A Decomposition of the Sources of Incomplete Cross-Border Transmission: The Case of Beer*

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Abstract

Despite its importance, we have a limited understanding of the microeconomics of the international transmission of shocks. The conventional wisdom is that relative price changes are the primary mechanism by which shocks are transmitted across borders. Yet traded-goods prices exhibit significant inertia in the face of shocks such as exchange-rate changes. This paper quantifies the sources of this incomplete transmission, that is, this price inertia using the example of the beer market. The paper addresses two literatures on the sources of local-currency price stability with very different modeling approaches. The empirical trade literature on this topic which includes Goldberg and Verboven (2001) attributes this price inertia to a local-cost component and to firms' markup adjustments but without modeling the role of each of these factors at each stage along a distribution chain. Papers in the international finance literature such as Burstein, Neves, and Rebelo (2003), Campa and Goldberg (2004), and Corsetti and Dedola (2004) attribute local-currency price stability to the share of local non-traded costs in final-goods prices, but do not allow for a role for markup adjustment by the firms that incur these costs, whether they be manufacturers or retailers. This paper is the first to quantify the relative importance of these two factors for both manufacturers and retailers in the incomplete transmission of shocks to prices. The paper documents two basic facts about the transmission of shocks across borders. First, there is a nonlinear relationship between integration at the microeconomic level (proxied for by market share) and the transmission of shocks to prices; Second, a local component in manufacturers' costs explains a large part of the incomplete transmission though markup adjustments by manufacturers and retailers play a nontrivial role. These facts are analyzed within the framework of an oligopoly model.

Keywords: cross-border transmission; international price discrimination; pass-through.

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1 Introduction

Despite its importance, we have a limited understanding of the microeconomics of the cross-border transmission of shocks. The conventional wisdom is that relative price changes are the primary mechanism by which shocks are transmitted across borders. Yet traded-goods prices exhibit significant inertia in the face of shocks such as exchange-rate changes. This paper quantifies the sources of this incomplete transmission, that is, this price inertia using the example of the beer market.

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These facts are analyzed within the framework of an oligopoly model. The paper has two goals: first, to document at the product level when shocks are transmitted across borders; and second, to identify the sources of their incomplete transmission within the framework of an oligopoly model.

The paper differs from previous work in three ways. First, I model the vertical relationships between manufacturers and retailers, which enables a richer analysis of the causes of incomplete transmission than was possible with previous models. Second, I use a product-level analysis to investigate the causes of incomplete transmission along a distribution chain. Though several recent papers have investigated the role of the distribution chain, and in particular, of a local-cost component in the incomplete transmission of foreign cost shocks to final-goods prices, their work has relied on aggregate data with their well-known limitations. Third, I use an oligopoly framework that allows me to address questions about the sources of transmission at a microeconomic level.

I begin my analysis by documenting in reduced-form regressions whether prices are systematically related to factors such as exchange-rate fluctuations and the share of local nontraded costs in final-goods prices. I then turn to a more systematic analysis of the sources of incomplete transmission. I estimate a structural econometric model that links firms' pass-through behavior to strategic interactions with other firms (supply conditions) and to interactions with consumers (demand conditions). Using the estimated demand system, I conduct counterfactual experiments to quantify how a foreign cost shock affects domestic and foreign firms' profits and consumer surplus. My general strategy is to estimate brand-level demand and then to use those estimates jointly with assumptions about firms' pricing behavior to recover both retail and manufacturer marginal costs without observing actual costs. I then use the estimated demand system, assumptions about firms' pricing behavior, and the derived marginal costs to compute the new equilibrium following a shock to foreign brands' marginal costs. I compute the change in firms' profits and in consumer surplus using the new equilibrium prices and quantities.

Theoretical work has shown that the response of prices to cost shocks depends on the curvature of a market's demand and cost schedules. This implies that any pass-through results may depend on a model's functional-form assumptions. I address this issue by estimating a very flexible demand system and by examining if my parameter estimates are consistent with industry lore and with price responses to exchange-rate and local-cost fluctuations in reduced-form regressions. In addition, I empirically test for the best-fit vertical market structure in the beer market in another paper, Hellerstein (2004), by comparing accounting price-cost margins to the derived price-cost margins different vertical models produce and by using non-nested tests developed by Villas-Boas (2004). This paper's empirical analysis focuses on the best-fit vertical market structure for this industry: A standard linear-pricing model in which manufacturers set wholesale prices and retailers follow setting retail prices.

I choose to study the beer market for several reasons. First, beer is a good that is fairly concentrated at the manufacturer level, consistent with my assumption of oligopoly. Because manufactured goods' prices tend to exhibit dampened responses to exchange rates in aggregate data, beer is an appropriate choice to investigate the puzzling phenomenon of incomplete transmission. Second, trade barriers such as voluntary export restraints or antidumping sanctions that likely distort price-setting behavior in other industries, such as autos or textiles, are rarely threatened or imposed in this industry. No anti-dumping cases have been brought in the U.S. beer industry in the past fifteen years, for example. This simplifies the analysis of price inertia. Third, I have a rich panel data set with monthly retail and wholesale prices for 34 products from 18 manufacturers over 40 months (July 1991-December 1994). It is unusual to observe both retail- and wholesale-price data for a single product over time. These data allow me to assess the validity of my empirical technique, in particular, how well the model captures wholesale-price movements.

The model's key identification assumption is that over the short run, nominal exchange-rate fluctuations dwarf other sources of variation in manufacturers' marginal costs such as input-price changes. This assumption, though strong, has clear support in the data.[1] Figure 1 illustrates how the exchange rate is much more volatile in monthly data than are brewers' other typical marginal costs for the case of Germany.[2] The paper presents figures of the derived exchange rate that suggest the model captures observed nominal exchange-rate movements fairly well for each of the sample's countries. The model assumes that foreign manufacturers incur marginal costs in foreign currencies to brew, bottle, and ship their beer. They observe the realized value of the nominal exchange rate before setting their prices in the domestic currency and they assume any exchange-rate change is exogenous and permanent over the sample period of one month.[3]

The counterfactual experiments produce five major results. First, there is a nonlinear relationship between integration at the microeconomic level and the transmission of shocks to prices; Second, a local component in manufacturers' costs explains a large part of the incomplete transmission though markup adjustments by manufacturers and the retailer play a nontrivial role, accounting for 26 percent of the incomplete transmission following a 5-percent exchange-rate depreciation, and 37 percent following a 5-percent exchange-rate appreciation. Third, foreign

[1] The breakdown of the Bretton-Woods fixed exchange-rate system in 1973 led to a permanent three-fold to nine-fold increase in nominal exchange-rate volatility. Meanwhile such fundamentals as real output, interest rates, or consumer prices showed no corresponding rise in volatility.

[2] This assumption is particularly valid for the beer industry which integrated backward starting in the late 1970s. By the early 1990s, most brewers purchased their agricultural inputs through long-term contracts with farmers which insulated them from short-run price fluctuations. Most brewers also manufactured their own packaging including labels, bottles, and cans. Some even integrated backward with respect to energy: In the late 1970s, *Adolph Coors* purchased and developed a coalfield to supply its plants as described in Ghemawat (1992).

[3] This assumption is consistent with the stylized fact identified by Meese and Rogoff (1983) that the best short-term forecast of the nominal exchange rate is a random walk.

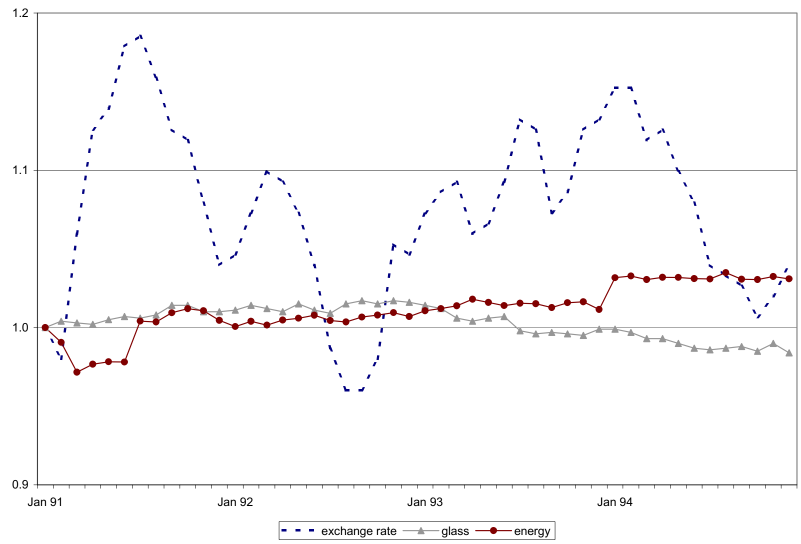

Figure 1: *The nominal exchange rate fluctuates by more than do typical input prices for German brewers.* Each series is normalized to 1 in January 1991. Monthly data. Sources: *BLS*, U.S. Department of Labor; Eurostat; International Financial Statistics, *IMF*.

manufacturers generally bear more of the social-welfare costs (or reap more of the social-welfare benefits) of a change in the nominal exchange rate than do consumers or domestic firms. Following a 5-percent depreciation, domestic manufacturer profits rise by 0.1 percent while consumer surplus falls by 4.2 percent, retailer profits by 2.1 percent, and foreign manufacturer profits by 6 percent. Fourth, previous work on cross-border transmission did not model the retailer's pricing decision, and thus implicitly assumed that manufacturers' interactions with downstream firms did not matter. My findings suggest that the retailer plays an important role by absorbing part of an exchange-rate-induced marginal-cost shock before it reaches consumers. The retailer's markups on foreign brands are more than twice the size of its markups on domestic brands: It may regard these higher markups as compensation for their greater fluctuation over time. Finally, the results suggest some strategic interaction between domestic and foreign manufacturers following an exchange-rate shock, one possible explanation for the incomplete transmission. After a depreciation, for example, domestic manufacturers with brands that are close substitutes for foreign brands increase their profits by cutting prices to take market share from foreign manufacturers.

The rest of the paper proceeds as follows. In the next section, I discuss the market and data along with some preliminary descriptive results. Section 3 sets out the theoretical model, and section 4 the estimation methodology. Results from the random-coefficients demand model are reported in section 5, and the results of the counterfactual experiments in section 6.

2 The Market and the Data

In this section I describe the market my data cover. I then present summary statistics for the data and some preliminary descriptive results.

2.1 Market

As recently as 1970, imported beers made up less than one percent of total U.S. beer consumption. Consumption of imported brands grew slowly in the 1980s and by double digits for each year in the 1990s resulting in a market share of over seven percent by the end of the decade. Despite these changes, the U.S. beer industry remains quite concentrated at the manufacturer level. The three largest domestic brewers *Anheuser-Busch* (45%), *Adolph Coors* (10%), and *Miller Brewing* (23%) together account for roughly 80 percent of U.S. beer sales.

Beer is an example of one type of imported good: packaged goods imported for consumption. Such imports do not require any further manufacture before reaching consumers and make up roughly half of the non-oil imports to the U.S. over the sample period. Beer shipments in my data are handled by independent wholesale distributors. The model abstracts from this additional step in the vertical chain, as the brewers set their distributors' prices through a practice known as *resale price maintenance* and cover a significant portion of their distributors' marginal costs. This practice makes the analysis of pricing behavior along the distribution chain relatively straightforward.

During the 1990s supermarkets increased the selection of beers they offered as well as the total shelf space devoted to beer. A study from this period found that beer was the tenth most frequently purchased item and the seventh most profitable item for the average U.S. supermarket.[4] Supermarkets sell approximately 20 percent of all beer consumed in the U.S. As my data focus on one metropolitan statistical area, I do not need to control for variation in retail alcohol sales regulations. Such regulations can differ considerably across states.

2.2 Data

My data come from *Dominick's Finer Foods*, the second-largest supermarket chain in the Chicago metropolitan area in the mid 1990s with a market share of roughly 20 percent. I have a rich scanner data set that records retail prices for each product sold by *Dominick's* over a period of four years. They were gathered by the *Kilts Center for Marketing* at the University of Chicago and include aggregate retail volume market shares and retail prices for 34 brands produced by 18 manufacturers. Summary statistics for prices, servings sold, and volume market shares are provided in Table 1. Of the chain's 88 stores, I include only those that report prices for the full sample period. My data contain roughly two-thirds (56) of the chain's stores.

I aggregate data from each *Dominick's* store into one of three price zones. These zones are defined by *Dominick's* mainly on the basis of customer demographics. Although they do not report these zones, I was able to identify them through zip-code level demographics (with a few

[4] Canadian Trade Commissioner (2000).

exceptions, each *Dominick's* store in my sample is the only store located in its zip code) and by comparing the average prices charged for the same product across stores. I classify each store according to its pricing behavior as a low-, medium-, or high-price store. I then aggregate sales across the stores in each pricing zone. This aggregation procedure retains some cross-sectional variation in the data which is helpful for the demand estimation. Residents' income covaries positively with retail prices across the three zones.

I define a product as one twelve-ounce serving of a brand of beer. Quantity is the total number of servings sold per month. I define a market as one of *Dominick's* price zones in one month. Products' market shares are calculated with respect to the potential market which is defined as the total beer purchased in supermarkets by the residents of the zip codes in which each *Dominick's* store is located. During this period, the annual per-capita consumption of beer in the U.S. was 22.6 gallons. This implies the potential market for total beer consumption to be 20 servings per capita per month in each pricing zone, that is: 1 gallon=128 ounces, so $\frac{(22.6*128)}{12*12} = 20.1$ servings per month. The potential market for beer sold in supermarkets is 20 percent of the total potential market for beer sales. Each adult consumes on average 4 servings per month that were purchased at a supermarket. So the potential market of beer servings sold in supermarkets is 4 multiplied by the resident adult population in each pricing zone.

I define the outside good to be all beer sold by other supermarkets to residents of the same zip codes as well as all beer sales in the sample's *Dominick's* stores not already included in my sample. These *Dominick's* sales mainly consist of microbrewery or other specialty brands, each with a relatively small market share. The share of *Dominick's* total revenue from beer sales included in my sample is high, with a mean of 65 percent. The combined volume market share of products covered in the sample with respect to the potential market is, on average, 18.5 percent.

Promotions occur infrequently in the *Dominick's* data. Bonus-buy sales appear to be the most common promotion used for beer which appear in the data as price reductions.

I supplement the *Dominick's* data with information on manufacturer costs, product characteristics, advertising, and the distribution of consumer demographics. Product characteristics come from the ratings of a *Consumer Reports* study conducted in 1996. Table 2 reports summary statistics for the following characteristics: percent alcohol, calories, bitterness, maltiness, hops, sulfury, fruity, and floral.

2.3 Preliminary Descriptive Results

I begin my analysis by documenting in reduced-form regressions whether *Dominick's* beer prices are systematically related to movements in bilateral nominal exchange-rates. I estimate the following basic price equation:

$$\ln p_{jt}^{r} = \alpha \ln e_{jt} + \beta \ln w_{jt}^{d} + \gamma \ln w_{jt}^{f} + \delta \ln I_{jt} + \varepsilon_{jt} \tag{1}$$

where the subscripts j and t refer to product j in market t where a market is defined as a month and price-zone pair, p^r is the product's retail price, w^d is local wages, e is the bilateral nominal exchange rate, w^f is foreign wages, I is a dummy for a brand-specific promotion, and ε is a random error term. The wage variables control for marginal-cost shocks and the promotion variable for demand shocks that may affect a brand's retail price. Note that the nominal exchange rate may be an endogenous variable in this equation: The error term may contain domestic supply and demand shocks that affect both domestic retail prices and the bilateral exchange rate. This potential endogeneity problem is dealt with statistically through the use of instrumental variables.

To my knowledge, no empirical study of pass-through addresses the econometric issue of exchange-rate endogeneity. The literature's partial-equilibrium studies assume exchange-rate fluctuations to be exogenous with respect to domestic prices. Even if a firm treats the exchange rate as exogenous, however, in reality it may be endogenous. A valid instrument in this case will be correlated with the exchange rate but not with macroeconomic disturbances in the U.S. that could affect both the exchange rate and an imported beer's retail price.

I estimate pass-through elasticities using foreign interest rates as instruments. The idea behind the instrument is to exploit the fact that interest-rate differentials are poor short-run predictors of exchange-rate movements (Krugman and Obstfeld 2000). This implies that the short-run determinants of foreign interest rates should be sufficiently independent of the domestic economy to serve as an instrument for exchange-rate endogeneity. Those supply and demand shocks that affect both domestic prices and the bilateral exchange rate should not be correlated with those shocks that primarily affect foreign interest rates in the short run.

Table 3 reports results from estimating the pricing equation. The first column reports coefficients from an OLS regression of the price on the exchange rate alone, the second column the coefficients from an OLS estimation of equation (1), and the third column the coefficients from an instrumental variables (IV) estimation of equation (1). The exchange rate has a small but significant relationship to the retail price of about 1 percent in the OLS results. In the IV results, the share of variation in the retail price attributed to movements in the exchange rate is 6 percent. The partial F-statistic from the first-stage regression, at 44.85, is significant at the 1-percent level which suggests that the instrument may have some power. Table 16 in the appendix reports the first-stage results.

3 Model

This section describes the supply model and derives simple expressions to compute pass-through coefficients and to decompose the sources of local-currency price rigidity between manufacturers' and retailers' nontraded costs and markup adjustments. It then sets out the random-coefficients model used to estimate demand.

3.1 Supply

Consider the standard linear-pricing model that leads to double-marginalization in which manufacturers, acting as Bertrand oligopolists with differentiated products, set their prices first and retailers then set their prices taking the wholesale prices they observe as given. Thus, a double margin is added to the marginal cost to produce the product. Strategic interactions between manufacturers and retailers with respect to prices follow a sequential Nash model. To solve the model, one uses backwards induction and solves the retailer's problem first.

3.1.1 Retailer

Consider a retail firm that sells all of the market's J differentiated products. Let all firms use linear pricing and face constant marginal costs. The profits of the retail firm in market t are given by:

$$\Pi_{jt}^{r} = \sum_{j} \left(p_{jt}^{r} - p_{jt}^{w} - ntc_{jt}^{r}\right) s_{jt}(p_{t}^{r}) \tag{2}$$

where p_{jt}^{r} is the price the retailer sets for product j, p_{jt}^{w} is the wholesale price paid by the retailer for product j, ntc_{jt}^{r} are destination-market nontraded costs paid by the retailer to sell product j, and $s_{jt}(p_{t}^{r})$ is the quantity demanded of product j which is a function of the prices of all J

products. Assuming that the retailer acts as a profit maximizer, the retail price p^r_{jt} must satisfy the first-order profit-maximizing conditions:

$$s_{jt} + \sum_k (p^r_{kt} - p^w_{kt} - ntc^r_{kt}) \frac{\partial s_{kt}}{\partial p^r_{jt}} = 0, \text{ for } j = 1, 2, ..., J_t. \tag{3}$$

This gives us a set of J equations, one for each product. One can solve for the markups by defining $S_{jk} = \frac{\partial s_{kt}(p^r_t)}{\partial p^r_{jt}}$ $j, k = 1, ..., J.$, and a $J \times J$ matrix $\mathit{\Omega}_{rt}$ called the retailer reaction matrix with the jth, kth element equal to S_{jk} , the marginal change in the kth product's market share given a change in the jth product's retail price. The stacked first-order conditions can be rewritten in vector notation:

$$s_t - \Omega_{rt}(p^r_t - p^w_t - ntc^r_t) = 0 \tag{4}$$

and inverted together in each market to get the retailer's pricing equation, in vector notation:

$$p^r_t = p^w_t + ntc^r_t - \Omega^{-1}_{rt} s_t \tag{5}$$

where the retail price for product j in market t will be the sum of its wholesale price, non-traded costs, and markup.

3.1.2 Manufacturers

Let there be M manufacturers that each produce some subset $\mathit{\Gamma}_{mt}$ of the market's J_t differentiated products. Each manufacturer chooses its wholesale price p^w_{jt} while assuming the retailer behaves according to its first-order condition (3). Manufacturer w's profit function is:

$$\Pi_t^w = \sum_{j \in \Gamma_{mt}} \left(p_{jt}^w - tc_{jt}^w - ntc_{jt}^w\right) s_{jt}(p_t^r\left(p_t^w\right)) \tag{6}$$

where tc_{jt}^w are traded costs and ntc_{jt}^w are destination-market nontraded costs incurred by the manufacturer to produce and sell product j.[5] Multiproduct firms are represented by a manufacturer ownership matrix, T_w, with elements $T_w\left(j,k\right)= 1$ if both products j and k are produced by the same manufacturer, and zero otherwise. Assuming a Bertrand-Nash equilibrium in prices and that all manufacturers act as profit maximizers, the wholesale price p_{jt}^w must satisfy the first-order profit-maximizing conditions:

$$s_{jt} - \sum_{k \in \Gamma_{mt}} T_w\left(k,j\right)\left(p_{kt}^w - tc_{kt}^w - ntc_{kt}^w\right)\frac{\partial s_{kt}}{\partial p_{jt}^w} = 0 \text{ for } j = 1, 2, ..., J_t. \tag{7}$$

This gives us another set of J equations, one for each product. Let Ω_{wt} be the manufacturer's reaction matrix with elements $\frac{\partial s_{kt}(p_t^r(p_t^w))}{\partial tc_{jt}^r}$, the change in each product's share with respect to a change in each product's traded marginal cost to the manufacturer. The manufacturer's reaction matrix is a transformation of the retailer's reaction matrix: $\Omega_{wt} = \Omega_{pt}'\Omega_{rt}$ where Ω_{pt} is a J-by-J matrix of the partial derivative of each retail price with respect to each product's wholesale price. Each column of Ω_{pt} contains the entries of a response matrix computed without observing the retailer's marginal costs. The properties of this manufacturer response matrix are described in greater detail in Villas-Boas (2004) and Villas-Boas and Hellerstein (2004). To obtain expressions for this matrix, one uses the implicit-function theorem to totally differentiate the retailer's first-

[5] Nontraded costs incurred by the manufacturer in its home country are treated as part of its traded costs. As such nontraded costs will be denominated in the home country's currency, they will be subject to shocks caused by variation in the nominal exchange rate which nontraded costs incurred in the destination market will not.

order condition for product j with respect to all retail prices ($dp_k^r,\ k = 1, .., N$) and with respect to the manufacturer's price p_f^w with variation dp_f^w :

(8)

$$\sum_{k=1}^{N} \underbrace{\left(\frac{\partial s_j}{\partial p_k^r} + \sum_{i=1}^{N} \left(T_r\left(i, j\right) \frac{\partial^2 s_i}{\partial p_j^r \partial p_k^r} \left(p_i^r - p_i^w - c_i^r - ntc_i^w - tc_i^w\right) \right) + T_r\left(k, j\right) \frac{\partial s_k}{\partial p_j^r} \right)}_{v(j,k)} dp_k^r - \underbrace{T_r\left(f, j\right) \frac{\partial s_f}{\partial p_j^r}}_{w(j,f)} dp_f^w$$

Let V be a matrix with general element $v(j, k)$ and W be an N-dimensional vector with general element $w(j, f)$. Then $Vdp^r - W_f dp_f^w = 0$. One can solve for the derivatives of all retail prices with respect to the manufacturer's price f for the fth column of Λ_w :

$$\frac{dp^r}{dp_f^w} = V^{-1} W_{f.}$$

Stacking the N columns together gives $\Lambda_w = V^{-1} W_f$ which gives the derivatives of all retail prices with respect to all manufacturer prices, with general element: $\Lambda_w\left(i, j\right) = \frac{dp_j^r}{dp_i^w}$. The ($j$th, kth) entry in Ω_{pt} is then the partial derivative of the kth product's retail price with respect to the jth product's wholesale price for that market. The (jth, kth) element of Ω_{wt} is the sum of the effect of the jth product's retail marginal costs on each of the J products' retail prices which in turn each affect the kth product's retail market share, that is: $\sum_m \frac{\partial s_{kt}}{\partial p_{mt}^r} \frac{\partial p_{mt}^r}{\partial p_{jt}^w}$ for $m = 1, 2, ...J$.

The manufacturers' marginal costs are then recovered by inverting the multiproduct manufacturer reaction matrix $\Omega_{wt}. * T_w$ for each market t, in vector notation:

(9) $$p_t^w = tc_t^w + ntc_t^w + \left(\Omega_{wt} * T_w\right)^{-1} s_t$$

where for product j in market t the wholesale price is the sum of the manufacturer traded costs, nontraded costs, and markup function. The manufacturer of product j can use its estimate of the retailer's nontraded costs and reaction function to compute how a change in the manufacturer price will affect the retailer price for its product. Manufacturers can assess the impact on the vertical profit, the size of the pie, as well as its share of the pie by considering the retailer reaction function before choosing a price. Manufacturers may also act strategically with respect to one another. The retailer mediates these interactions by its pass-through of a given manufacturer's price change to the product's retail price. Manufacturers set prices after considering the nontraded costs the retailer must incur, the retailer's pass-through of any manufacturer price changes to the retail price, and other manufacturers' and consumers' reactions to any retail-price changes.

3.1.3 Counterfactual Experiments: Pass-Through Coefficients

To recover pass-through coefficients I estimate the effect of a shock to foreign firms' marginal costs on all firms' wholesale and retail prices by computing a new Bertrand-Nash equilibrium. Suppose a shock hits the traded component of the jth product's marginal cost. To compute the manufacturer pass-through, one substitutes the new vector of traded marginal costs, tc_t^{w*}, into the system of J nonlinear equations that characterize manufacturer pricing behavior, and then searches for the wholesale price vector p_t^{w*} that will solve the system in each market t:

$$p_{jt}^{w*} = tc_{jt}^{w*} + ntc_{jt}^{w} - \sum_{k \in \Gamma_{mt}} \left(\Omega_{wt} * T_w\right)^{-1} s_{kt} \text{ for } j = 1, 2, ..., J_t. \tag{10}$$

To get an expression for the matrix Λ_w with general element $\Lambda_w\left(i, j\right) = \frac{\partial p_j^w}{\partial tc_i^w}$ I totally differentiate the manufacturer's first-order condition for product j with respect to all manufacturer prices

$(dp_k^w,\ k = 1,..,N)$ and with respect to the traded marginal cost tc_f^w with variation dtc_f^w :

(11)

$$\sum_{k=1}^{N} \underbrace{\left(\frac{\partial s_j}{\partial p_k^w} + \sum_{i=1}^{N} \left(T_w\left(i,j\right) \frac{\partial^2 s_i}{\partial p_j^w \partial p_k^w} \left(p_i^w - ntc_i^w - tc_i^w\right) \right) + T_w\left(k,j\right) \frac{\partial s_k}{\partial p_j^w} \right)}_{y(j,k)} dp_k^w - \underbrace{T_w\left(f,j\right) \frac{\partial s_f}{\partial p_j^w}}_{z(j,f)} dtc_f^w$$

Let Y be a matrix with general element $y(j,k)$ and Z be an N-dimensional vector with general element $z(j,f)$. Then $Ydp^w - Z_f dtc_f^w = 0$. One can solve for the derivatives of all wholesale prices with respect to the traded marginal cost f for the fth column of Λ_w :

$$\frac{dp^w}{dtc_f^w} = Y^{-1} Z_{f.}$$

Stacking the N columns together gives the matrix $\Lambda_w = Y^{-1}Z$ which computes the derivatives of all manufacturer prices with respect to all manufacturer traded marginal costs, with general element: $\Lambda_w\left(i,j\right) = \frac{dp_j^w}{dtc_i^w}$.

3.2 Retail Pass-Through

To compute pass-through at the retail level, one substitutes the derived values of the vector p_t^{w*} into the system of J nonlinear equations for the retail firm, and then searches for the retail price vector p_t^{r*} that will solve it:

$$p_{jt}^{r*} = p_{jt}^{w*} + ntc_{jt}^r - \sum_k \left(\Omega_{wt} * T_w\right)^{-1} s_{kt} \text{ for } j,k = 1,2,...,J_t. \tag{12}$$

To get an expression for the matrix Λ_r with general element $\Lambda_r\left(i,j\right) = \frac{\partial p_j^r}{\partial tc_i^w}$ one must first calculate $\frac{\partial p_j^r}{\partial p_i^w}$, as described in the previous section. Retail-traded pass-through, defined as pass-through of the original marginal-cost shock to the retail price, is given by $\left(\frac{dp^r}{dp_f^w}\right)' \frac{dp^w}{dtc_f^w}$. To build intuition, the next section derives expressions for $\frac{dp^w}{dtc^w_f}$, $\frac{dp^r}{dp^w_f}$, and $\left(\frac{dp^r}{dp^w_f}\right)' \frac{dp^w}{dtc^w_f}$ for a simple model with single-product firms.

3.2.1 Simple Model: Single-Product Manufacturers

Consider a simple model of single-product manufacturers each selling to single-product retailers. One can compute the product j's wholesale pass-through elasticity by using the implicit-function theorem to take the total derivative of p^w_{jt} with respect to tc^w_{jt} and rearranging terms:

$$\text{(13)} \qquad \frac{dp^w_{jt}}{dtc^w_{jt}} = \frac{1}{2 - \frac{s_{jt}}{\frac{\partial s_{jt}}{\partial \bullet^w_{jt}}} \frac{\frac{d^2 s}{\partial \bullet^{w2}_{jt}}}{\frac{\partial s_{jt}}{\partial \bullet^w_{jt}}}} = \frac{1}{2 + \text{markup} \cdot \text{curvature coefficient}}$$

$$\text{(14)} \qquad \frac{dp^w_{jt}}{dtc^w_{jt}} \frac{tc^w_{jt}}{p^w_{jt}} = \frac{1}{\left(2 - \frac{s_{jt}}{\frac{\partial s_{jt}}{\partial \bullet^w_{jt}}} \frac{\frac{d^2 s}{\partial \bullet^{w2}_{jt}}}{\frac{\partial s_{jt}}{\partial \bullet^w_{jt}}}\right) \frac{p^w_{jt}}{tc^w_{jt}}} = \frac{1}{(2 + \text{markup} \cdot \text{curvature coefficient }) \frac{p^w_{jt}}{tc^w_{jt}}}$$

The wholesale pass-through rate is given by: $PT^w = \frac{\left(p^{w*}_{jt} - p^w_{jt}\right)}{p^{w*}_{jt} + p^w_{jt}} \cdot \frac{tc^{w*}_{jt} + tc^w_{jt}}{tc^{w*}_{jt} - tc^w_{jt}}$. Equation (14) shows that it is determined by the jth good's markup, that is, its market share s_{jt} divided by the slope of the derived demand curve with respect to the wholesale price, $\frac{\partial s_{jt}}{\partial p^w_{jt}}$, the curvature of the derived demand curve with respect to the wholesale price, summarized by the curvature coefficient, $\frac{\frac{d^2 s}{\partial \bullet^{w2}_{jt}}}{\frac{\partial s_{jt}}{\partial \bullet^w_{jt}}}$, and the ratio of the manufacturer's wholesale price to the traded component of its marginal cost, $\frac{p^w_{jt}}{tc^w_{jt}}$. When derived demand is linear, so $\frac{d^2 s}{\partial p^{w2}_{jt}} = 0$, then $\frac{\partial p^w_{jt}}{\partial tc^w_{jt}} = \frac{1}{2}$ and pass-through is: $\frac{\frac{\partial \bullet^w_{jt}}{\bullet^w_{jt}}}{\frac{\partial tc^w_{jt}}{tc^w_{jt}}} = \frac{1}{2\frac{\bullet^w_{jt}}{tc^w_{jt}}}$. When the derived demand curve is less concave than the linear case so $\frac{d^2 s}{\partial p^{w2}_{jt}} > 0$, $\frac{\partial p^w_{jt}}{\partial tc^w_{jt}} > \frac{1}{2}$, manufacturer pass-through rises: $\frac{\frac{\partial \bullet^w_{jt}}{\bullet^w_{jt}}}{\frac{\partial tc^w_{jt}}{tc^w_{jt}}} > \frac{1}{2\frac{\bullet^w_{jt}}{tc^w_{jt}}}$When the derived demand curve is more concave than the linear case so $\frac{d^2 s}{\partial p_{jt}^{w2}} < 0$, $\frac{\partial p_{jt}^w}{\partial tc_{jt}^w} < \frac{1}{2}$, manufacturer pass-through falls: $\frac{\frac{\partial \bullet_{jt}^w}{\bullet_{jt}^w}}{\frac{\partial tc_{jt}^w}{tc_{jt}^w}} < \frac{1}{2\frac{\bullet_{jt}^w}{tc_{jt}^w}}$. As a product's curvature coefficient or its markup rises, manufacturer pass-through falls if the second derivative is negative. As the ratio of the product's wholesale price to its traded marginal costs rises, manufacturer pass-through also falls.

3.2.2 Simple Model: Single-Product Retailer

Assuming the retailer's nontraded marginal costs ntc_{jt}^r vary independently of the wholesale price, the change in product j's retail price for a given change in its wholesale price is:

$$(15) \qquad \frac{dp_{jt}^r}{dp_{jt}^w} = \frac{1}{2 - \frac{s_t}{\frac{\partial s_{jt}}{\partial \bullet_{jt}}} \frac{\frac{d^2 s_t}{\partial \bullet_{jt}}}{\frac{\partial s_{jt}}{\partial \bullet_{jt}}}} = \frac{1}{2 + \text{markup} \cdot \text{curvature coefficient}}$$

$$(16) \qquad \frac{dp_{jt}^r}{dp_{jt}^w} \frac{p_{jt}^w}{p_{jt}^r} = \frac{1}{\left(2 - \frac{s_t}{\frac{\partial s_{jt}}{\partial \bullet_{jt}}} \frac{\frac{d^2 s_t}{\partial \bullet_{jt}}}{\frac{\partial s_{jt}}{\partial \bullet_{jt}}}\right) \frac{p_{jt}^r}{p_{jt}^w}} = \frac{1}{(2 + \text{markup} \cdot \text{curvature coefficient}) \frac{p_{jt}^r}{p_{jt}^w}}$$

Retail pass-through, defined as pass-through by the retailer of just those costs passed on by the manufacturer is: $PT^R = \frac{p_{jt}^{r*} - p_{jt}^r}{p_{jt}^{r*} + p_{jt}^r} \frac{p_{jt}^{w*} + p_{jt}^w}{p_{jt}^{w*} - p_{jt}^w}$. Equation (16) shows that it is determined by the jth good's markup, that is, its market share s_{jt} divided by the slope of the demand curve with respect to the retail price, $\frac{\partial s_{jt}}{\partial p_{jt}^r}$, the curvature of the demand curve with respect to the retail price, summarized by the curvature coefficient, $\frac{\frac{d^2 s_t}{\partial \bullet_{jt}}}{\frac{\partial s_{jt}}{\partial \bullet_{jt}}}$, and the ratio of the retailer's price to the manufacturer's price, $\frac{p_{jt}^r}{p_{jt}^w}$ .When demand is linear, so $\frac{d^2 s_t}{\partial p_{jt}} = 0$, then $\frac{\partial p_{jt}^w}{\partial p_{jt}^w} = \frac{1}{2}$; $\frac{dp_{jt}^r}{dp_{jt}^w} \frac{p_{jt}^w}{p_{jt}^r} = \frac{1}{2\frac{\bullet_{jt}^r}{\bullet_{jt}^w}}$ When the demand curve is more concave than the linear case so $\frac{d^2 s}{\partial p_{jt}^{r2}} < 0$, then $\frac{p_{jt}^r}{p_{jt}^w} < \frac{1}{2}$, retail pass-through falls: $\frac{dp_{jt}^r}{dp_{jt}^w}\frac{p_{jt}^w}{p_{jt}^r} < \frac{1}{2\frac{\bullet_{jt}^r}{\bullet_{jt}^w}}$. As the markup or the curvature coefficient rises, pass-through falls if the second derivative is negative. As the ratio of the retail price to the manufacturer price $\frac{p_{jt}^r}{p_{jt}^w}$ rises, pass-through falls. Finally, retail traded-goods pass-through, defined as pass-through of the original marginal-cost shock to the retail price is $PT^V = \frac{p_{jt}^{r*} - p_{jt}^r}{p_{jt}^{r*} + p_{jt}^r} \cdot \frac{tc_{jt}^{w*} + tc_{jt}^w}{tc_{jt}^{w*} - tc_{jt}^w}$. It is given by $\left(\frac{dp^r}{dp_f^w}\right)' \frac{dp^w}{dtc_f^w}$.

3.3 Demand

The pass-through computations done with the Bertrand-Nash supply model require consistent estimates of demand. Market demand is derived from a standard discrete-choice model of consumer behavior that follows the work of Berry (1994), Berry, Levinsohn, and Pakes (1995), and Nevo (2001) among others. I use a random-coefficients logit model to estimate the demand system, as it is a very flexible and general model. The pass-through coefficients' accuracy depends in particular on consistent estimation of the curvature of the demand curve, that is, of the second derivative of the demand equation. The random-coefficients model imposes very few restrictions on the demand system's own- and cross-price elasticities. This flexibility makes it the most appropriate model to study pass-through in this market.[6]

Suppose consumer i chooses to purchase one unit of good j if and only if the utility from consuming that good is as great as the utility from consuming any other good. Consumer utility depends on product characteristics and individual taste parameters: product-level market shares are derived as the aggregate outcome of individual consumer decisions. All the parameters of the demand system can be estimated from product-level data, that is, from product prices, quantities,

[6] Other possible demand models such as the multistage budgeting model or the nested logit model do not fit this market particularly well. It is difficult to define clear nests or stages in beer consumption because of the high cross-price elasticities between domestic light beers and foreign light and regular beers. When a consumer chooses to drink a light beer that also is an import, it is not clear if he categorized beers primarily as domestic or imported and secondarily as light or regular, or vice versa.

and characteristics.

Suppose we observe t=*1*, ..., T markets. Let the indirect utility for consumer i in consuming product j in market t take a quasi-linear form:

$$(17) \qquad u_{ijt} = x_{jt}\beta - \alpha p_{jt} + \xi_{jt} + \varepsilon_{ijt} = V_{ijt} + \varepsilon_{ijt}, \quad i = 1, ..., I., \quad j = 1, ..., J., \quad t = 1, ..., T.$$

where ε_{ijt} is a mean-zero stochastic term. A consumer's utility from consuming a given product is a function of a vector of individual characteristics ζ and a vector of product characteristics (x, ξ, p) where p are product prices, x are product characteristics observed by the econometrician, the consumer, and the producer, and ξ are product characteristics observed by the producer and consumer but not by the econometrician. Let the taste for certain product characteristics vary with individual consumer characteristics:

$$(18) \qquad \begin{pmatrix} \alpha_i \\ \beta_i \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \end{pmatrix} + \Pi D_i + \Sigma v_i$$

where D_i is a vector of demographics for consumer i, Π is a matrix of coefficients that characterize how consumer tastes vary with demographics, v_i is a vector of unobserved characteristics for consumer i, and Σ is a matrix of coefficients that characterizes how consumer tastes vary with their unobserved characteristics. I assume that, conditional on demographics, the distribution of consumers' unobserved characteristics is multivariate normal. The demographic draws give an empirical distribution for the observed consumer characteristics D_i. Indirect utility can be redefined in terms of mean utility $\delta_{jt}= \beta x_{jt} - \alpha p_{jt} + \xi_{jt}$ and deviations (in vector notation) from that mean $\mu_{ijt}= [\Pi D_i \; \Sigma v_i] * [p_{jt} \;\; x_{jt}]$:

$$u_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt} \tag{19}$$

Finally, consumers have the option of an outside good. Consumer i can choose not to purchase one of the products in the sample. The price of the outside good is assumed to be set independently of the prices observed in the sample.[7] The mean utility of the outside good is normalized to be zero and constant over markets. The indirect utility from choosing to consume the outside good is:

$$u_{i0t} = \xi_{0t} + \pi_0 D_i + \sigma_0 v_{i0} + \varepsilon_{i0t} \tag{20}$$

Let A_j be the set of consumer traits that induce purchase of good j. The market share of good j in market t is given by the probability that product j is chosen:

$$s_{jt} = \int_{\zeta \in A_j} P^*(d\zeta) \tag{21}$$

where $P^*(d\zeta)$ is the density of consumer characteristics $\zeta = [D \quad \nu]$ in the population. To compute this integral, one must make assumptions about the distribution of consumer characteristics. I report estimates from two models. For diagnostic purposes, I initially restrict heterogeneity in

[7] As the manufacturers I observe supply their products to the outside market, this assumption may be problematic given my data. Recent empirical work shows that consumers rarely search over several local supermarkets to locate the lowest price for a single good. This implies that beer in other supermarkets (the outside good in my model) is unlikely to be priced to respond in the short run (over the course of a month) to the prices set by *Dominick's*. Any distortions introduced by this assumption are likely to be second order. The inclusion of an outside good means my use of a single retailer does not require an assumption of monopoly in the retail market. It makes the estimates of pass-through more credible given that the retail firm in my sample is constrained by the availability of goods other than those it sells. Even if the price of the outside good does not respond to price changes in the sample, it remains a potential choice for consumers when faced with a price increase for products in the sample.

consumer tastes to enter only through the random shock ε_{ijt} which is independently and identically distributed with a Type I extreme-value distribution. For this model, the probability of individual i purchasing product j in market t is given by the multinomial logit expression:

$$s_{ijt} = \frac{e^{\delta_{jt}}}{1 + \sum_{k=1}^{J_t} e^{\delta_{kt}}} \tag{22}$$

where δ_{jt} is the mean utility common to all consumers and J_t remains the total number of products in the market at time t.

In the full random-coefficients model, I assume ε_{ijt} is i.i.d with a Type I extreme-value distribution but now allow heterogeneity in consumer preferences to enter through an additional term μ_{it}. This allows more general substitution patterns among products than is permitted under the restrictions of the multinomial logit model. The probability of individual i purchasing product j in market t must now be computed by simulation. This probability is given by computing the integral over the taste terms μ_{it} of the multinomial logit expression:

$$s_{jt} = \int_{\mu_{it}} \frac{e^{\delta_{jt} + \mu_{ijt}}}{1 + \sum_k e^{\delta_{kt} + \mu_{ikt}}} f(\mu_{it})\, d\mu_{it} \tag{23}$$

The integral is approximated by the smooth simulator which, given a set of N draws from the density of consumer characteristics $P^*(d\zeta)$, can be written:

$$s_{jt} = \frac{1}{N} \sum_{i=1}^{N} \frac{e^{\delta_{jt} + \mu_{ijt}}}{1 + \sum_k e^{\delta_{kt} + \mu_{ikt}}} \tag{24}$$

Given these predicted market shares, I search for demand parameters that implicitly minimize the distance between these predicted market shares and the observed market shares using a generalized method-of-moments (GMM) procedure, as I discuss in further detail in the estimation section.

3.4 Discussion

Before turning to the estimation procedures, it may be useful to explain how the model can be used to identify the sources of traded-goods price inertia as well as its limitations. The pricing equations (10) and (12) decompose each brand's price into six components: the manufacturer's and retailer's markups and traded and nontraded marginal costs. Following a change in firms' traded marginal costs, price inertia that cannot be explained by the presence of local non-traded costs implies markup adjustment.

I use a reduced-form estimation to identify the share of the local nontraded costs in each product's retail price. Following Goldberg and Verboven (2001), I estimate the following basic price equation:

$$\ln p^r_{jt} e_{jt} = \beta \ln w^d_{jt} e_{jt} + \gamma \ln w^f_{jt} + \varepsilon_{jt} \tag{25}$$

where the subscripts j and t refer to product j in market t where a market is defined as a month and price-zone pair, p^r is the product's retail price, w^d is local wages, e is the bilateral nominal exchange rate, w^f is foreign wages, and ε is a random error term. Local wages are hourly compensation in local currency terms for the grocery sector in Illinois multiplied by the exchange rate which is foreign currency units per unit of domestic currency. The dependent variable is the retail price for each brand multiplied by the exchange rate which is foreign currency units per unit of domestic currency. The regression also includes brand dummy variables. Table 4's results indicate that the share of variation in the retail price attributed to movements in local costs is between 82 and 85 percent, depending on the control variables used. Splitting the difference between the two regression results, I calibrate the model so that 83.5 percent of the retail price's movement will be attributable to the presence of nontraded local costs.

4 Estimation

This section describes the econometric procedures used to estimate the model's demand parameters.

4.1 Demand

The results depend on consistent estimates of the model's demand parameters. Two issues arise in estimating a complete demand system in an oligopolistic market with differentiated products: the high dimensionality of elasticities to estimate and the potential endogeneity of price.[8] Following McFadden (1973), Berry, Levinsohn, and Pakes (1995), and Nevo (2001) I draw on the discrete-choice literature to address the first issue: I project the products onto a characteristics space with a much smaller dimension than the number of products. The second issue is that a product's price may be correlated with changes in its unobserved characteristics. I deal with this second issue by instrumenting for the potential endogeneity of price. Following Villas-Boas (2004), I use input prices interacted with product fixed effects as instruments. Input prices should be correlated with those aspects of price that affect consumer demand but are not themselves affected by consumer demand, that is, with supply shocks.

I estimate the demand parameters by following the algorithm proposed by Berry (1994). This algorithm uses a nonlinear generalized-method-of-moments (GMM) procedure. The main step in the estimation is to construct a moment condition that interacts instrumental variables and

[8] In an oligopolistic market with differentiated products, the number of parameters to be estimated is proportional to the square of the number of products, which creates a dimensionality problem given a large number of products.

a structural error term to form a nonlinear GMM estimator. Let θ signify the demand-side parameters to be estimated with θ_1 denoting the model's linear parameters and θ_2 its non-linear parameters. I compute the structural error term as a function of the data and demand parameters by solving for the mean utility levels (across the individuals sampled) that solve the implicit system of equations:

$$s_t\left(x_t, p_{t,} \delta_t | \theta_2\right) = S_t \tag{26}$$

where S_t are the observed market shares and $s_t\left(x_t, p_{t.} \delta_t | \theta_2\right)$ is the market-share function defined in equation (*24*). For the logit model, this is given by the difference between the log of a product's observed market share and the log of the outside good's observed market share: $\delta_{jt} = \log(S_{jt}) - \log\left(S_{0t}\right)$. For the full random-coefficients model, it is computed by simulation.[9]

Following this inversion, one relates the recovered mean utility from consuming product j in market t to its price, p_{jt}, its constant observed and unobserved product characteristics, d_j, and the error term $\Delta\xi_{jt}$ which now contains changes in unobserved product characteristics:

$$\Delta\xi_{jt} = \delta_{jt} - \beta_j d_j - \alpha p_{jt} \tag{27}$$

I use brand fixed effects as product characteristics following Nevo (2001). The product fixed effects d_j proxy for the observed characteristics term x_j in equation (*17*) and mean unobserved characteristics. The mean utility term here denotes the part of the indirect utility expression in equation (*19*) that does not vary across consumers.

[9] See Nevo (2000) for details.

4.2 Instruments

The moment condition discussed above requires an instrument that is correlated with product-level prices p_{jt} but not with changes in unobserved product characteristics $\Delta\xi_{jt}$ to achieve identification of the model. While I observe national promotional activity by brand, I do not observe local promotional activity. It follows that the residual $\Delta\xi_{jt}$ likely contains changes in products' perceived characteristics that are stimulated by local promotional activity. For example, an increase in the mean utility from consuming product j caused by a rise in product j's unobserved promotional activity should cause a rightward shift in product j's demand curve and, thus, a rise in its retail price. Therefore, the residual will be correlated with the price and (nonlinear) least squares will yield inconsistent estimates. The solution to this endogeneity problem is to introduce a set of j instrumental variables z_{jt} that are orthogonal to the error term $\Delta\xi_{jt}$ of interest. The population moment condition requires that the variables z_{jt} be orthogonal to those unobserved changes in product characteristics stimulated by local advertising.

I use the prices of inputs to the brewing process as instruments. Input prices should be correlated with the retail price, which affects consumer demand, but are not themselves correlated with changes in unobserved characteristics that enter the consumer demand. Input prices like wages are unlikely to have any relationship to the types of promotional activity that will stimulate perceived changes in the characteristics of the sample's products. My instruments are hourly compensation in local currency terms for production workers in Food, Beverage and Tobacco Manufacturing Industries. These annual figures come from the Foreign Labor Statistics Program of the U.S. Department of Labor's Bureau of Labor Statistics. Bilateral nominal exchange rates account for some of the variation in these data. The model's identification of monthly variation in nominal exchange-rates should not be affected, however, given the time mismatch between my instrument data (which are annual) and my price data (which are monthly). I interact the hourly compensation variables, which vary by country and year, with indicator variables for each brand. This allows each product's price to respond independently to a given supply shock.

One might expect foreign wages to be weakly correlated with domestic retail prices, thus generating a weak instrumental-variables problem.[10] Given the well-known border effect on prices we should expect a somewhat weaker relationship between wages and prices for foreign products than for domestic products.[11] The model's first-stage results, reported in table 15 in the appendix, indicate that foreign products' input prices appear to be effective as instruments.

Manufacturer cost data for use as instruments come from the U.S. Department of Labor's Foreign Labor Statistics Program. The joint distribution of each pricing zone's residents with respect to age and income comes from the 1990 *U.S. Census*. To construct appropriate demographics for each pricing zone, I collected a sample of the joint distribution of residents' age and income for each zip code in which a *Dominick's* store was located. I then aggregate the data across each pricing zone to get one set of demographics for each zone.

5 Results

This section presents results from the estimation of the model. It first discusses results from the estimation of the demand system. It then examines how well the derived markups and marginal costs reflect stylized facts for the beer market.

[10] Staiger and Stock (1997) examine the properties of the IV estimator in the presence of weak instruments.
[11] Engel and Rogers (1996) examine the persistent deviations from the law of one price across national borders.

5.1 Demand Estimation: Logit Demand

Table 5 reports results from estimation of demand using the multinomial logit model. Due to its restrictive functional form, this model will not produce credible estimates of pass-through. However, it is helpful to see how well the instruments for price perform in the logit demand estimation before turning to the full random-coefficients model. Table 15 in the appendix reports the first-stage results for demand. Most of the coefficients have the expected sign: as hourly compensation increases, the retail price of each product should increase. T-statistics calculated using Huber-White robust standard errors indicate that most of the coefficients are significant at the 5-percent level. The negative coefficients on some variables likely result from collinearity between some of the regressors.

Table 5 suggests the instruments may have some power. The first-stage F-test of the instruments, at 17.42, is significant at the 1-percent level. The consumer's sensitivity to price should increase after I instrument for unobserved changes in characteristics. That is, consumers should appear more sensitive to price once I instrument for the impact of unobserved (by the econometrician, not by firms or consumers) changes in product characteristics on their consumption choices. It is promising that the price coefficient falls from -5.62 in the OLS estimation to -8.34 in the IV estimation. The second and fourth columns of Table 5 include brand-level national advertising expenditure in the estimation. Although signed as expected, at .17 in the OLS estimation and .16 in the IV estimation, the advertising coefficient is highly insignificant. The brand-level fixed effects likely capture those aspects of consumer taste that are stimulated by national advertising. The Hausman exogeneity test for the price variable, at 10.28, is significant at the 1-percent level. A Hausman test of overidentifying restrictions fails to reject this specification. It returns a value of 11.56, far below the critical value of 45 that must be surpassed to fail the test.

5.2 Demand: Random-Coefficients Model

Table 6 reports results from estimation of the demand equation (*27*). I allow consumers' age and income to interact with their taste coefficients for price and percent alcohol. As I estimate the demand equation using product fixed effects, I recover the consumer taste coefficients in a generalized-least-squares regression of the estimated product fixed effects on product characteristics. This GLS regression assumes changes in brands' unobserved characteristics $\Delta\xi$ are independent of changes in brands' observed characteristics x: $E\left(\Delta\xi|x\right) = 0$.

The coefficients on the characteristics appear reasonable. As consumers' age and income rise, they become less price sensitive. The coefficients on age, at 3.16, and on income, at .28, are significant at the 5-percent level. The mean preference in the population is in favor of a bitter and hoppy taste in beer. Both characteristics have positive and highly significant coefficients. The mean preference in the population is quite averse to sweet, fruity, or malty flavors in beer. All three have negative coefficients, with the first two highly significant. As the percent alcohol rises, the mean utility in the population falls. This result appears reasonable once one considers that identification here comes from the variation in the percent alcohol between light and regular beers. As light beers sell at a premium, there clearly is some gain in utility from less alcohol within a given range. I do not consider nonalcoholic beers in this sample, so the choice of no alcohol is not reflected in this coefficient. Calories have a negative sign, as one would expect, though the coefficient is not significant. Finally, an indicator variable for poor quality, the "Sulfury/Skunky" characteristic, has a large, negative, and highly significant coefficient as one would expect. The minimum-distance weighted R^2 is .46 indicating these characteristics explain the variation in the estimated product fixed effects fairly well.

Table 7 reports a sample of the median own- and cross-price elasticities for selected brands.

The cross-price elasticities are generally intuitive. The cross-price elasticities are higher between imported brands than between imported and domestic brands. A change in the price of *Amstel*, from Holland, has a greater impact on the market share of other imported brands such as *Heineken* at .0168 or *Beck's* at .0162 than on such domestic brands as *Miller High Life* at .0054. The cross-price elasticities between a domestic premium light beer such as *Bud Light* and an import such as *Beck's* at .1005 or *Corona* at .0986 are somewhat higher than those between *Bud Light* and the domestic brands *Bud* at .0853 or *Miller High Life* at .0827.

Table 8 reports retail prices and derived markups for selected brands. Foreign brands' median retail price of one dollar for foreign brands is about twice that of domestic brands, at 49 cents, which is consistent with industry lore.[12] The median retail markup for domestic brands is 12 cents while for imported brands it is over twice that at 29 cents. Markups at the manufacturer level are somewhat lower: the median domestic markup is 9 cents and the median foreign markup is 20 cents. Markups are generally higher for light beers than for regular beers, also consistent with the market's stylized facts.

Figure 2 compares the observed and derived exchange rates over the sample period for most of the countries in the sample. The derived exchange rates are 12-month moving averages to remove seasonal fluctuations. The high covariance between the two variables suggests the structural model identifies nominal exchange-rate movements fairly well for each of the sample's countries. The model's derived wholesale prices also appear to follow observed wholesale-price movements fairly closely: the correlation between the two series is over 86 percent across all brands, zones, and months.

[12] Ghemawat (1992) reports that "imported brands... wholesaled at twice the average price of domestic brands" p. 5.

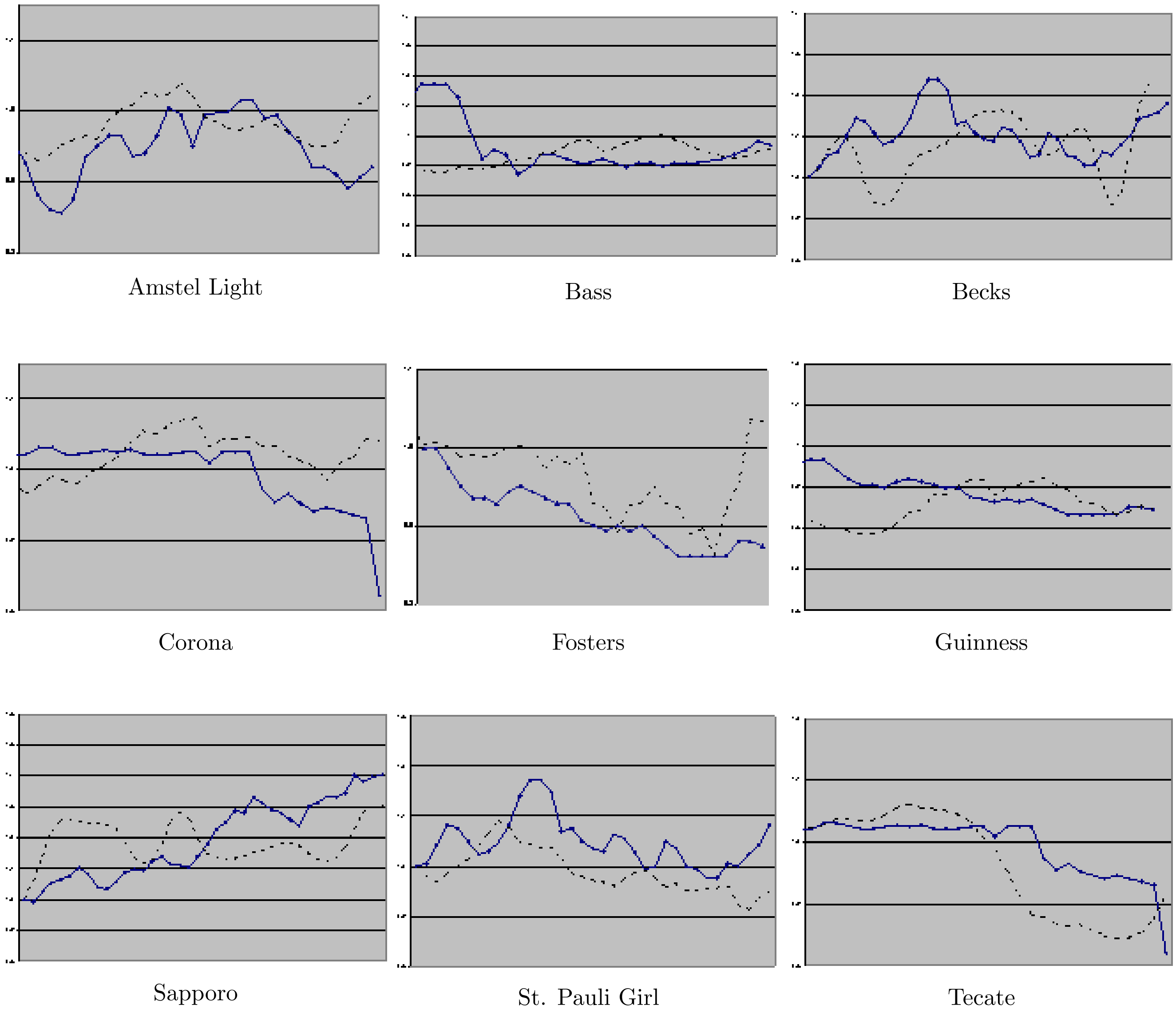

Figure 2. A comparison of the observed and the derived exchange rates. The derived exchange rate is a 12-month moving average and is the broken line in each figure. The observed exchange rate is the average monthly bilateral nominal exchange rate between the U.S. and the country in which the brand is produced. Note that *Guinness* and *Fosters* are produced in Canada. The time period is from July 1992 to December 1994. Sources: My calculations: International Financial Statistics, *IMF*.

6 Counterfactual Experiments and Welfare Analysis

Using the full random-coefficients model and the derived marginal costs I conduct counterfactual experiments to analyze how firms and consumers react to foreign shocks. This section presents and discusses the results from these experiments.

The first counterfactual experiments consider how foreign manufacturers and the retailer adjust their prices following a five-percent increase in foreign firms' marginal costs due to an exchange-rate depreciation. The first column of Table 9 reports manufacturer-traded pass-through: the incomplete pass-through of the original shock to the wholesale price due to manufacturer markup adjustment. The second column reports retail-nontraded pass-through: the incomplete pass-through of the original shock to the retail price due to the presence of a local component in retail costs. The last column reports the retail-traded pass-through: the incomplete pass-through of the original shock to the retail price due to retailer markup adjustment. The model is calibrated so that the manufacturer-nontraded pass-through, the incomplete pass-through of the original shock to the wholesale price due to the presence of a local component in manufacturer costs, is 50 percent, drawing on industry lore and on the estimation results from section 4.

I find some variation in firms' pass-through across brands. The median manufacturer-traded pass-through of a 5-percent depreciation ranges from 5 percent for *Grolsch* to 66 percent for *Corona*: It is 35 percent across all brands. The retailer's median non-traded pass-through elasticity is 16 percent and its traded pass-through elasticity is 9 percent. Pass-through elasticities following a 5-percent appreciation are lower than those following a depreciation: The median manufacturer-traded, retail-nontraded, and retail-traded pass-through elasticities are 16, 8, and 7 percent, respectively.

The results are generally consistent with the predictions of the theoretical model discussed in section 3. Figures 3 and 4 illustrate the nonlinear relationship between integration at the microeconomic level, proxied for by market share, and the transmission of shocks to prices. The figures display scatterplots with each brand's median share of imported brands' total sales on the X-axis and manufacturer traded, retail nontraded, and retail traded pass-through elasticities on the Y-axis. Figure 3 shows that following a 5-percent depreciation, pass-through elasticities rise rapidly as brands' market share goes from 1 to 5 percent, peak for those brands with a 12-percent market share, and then decline slightly. Figure 4 shows the opposite pattern: Following a 5-percent appreciation, pass-through elasticities fall rapidly as brands' market share goes from 1 to 5 percent, are zero for brands with 12-percent market share, and then rise again. Retail-traded pass-through elasticities do not follow this pattern, however. They remain at or below zero for those brands with market share greater than 20 percent.

The pass-through elasticities following a depreciation generally resemble those of previous studies. Goldberg and Knetter (1997) report the literature's median estimate of pass-through elasticities to import prices to be 50 percent over the course of one year.[13] Knetter (1993) estimates a 56-percent pass-through to export prices for German firms exporting beer to the U.S. market. The model produces median manufacturer-traded pass-through elasticities of 50 and 37 percent, respectively, following a depreciation, for the two German brands in the sample: *Beck's* and *St. Pauli Girl*. The elasticities are much lower following an appreciation, however, at 3 and 10 percent, respectively.

Tables 11 and 12 decompose the sources of the incomplete transmission of the exchange-rate shocks to retail prices documented in Tables 9 and 10. The first column of each table reports

[13] As Menon (1995) notes in his survey of the literature, the distribution across studies of these estimates has thick tails: Researchers have found very different pass-through coefficients even when working with data that cover the same industries and time periods.

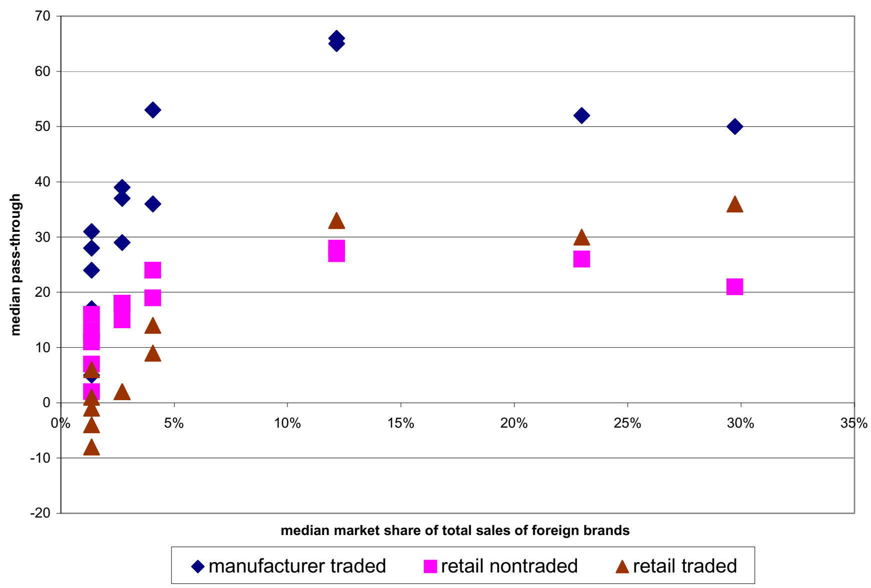

Figure 3: *Market share has a nonlinear relationship to pass-through following a depreciation...*

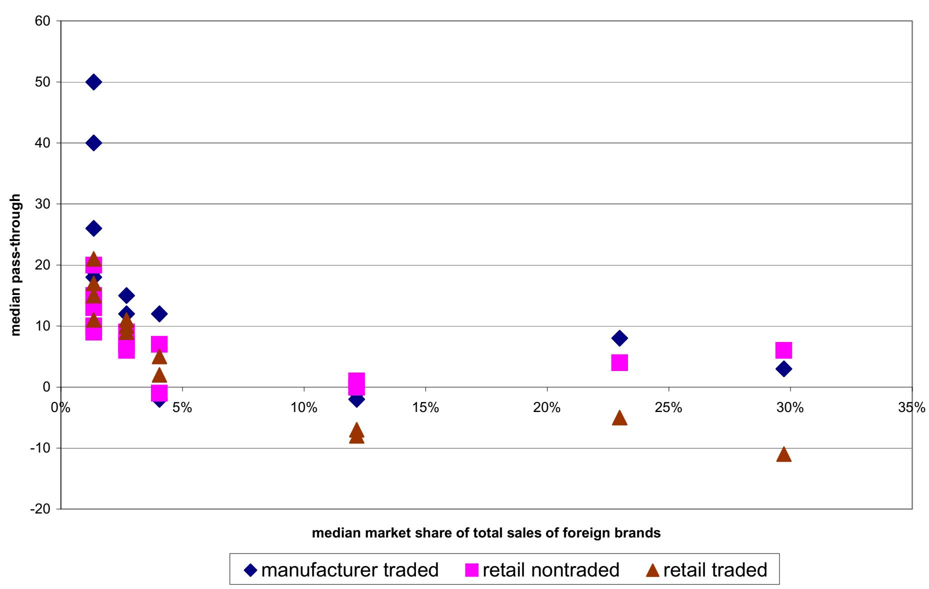

Figure 4: *As well as following an appreciation.*

the share of the incomplete transmission that can be attributed to a local-cost component in manufacturers' marginal costs. The second column reports the share that can be attributed to markup adjustment by manufacturers following the shock. The third column reports the share attributable to a local-cost component in retailers' marginal costs, and the fourth column the share attributable to the retailer's markup adjustment.

Manufacturers' local-cost component plays the most significant role in the incomplete transmission of the original shock to retail prices. Following a 5-percent exchange-rate depreciation, it is responsible for just over half, or 54 percent, of the observed retail-price inertia. Manufacturer markup adjustment accounts for 17 percent of the remaining adjustment, while the retailer local-cost component and markup adjustment account for 20 and 8 percent, respectively. Following a 5-percent exchange-rate appreciation, the manufacturer local-cost component accounts for 55 percent of the price adjustment, its markup adjustment for 38 percent, the retailer's local-cost component for 8 percent, and its markup adjustment for 1 percent. Overall, local-cost components account for 74 percent of the observed price inertia following a depreciation and 63 percent following an appreciation. Firms' markup adjustment accounts for 26 percent of the observed price inertia following a depreciation and 37 percent following an appreciation.

To assess the overall welfare effects of this incomplete transmission, Table 13 reports the equilibrium effects of a 5-percent exchange-rate change on firms' profits and on consumer welfare. Following a depreciation, foreign manufacturers suffer the most as their profits decline by 5.8 percent. Domestic manufacturers benefit though only marginally: Their profits rise by 0.1 percent. Consumer surplus falls by 4.2 percent and retailer profits by 2.1 percent. Following a 5-percent appreciation, in contrast, the retailer profits basically remain unchanged. Consumers are somewhat better off than before: Consumer surplus rises by one percent. Foreign manufacturers do quite well: Their profits rise by 4.6 percent. Overall, Table 13 shows that the effects of a foreign-cost shock are large and unevenly distributed across domestic and foreign firms and domestic consumers.

Table 14 considers the possible role of domestic manufacturers in foreign manufacturers' markup adjustment: It reports the equilibrium effects of 5-percent increase in foreign firms' marginal costs on selected domestic brands' profits, price-cost markups, and quantities sold. The first two columns give the percent change by brand in manufacturer and retailer profits following the depreciation. The third column gives the median percent change in the quantity sold by brand, and the last two columns the median percent change in the manufacturer and retailer markups by brand. Comparing the first two columns of Table 14 to the last three columns gives some indication of the underlying causes of variation in a brand's total profits: changes in the quantity sold or changes in the markup. The results suggest some strategic interaction between import-competing domestic manufacturers and foreign manufacturers following a depreciation. Import-competing domestic manufacturers increase their profits by lowering prices to take market share from foreign manufacturers. The domestic brands with increased profits are the light or superpremium brands that compete most directly with imported beers. As Column 1 of Table 14 shows, only superpremium or light beers' profits rise significantly: Manufacturer and retailer profits rise for *Bud Light* by 3 and 6 percent, *Michelob Light* by 6 and 10 percent, and *Miller High Life* by 2 and 4 percent. The profits of non-import-competing brands such as *Bud, Coors, Old Milwaukee, or Stroh's* change very little or decline. Premium brands that are not light beers such as *Bud* and *Coors* and sub-premium brands such as *Old Milwaukee* or *Stroh's* are considered poor substitutes for imported brands and so have little to gain from shrinking markups to try to capture market share following a depreciation.

These strategic interactions between domestic and foreign manufacturers provide one possible explanation for the puzzle of incomplete cross-border transmission. It may not be profit maximizing for foreign manufacturers to fully pass-through a cost shock in a market where some domestic manufacturers exploit each increase in a foreign brand's price to increase their market share.

7 Conclusion

This paper makes three contributions. The first is an explanation of an approach I find useful to quantify the effect of a foreign shock on domestic consumers and on domestic and foreign firms. The approach enables me to ask more and deeper questions about the microeconomics of international transmission than was possible with previous empirical models. I estimate a structural econometric model that makes it possible to compute manufacturers' and retailers' pass-through of a foreign cost shock without observing wholesale prices or firms' marginal costs. Using the estimated demand system, I conduct counterfactual experiments to determine whether domestic manufacturers, foreign manufacturers, a domestic retailer, or domestic consumers bear the cost of the shock. Second, I use an unusually detailed dataset with retail and wholesale prices that allows me to check the validity of my empirical technique. Third, I quantify the importance of various sources for the incomplete process of international transmission. To my knowledge, this paper is the first to quantify the relative importance of two factors – non-traded costs and markup adjustments – for both manufacturers and retailers in the incomplete transmission of shocks to prices. My results suggest that a local-cost component in manufacturers' costs explains a large part of the incomplete transmission though markup adjustments by manufacturers and retailers play a nontrivial role.

References

[1] "Can You Judge a Beer by its Label? Beer Ratings," *Consumer Reports*, 10–19 (June 1996).

[2] "The Alcoholic Beverage Market in the United States," *Canadian Trade Commissioner* (June 2000).

[3] Ashenfelter, Orley, et al. "Identifying the Firm-Specific Cost Pass-Through Rate," *Mimeo* (January 1998).

[4] Bergin, Paul R. and Robert C. Feenstra. "Pricing-to-Market, Staggered Contracts, and Real Exchange Rate Persistence," *Journal of International Economics*, *54*(2):333–59 (August 2001).

[5] Berry, Steven. "Estimating Discrete-Choice Models of Product Differentiation," *RAND Journal of Economics*, *25*(2):242–62 (Summer 1994).

[6] Berry, Steven, et al. "Automobile Prices in Market Equilibrium," *Econometrica*, *63*(4):841–90 (July 1995).

[7] Betts, Caroline and Michael Devereux. "Exchange Rate Dynamics in a Model of Pricing to Market," *Journal of International Economics*, *50*:215–44 (February 2000).

[8] Bresnahan, Timothy F. "Competition and Collusion in the American Automobile Industry: The 1955 Price War," *Journal of Industrial Economics*, *35*(4):457–82 (June 1987).

[9] Bresnahan, Timothy F. and Peter C. Reiss. "Dealer and Manufacturer Margins," *Rand Journal of Economics*, *16*(2):253–68 (Summer 1985).

[10] Burstein, Ariel, Joao Neves and Sergio Rebelo. "Distribution Costs and Real Exchange-Rate Dynamics," *Journal of Monetary Economics* (September 2003).

[11] Campa, Jose and Linda Goldberg. "Do Distribution Margins Solve the Exchange-Rate Disconnect Puzzle?," *Working Paper* (May 2004).

[12] Campa, Jose Manuel and Linda S. Goldberg. "Exchange-Rate Pass-Through into Import Prices: A Macro or Micro Phenomenon?," *NBER Working Paper*, *8934* (May 2002).

[13] Chevalier, Judith A., et al. "Why Don't Prices Rise during Periods of Peak Demand? Evidence from Scanner Data," *American Economic Review*, *93*(1):15–37 (March 2003).

[14] Corsetti, Gian-Carlo and Luca Dedola. "Macroeconomics of International Price Discrimination," *Journal of International Economics* (forthcoming).

[15] Devereux, Michael B., et al. "Exchange Rate Pass-Through and the Welfare Effects of the Euro," *International Economic Review*, *44*(1):223–42 (February 2003).

[16] Dornbusch, Rudiger. "Exchange Rates and Prices," *American Economic Review*, *77*(1):93–106 (March 1987).

[17] Engel, Charles and John H. Rogers. "How Wide Is the Border?," *American Economic Review*, *86*(5):1112–25 (December 1996).

[18] Engel, Charles and John H. Rogers. "Deviations from Purchasing Power Parity: Causes and Welfare Costs," *Journal of International Economics*, *55*(1):29–57 (October 2001).

[19] Feenstra, Robert C. "Symmetric Pass-Through of Tariffs and Exchange Rates Under Imperfect Competition: An Empirical Test," *Journal of International Economics*, *27*:25–45 (1989).

[20] Feenstra, Robert C., et al. "Market Share and Exchange Rate Pass-Through in World Automobile Trade," *Journal of International Economics*, *40*(1-2):187–207 (February 1996).

[21] Froot, Kenneth A. and Paul D. Klemperer. "Exchange Rate Pass-Through When Market Share Matters," *American Economic Review*, *79*(4):637–54 (September 1989).

[22] Ghemawat, Pankaj. "Adolph Coors in the Brewing Industry," *HBS Case Study*, *9388014* (1992).

[23] Goldberg, Pinelopi and Frank Verboven. "The Evolution of Price Dispersion in the European Car Market," *Review of Economic Studies*, *68*:811–48 (2001).

[24] Goldberg, Pinelopi Koujianou. "Product Differentiation and Oligopoly in International Markets: The Case of the US Automobile Industry," *Econometrica*, *63*(4):891–951 (July 1995).

[25] Goldberg, Pinelopi Koujianou and Michael M. Knetter. "Goods Prices and Exchange Rates: What Have We Learned?," *Journal of Economic Literature*, *35*(3):1243–72 (September 1997).

[26] Hausman, Jerry, et al. "Competitive Analysis with Differenciated Products," *Annales d'Economie et de Statistique*, *34*:159–80 (April-June 1994).

[27] Hellerstein, Rebecca. "Vertical Contracts and Exchange Rates: An Empirical Analysis," *Mimeo* (2004).

[28] Kadiyali, Vrinda. "Exchange Rate Pass-through for Strategic Pricing and Advertising: An Empirical Analysis of the US Photographic Film Industry," *Journal of International Economics*, *43*(3-4):437–61 (November 1997).

[29] Katz, Michael L. "Vertical Contractual Relations." *Handbook of industrial organization* VOL 1, edited by Richard Schmalensee and Robert D. Willig, 655–721, Amsterdam, Oxford and Tokyo: North-Holland, 1989.

[30] Knetter, Michael M. "Price Discrimination by US and German Exporters," *American Economic Review*, *79*(1):198–210 (March 1989).

[31] Knetter, Michael M. "International Comparisons of Price-to-Market Behavior," *American Economic Review*, *83*(3):473–86 (June 1993).

[32] Krugman, Paul and Maurice Obstfeld, editors. *International Economics: Theory and Policy* (5th Edition). Reading, MA: Addison-Wesley, 2000.

[33] Lee, Eunkyu and Richard Staelin. "Vertical Strategic Interaction: Implications for Channel Pricing Strategy," *Marketing Science*, *16*(3):185–207 (1997).

[34] McFadden, Daniel. "Conditional Logit Analysis of Qualitative Choice Behavior." *Frontiers of econometrics* edited by Paul Zarembka, 105–42, New York: Academic Press, 1973.

[35] McFadden, Daniel. "Econometric Models of Probabilistic Choice." *Structural analysis of discrete data* edited by Charles F. Manski and Daniel McFadden, 169–73, Cambridge: MIT Press, 1981.

[36] McFadden, Daniel and Kenneth Train. "Mixed MNL Models for Discrete Response," *Journal of Applied Econometrics*, *15*(5):447–70 (September-October 2000).

[37] Meese, Richard and Kenneth Rogoff. "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample," *Journal of International Economics*, *14*:3–24 (February 1983).

[38] Menon, Jayant. "Exchange Rate Pass-Through," *Journal of Economic Surveys*, *9*(2):197–231 (June 1995).

[39] Mortimer, Julie Holland. "Vertical Contracts in the Video Rental Industry," *Working Paper* (April 2004).

[40] Nevo, Aviv. "Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry," *RAND Journal of Economics*, *31*(3):395–421 (Autumn 2000).

[41] Nevo, Aviv. "A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand," *Journal of Economics and Management Strategy*, *9*(4):513–48 (Winter 2000).

[42] Nevo, Aviv. "Measuring Market Power in the Ready-to-Eat Cereal Industry," *Econometrica*, *69*(2):307–42 (March 2001).

[43] Staiger, Douglas and James H. Stock. "Instrumental Variables Regression with Weak Instruments," *Econometrica*, *65*(3):557–86 (May 1997).

[44] Tille, Cedric. "The Role of Consumption Substitutability in the International Transmission of Monetary Shocks," *Journal of International Economics*, *53*(2):421–44 (April 2001).

[45] Tirole, Jean. *The theory of industrial organization*. Cambridge, MA and London: MIT Press, 1988.

[46] Villas-Boas, Sofia. "Vertical Contracts Between Manufacturers and Retailers: Inference with Limited Data," *Mimeo* (June 2004).

[47] Villas-Boas, Sofia and Rebecca Hellerstein. "Identification of Supply Models of Retailer and Manufacturer Pricing," *CUDARE Working Paper No. 993* (October 2004).

Description	Mean	Median	Standard Deviation	Min	Max
Retail prices (cents per serving)	71	61	27	27	132
Market share of each product	.54	.15	1.16	.00005	9.17
Servings sold	16589	4655	34800	1.83	279,918
Share of Dominick's beer sales	65.04	65.89	13.96	31.58	98.20
Market share of 34 products	18.46	17.34	7.38	7.01	36.12
Market share of outside good	81.54	82.66	7.38	63.89	93.21

Table 1: *Summary statistics for prices, servings sold, and market shares for the 34 products in the sample.* The share of *Dominick's* total beer sales refers to the share of revenue of the 34 products I consider in the total beer sales by the *Dominick's* stores in my sample. The market share refers to the volume share of the product in the potential market which I define as all beer servings sold at supermarkets in the zip codes in which one of the *Dominick's* stores in my sample is located. Source: *Dominick's*.

Description	Mean	Median	Std	Minimum	Maximum
Percent Alcohol	4.52	4.60	.68	2.41	6.04
Calories	132.18	142.50	23.00	72.00	164.00
Bitterness	2.50	2.10	1.08	1.70	5.80
Maltiness	1.67	1.20	1.52	.60	7.10
Hops (=1 if yes)	.12	–	–	–	–
Sulfury/Skunky (=1 if yes)	.29	–	–	–	–
Fruity (=1 if yes)	.21	–	–	–	–
Floral (=1 if yes)	.12	–	–	–	–

Table 2: *Product characteristics.* Source: "Beer Ratings." *Consumer Reports*, June (1996), pp. 10-19.

Retail price	OLS	OLS	IV
Exchange rate	.011	.014	.057
	(.001)**	(.003)**	(.018)**
Local wages		.245	.536
		(.099)*	(.165)**
Foreign wages		.001	.029
		(.002)	(.012)*
Feature		-.124	-.132
		(.005)**	(.006)**
Constant	.011	-.468	-.919
	(.004)**	(.217)*	(.309)**
Observations	1680	1680	1680
R^2	.024	.26	
1^{st}-stage partial F stat.			44.85

Table 3: *Some preliminary descriptive results.* Local wages are hourly compensation in local currency terms for the grocery sector in Illinois. The dependent variable is the retail price for each brand. Foreign wages are hourly wages in food and beverage manufacturing. The exchange-rate is the monthly average of the previous month's spot rate. Feature is a dummy variable that indicates if the brand was promoted by the store during that month in its weekly circular or in its display within the store. In the instrumental variables estimation, the instrument is interest rates in the countries that would eventually make up the Euro area. Source: My calculations.

Retail price	OLS	OLS
Local wages	.82	.85
	(.02)**	(.02)**
Foreign wages		.01
		(.002)**
Constant	-1.71	-1.73
	(.07)**	(.07)**
Observations	1680	1680
R^2	.47	.47

Table 4: *An estimation of the share of local nontraded costs in retail beer prices.* Local wages are hourly compensation in local currency terms for the grocery sector in Illinois multiplied by the exchange rate which is foreign currency units per unit of domestic currency. The dependent variable is the retail price for each brand multiplied by the exchange rate which is foreign currency units per unit of domestic currency. The regression also includes brand dummy variables. Source: My calculations.

Variable	OLS		IV		
Price	-5.62	-5.62	-8.34	-8.32	.
	(.27)	(.27)	(.99)	(.99)	
Advertising		.17		.16	
		(.22)		(.22)	
Measures of Fit					
Adjusted R^2	.86	.86			
Price Exogeneity Test			10.28	10.13	
95% Critical Value			(3.84)	(3.84)	
Overidentification Test			11.56	11.60	
95% Critical Value			(45)	(45)	
First-Stage Results					
F-Statistic			17.42	17.40	
Partial R^2			.98	.97	
Instruments			wages	wages	

Table 5: *Diagnostic results from the logit model of demand.* Dependent variable is $ln(S_{jt}) - ln(S_{ot})$. All four regressions include brand fixed effects. Based on 4080 observations. Huber-White robust standard errors are reported in parentheses. Wages denote a measure of hourly compensation from the U.S. Bureau of Labor Statistics which is described in the text. Advertising is the annual amount spent on advertising for each brand across all potential media outlets. Sources: Competitive Media Reporting, 1991-1994; My calculations.

Variable	Mean in Population	Interaction with:		
		Unobservables	Age	Income
Constant	-12.664* (.478)			
Price	-21.743* (7.184)	1.407 (2.122)	3.157* (1.506)	.280* (.136)
Bitterness	1.195* (.039)			
Hops	1.277* (.001)			
Sulfury/Skunky	-1.139* (.061)			
Percent Alcohol	-1.59* (.104)	.028 (.759)	-.143 (.154)	-.014 (.022)
Calories	-.003 (.042)			
Maltiness	-.415 (.478)			
Fruity	-.974* (.046)			
Floral	-1.803* (.103)			
GMM Objective	45.83			
M-D Weighted R^2	.46			

Table 6: *Results from the full random-coefficients model of demand.* Based on 4080 observations. Asymptotically robust standard errors in parentheses. Starred coefficients are significant at the 5-percent level. Source: My calculations.

Brand	Amstel	Beck's	Bud	Bud L	Corona	Heineken	Miller HL
Amstel	-6.06	.0162	.0058	.0075	.0163	.0168	.0054
Beck's	.1437	-5.71	.0528	.0684	.1320	.1356	.0506
Bud	.1299	.1359	-6.37	.1560	.1413	.1345	.1511
Bud Light	.0977	.1005	.0853	-5.88	.0986	.0992	.0827
Corona	.0717	.0673	.0263	.0334	-6.04	.0693	.0261
Heineken	.1309	.1236	.0464	.0601	.1276	-6.12	.0453
Miller HL	.0843	.0910	.1015	.1041	.0915	.0895	-6.49

Table 7: *A sample of median own- and cross-price demand elasticities.* Cell entries i, j, where i indexes row and j column, give the percent change in the market share of brand j given a 1-percent change in the price of brand i. Each entry reports the median of the elasticities from the 120 markets. Source: My calculations.

Product	Price	Markup		
	Retail	Manufacturer	Retailer	Vertical
	cents	cents	cents	cents
Domestic Brands				
Bud Light	53	10	15	25
Coors	49	8	13	22
Keystone Light	35	6	9	16
Michelob Light	59	11	18	28
Miller Genuine Draft	51	9	13	22
Stroh's	40	7	11	18
All Domestic Brands	49	9	12	21
Foreign Brands				
Amstel	99	22	30	52
Beck's	88	20	28	48
Corona	97	19	29	48
Heineken	99	21	28	49
Molson Light	76	18	28	46
Sapporo	106	24	31	55
All Foreign Brands	100	20	29	50

Table 8: *Median retail prices and derived price-cost markups for selected brands.* Median across 120 markets. The markup is price less marginal cost with units in cents per 12-ounce serving. Source: My calculations.

	Manufacturer Traded	Retail Nontraded	Retail Traded
Amstel	36	19	9
Bass	39	18	2
Beck's	50	21	36
Corona	66	27	33
Foster's	29	15	2
Grolsch	5	2	-8
Guinness	53	24	14
Harp	24	11	-4
Heineken	52	26	30
Molson L	31	16	6
Peroni	65	28	33
Sapporo	17	7	-1
St. Pauli	37	18	2
Tecate	28	12	1
All Foreign	35	16	9

Table 9: *Counterfactual experiments: median pass-through of a 5-percent increase in foreign brands' marginal costs.* Median over 120 markets. Retail traded pass-through: the retail price's percent change for a given percent change in foreign brands' marginal costs. Manufacturer traded pass-through: the wholesale price's percent change for a given percent change foreign brands' marginal costs. Retail nontraded pass-through: the retail price's percent change for a given percent change in the wholesale price due to the presence of a local component in costs. Source: My calculations.

	Manufacturer Traded	Retail Nontraded	Retail Traded
Amstel	12	7	5
Bass	12	6	9
Beck's	3	6	-11
Corona	-2	0	-8
Foster's	15	9	10
Grolsch	50	20	21
Guinness	-2	-1	2
Harp	26	13	17
Heineken	8	4	-5
Molson L	19	10	11
Peroni	-1	1	-7
Sapporo	40	15	15
St. Pauli	10	7	11
Tecate	18	9	15
All Foreign	16	8	7

Table 10: *Counterfactual experiments: median pass-through of a 5-percent decrease in foreign brands' marginal costs.* Median over 120 markets. Retail traded pass-through: the retail price's percent change for a given percent change in foreign brands' marginal costs. Manufacturer traded pass-through: the wholesale price's percent change for a given percent change foreign brands' marginal costs. Retail nontraded pass-through: the retail price's percent change for a given percent change in the wholesale price due to the presence of a local component in costs. Source: My calculations.

	Manufacturer		Retail	
	Nontraded	Traded	Nontraded	Traded
Amstel	54	16	18	11
Bass	51	11	21	16
Beck's	78	0	45	-23
Corona	74	-23	56	-8
Foster's	51	22	14	13
Grolsch	46	42	2	10
Guinness	58	-3	34	11
Harp	48	25	13	14
Heineken	71	-2	37	-6
Molson L	53	20	16	11
Peroni	74	-22	55	-7
Sapporo	49	33	10	8
St. Pauli	51	14	19	16
Tecate	50	22	17	11
All Foreign	54	17	20	8

Table 11: *Counterfactual experiments: Decomposition of the incomplete transmission of a 5-percent increase in foreign brands' marginal costs to final-goods prices.* Median over 120 markets. Manufacturer nontraded: the share of the incomplete transmission explained by the presence of a local component in manufacturer's marginal costs. Retail traded: the share of the incomplete transmission explained by the retailer's markup adjustment. Manufacturer traded: the share of the incomplete transmission explained by manufacturers' markup adjustment. Retail nontraded: the share of the incomplete transmission explained by the presence of a local component in the retailer's costs. Source: My calculations.

	Manufacturer		Retail	
	Nontraded	Traded	Nontraded	Traded
Amstel	53	39	6	2
Bass	56	41	7	-3
Beck's	46	41	-2	15
Corona	47	48	-2	7
Foster's	57	38	6	-1
Grolsch	64	-1	37	-1
Guinness	52	52	-1	-3
Harp	62	27	17	-6
Heineken	49	39	4	8
Molson L	57	34	10	-1
Peroni	47	47	-2	8
Sapporo	60	11	29	0
St. Pauli	57	44	4	-5
Tecate	60	36	11	-8
All Foreign	55	36	8	1

Table 12: *Counterfactual experiments: Decomposition of the incomplete transmission of a 5-percent decrease in foreign brands' marginal costs to final-goods prices.* Median over 120 markets. Manufacturer nontraded: the share of the incomplete transmission explained by the presence of a local component in manufacturer's marginal costs. Retail traded: the share of the incomplete transmission explained by the retailer's markup adjustment. Manufacturer traded: the share of the incomplete transmission explained by manufacturers' markup adjustment. Retail nontraded: the share of the incomplete transmission explained by the presence of a local component in the retailer's costs. Source: My calculations.

	Depreciation	Appreciation
	%	%
Retailer Profit	-2.10	-.24
Domestic Manufacturer Profit	.09	-.07
Foreign Manufacturer Profit	-5.83	4.57
Consumer Surplus	-4.20	.75

Table 13: *Median percent changes in variable profits and consumer surplus following a 5-percent change in the exchange rate.* 4080 observations.

Product	Profit		Quantity	Markup	
	Manufacturer	Retail		Manufacturer	Retail
Budweiser	0	-2	-2	2	0
Bud Light	3	6	6	-1	-1
Coors	-1	-4	-4	3	0
Coors Light	1	0	0	1	0
Michelob Light	6	10	13	-6	-3
Miller High Life	2	4	5	-2	-1
Old Milwaukee	-4	-10	-11	8	1
Old Style Classic	-3	-7	-8	6	1
Stroh's	-4	-10	-11	9	2
All Domestic Brands	0	-1	-1	2	0

Table 14: *Median percent changes in selected domestic brands' profits, quantities, and markups after a 5-percent depreciation.* Median percent change in profits, quantity sold and in the retail and manufacturer product markup over all markets. 4080 observations.

A Appendix

	Hourly Wages	T-Statistic
Amstel	.0596	1.46
Bass	.5714	3.75
Beck's	-.0063	-.46
Budweiser	.1218	3.44
Bud Light	.1710	4.10
Busch	.1464	1.66
Busch Light	.0793	1.04
Coors	.1598	3.86
Coors Light	.0039	.09
Corona	-.0001	-2.44
Foster's	-.3095	-6.11
Grolsch	.1087	2.67
Guinness	.0027	.01
Harp	.3371	2.36
Heineken	.0607	1.42
Keystone Light	-.0143	-.50
Michelob Light	.6118	7.63
Miller Genuine Draft	.1827	6.31
Miller High Life	.0702	2.05
Miller Lite	.1925	6.71
Milwaukee's Best	.5678	8.92
Milwaukee's Best Light	.3147	4.37
Molson Golden	.1216	.85
Molson Light	.1869	1.22
Old Milwaukee	-.3186	-7.72
Old Style	.2595	3.99
Old Style Classic	-.1666	-3.32
Peroni	.0001	1.81
Rolling Rock	.7274	7.69
Sapporo	-.0014	-1.00
Special Export	.2750	2.96
St. Pauli	-.1472	-3.18
Stroh's	-.0753	-1.11
Tecate	.0002	7.21

Table 15: *First-stage results for demand.* Hourly compensation in local currency terms for the food, beverage, and tobacco manufacturing industries. T-statistics are based on Huber-White robust standard errors. The dependent variable is the retail price for each brand in each month and each price zone. The regression also includes brand dummy variables. 4080 observations. Sources: My calculations; *Foreign Labor Statistics Program*, Bureau of Labor Statistics, U.S. Department of Labor.

Bilateral exchange rate	OLS
Euro-area interest rate	.797 (.119)**
Foreign wages	-.666 (.015)**
Domestic wages	-2.997 (1.141)**
Feature	.19 (.046)**
Constant	.284 (2.739)
Observations	1680
R^2	.744
1^{st}-stage partial F stat.	44.85

Table 16: *First-stage results for the reduced-form pass-through estimation.* Local wages are hourly compensation in local currency terms for the grocery sector in Illinois. The dependent variable is the bilateral nominal exchange-rate for each brand. Foreign wages are hourly wages in food and beverage manufacturing. Feature is a dummy variable that indicates if the brand was promoted by the store during that month in its weekly circular or in its display within the store. The instrument is interest rates in the countries that would eventually make up the Euro area. Source: My calculations.

Depreciation	Profit Manufacturer	Retail	Appreciation	Profit Manufacturer	Retailer
Amstel	-5	-1		5	1
Bass	-5	-1		8	1
Becks	-13	-8		2	-5
Corona	-16	-8		2	-6
Fosters	-3	0		7	1
Grolsch	2	1		10	6
Guinness	-9	-3		4	-3
Harp	-2	2		11	4
Heineken	-13	-8		2	-3
Molson Light	-5	0		5	1
Peroni	-16	-8		2	-5
Sapporo	-1	3		12	2
St. Pauli Girl	-3	1		7	2
Tecate	-2	3		10	3

Table 17: *Median percent changes in manufacturer and retailer profits after a 5-percent change in the nominal exchange rate.* Median percent change in profits over all markets. 4080 observations.