					
RetailBranded	-0.0045	0.0004	-0.0020	-0.0101	-0.4718***	-0.3841***
	(0.0049)	(0.0053)	(0.0107)	(0.0086)	(0.0896)	(0.0731)
	[0.0050]					
Product Share	0.1903*	-0.0231	0.5078**	0.0633**	-0.2851	-0.0447
	(0.1095)	(0.0169)	(0.2092)	(0.0315)	(0.3668)	(0.0842)
	[0.0590]					
Brand Share	0.0600***	0.0762***	0.0211	0.0270*	0.8815***	0.7190***
	(0.0086)	(0.0102)	(0.0166)	(0.0141)	(0.1922)	(0.1663)
	[0.0072]					
Obs.	203479	203479	203076	203078	203077	203077
R^2 within	0.0273	0.0455	0.0127	0.1365	0.1063	0.1744
Controls	Category	Subclass	Category	Subclass	Category	Subclass

Note: The reported coefficients are the interaction terms from estimation equation 21 using the 12-month rolling window specification where the dependent variable is the 12-month change in log average monthly price and the independent variable is the 12-month change in log average monthly cost, using UPC-commodity and month fixed effects. We restrict the sample to category/commodity pairs that feature a positive and significant pass-through from commodity to retail prices at the 1% level. Robust standard errors in parentheses, Driscoll and Kraay (1998) standard errors in square brackets where we could calculate them.

Table 10: Multiple-retailers: Regular Price and Commodity Price Passthroughs

Dependent Variable (Log Passthrough of Commodity Prices to Regular Price)								
Median	0.079							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PrivateLabel	0.356***	0.357***	0.453***	0.357***	0.457***	0.479***	0.488***	0.436***
s.e	(0.067)	(0.068)	(0.069)	(0.69)	(0.067)	(0.067)	(0.066)	(0.067)
Product RevShare(Within Store)		-8.512***				-5.454***		
s.e.		(0.042)				(0.055)		
Product RevShare(All Sample)				-7.439***				-7.680***
s.e.				(0.824)				(1.124)
Category	Y	Y	Y	Y	Y	Y	Y	Y
Chain	Y	Y	Y	Y	N	N	N	N
City	N	N	N	N	Y	Y	Y	Y
Obs	12556	12556	12556	12556	12393	12393	12393	12393
R^2	0.107	0.128	0.105	0.065	0.07	0.093	0.067	0.065

Note: The dependent variable is the logarithm of estimated product-store level pass-through using the 12 month "long-term" passthrough, where the dependent variable is the change in log average monthly retail price, the independent variable is the change in the log commodity index for a linked commodity, and the sample comprises the 132 months from January 2001 to December 2011. The results reported here are for estimation of equation 20 where each individual observation is a product x commodity pass-through coefficient, and use heteroskedasticity robust standard errors.

Table 11: 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 12: 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.

Table 13: European country-level pass-throughs and private label shares

Panel A: Pooled country/category commodity to consumer price pass-through (2005:1-2013:3)		
T difference	12 months	1 month
Median category pass-through when PL=0	0.041	0.109
$\Delta \ln c * plshare_j$	-0.163**	-0.250**
s.e.	(0.077)	(0.105)
Obs.	12154	15175
$\bar{R}^2$	0.011	0.027
Countries	22	22
Categories	11	11
Country x category	210	210

Panel B: Pooled country/category commodity to producer price pass-through (2005:1-2013:3)		
T difference	12 months	1 month
Median category pass-through when PL=0	0.031	0.024
$\Delta \ln c * plshare_j$	0.146**	0.204***
s.e.	(0.069)	(0.053)
Obs.	4725	5499
$\bar{R}^2$	0.013	0.047
Countries	7	7
Categories	10	10
Country x category	61	64

Note: This table reports the coefficient γ from estimation of equation 24. Regressions include country by category dummies, period dummies, and allow for separate coefficients for each of the eleven categories. Standard errors in parentheses are calculated using Driscoll and Kraay (1998) standard errors with lag order 12. Column (1) differences prices and commodities by twelve months while column (2) uses monthly differences.

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

Table 14: 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 19, 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 20 where each observation corresponds to an individual product pass-through coefficient, and use heteroskedasticity robust standard errors.

Table 15: 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 19, 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 20 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 16: 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 19, 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 20 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.