Who Bears the Cost of a Change in the Exchange Rate? The Case of Imported Beer*

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Abstract

Nominal exchange rates are remarkably volatile. They ordinarily appear disconnected from the fundamentals of the economies whose currencies they price. These facts make up a classic puzzle about the international economy. If prices do not respond fully to changes in the nominal exchange rate, who bears the cost of such large and unpredictable changes: foreign firms, domestic firms, or domestic consumers? This study develops a structural approach to analyze the welfare effects of a change in the nominal exchange rate using the example of the beer market. I estimate a structural econometric model that makes it possible to compute manufacturers' and retailers' pass-through of a nominal exchange-rate change without observing wholesale prices or firms' marginal costs. I conduct counterfactual experiments to quantify how the change affects domestic and foreign firms' profits and domestic consumer welfare. The counterfactual experiments show that foreign manufacturers bear more of the cost of a change in the nominal exchange rate than do domestic consumers, domestic manufacturers, or the domestic retailer. Following a 10-percent domestic-currency depreciation, foreign manufacturers' profits decline by 22 percent, domestic consumer surplus falls by 8 percent, the retailer's profits fall by 5 percent, and domestic manufacturers' profits increase by 1.7 percent. The model can be applied to other industries and can serve as a tool to assess the welfare effects of various exchange-rate policies.

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1 Introduction

Nominal exchange rates are remarkably volatile. They ordinarily appear disconnected from the fundamentals of the economies whose currencies they price. These facts make up a classic puzzle about the international economy. If prices do not respond fully to changes in the nominal exchange rate, who bears the cost of such large and unpredictable changes: foreign firms, domestic firms, or domestic consumers? This study examines the welfare effects of a change in the nominal exchange rate using the example of the beer industry. We should care about analyzing these welfare effects, not only to understand how the nominal exchange rate affects the domestic economy but also because assumptions about exchange-rates' welfare effects shape economists' policy recommendations on basic issues in international financial markets. For example, policymakers often want to know how much a currency must depreciate to eliminate a given trade deficit. How firms choose to pass through an exchange-rate depreciation determines the depreciation's welfare effects, including its effect on the trade balance. Exchange-rate pass-through is conventionally defined as the percent change in an imported good's local-currency price for a given percent change in the nominal exchange rate. More empirical evidence about firms' pass-through behavior would enable economists to recommend a welfare-maximizing response to a given trade deficit. Such evidence would also shape policy recommendations on such issues as the choice of exchange-rate regime, the conduct of monetary policy, and the response to a currency crisis.

I develop and estimate a structural econometric model that offers predictions linking 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 nominal exchange-rate change affects domestic and foreign firms' profits and consumer surplus. The structural model computes these effects without observing wholesale prices or marginal costs (of manufacturers or retailers). The model can be applied to other industries and can serve as a tool to assess the welfare effects of various exchange-rate policies.

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 an exchange-rate-induced change in foreign brands' marginal costs. I compute the change in firms' profits and in consumer surplus using the new equilibrium prices and quantities.

The model's key identification assumption is that nominal exchange-rate fluctuations dwarf other shocks to manufacturers' marginal costs such as productivity or input-price changes over the short term. Figure 1 shows that the exchange rate is much more volatile than are brewers' other typical marginal costs. Thus this assumption, though strong, has clear support in the data. The paper presents figures that indicate the model appears to captures exchange-rate movements for each of the sample's countries.

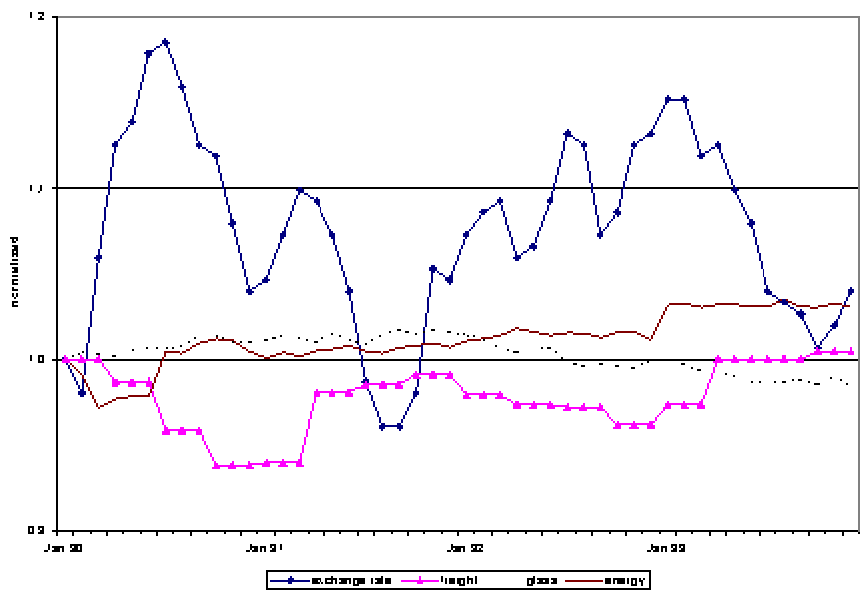

Figure 1: *The nominal exchange rate fluctuates by much more than do other typical input prices for German brewers.*

Though several theoretical papers examine how exchange-rate fluctuations may affect welfare, no published empirical study has formally estimated these costs.[1] A valuable antecedent of this paper is Kadiyali's (1997) structural model of pass-through in the film industry. Kadiyali's model is applicable, however, only to industries with very few products, while the model presented here can be applied to many industries.[2]

I empirically test for the best-fit vertical market structure in the beer market in another paper by comparing accounting price-cost margins to the derived price-cost margins each vertical model produces and by using non-nested tests developed by Villas-Boas (2003). This paper's empirical analysis focuses on the best-fit vertical market structure for this industry, that is, double marginalization with manufacturers acting as multi-product firms.[3]

My data come from a single large retailer (with 120 stores) in a major Midwestern city. I use a panel data set of retail prices and quantities sold for 34 products from a number of manufacturers over 40 months (July 1991-December 1994). My model thus includes a single retailer and a number of manufacturers, whom I model as Bertrand-Nash competitors with differ-

[1] Devereux, Engel, and Tille (2003) and Corsetti, Pesenti, Roubini, and Tille (2000) present theoretical models of the welfare effects of exchange-rate fluctuations.

[2] Another important predecessor is Goldberg's (1995) structural model of the U.S. auto market which uses a nested-logit demand system.

[3] For more detail on the double-marginalization supply model, see Tirole (1988).

entiated products. The model includes an outside good and thus does not assume that the retailer has a monopoly in the local market.

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 pass-through. The threat of trade barriers such as voluntary export restraints or antidumping sanctions that likely affect price-setting behavior in other industries, such as autos or textiles, are rare in this industry.

The counterfactual experiments produce three major results. First, foreign manufacturers generally bear more of the cost (or reap more of the benefit) of a change in the nominal exchange rate than do consumers, domestic manufacturers, or the retailer. Following a 10-percent domestic currency depreciation, foreign manufacturers' profits decline by 22 percent, domestic consumer surplus by 8 percent, and the retailer's profits by 5 percent: Domestic manufacturers' profits increase by 1.7 percent. Second, the results suggest some strategic interaction between domestic and foreign manufacturers following a depreciation: domestic manufacturers with brands that are close substitutes for foreign brands increase their profits by lowering prices to take market share from foreign manufacturers. Third, previous work on pass-through did not model the pricing decision of the retailer, 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. I find that the retailer passes through wholesale-price increases on domestic brands fully, but only partially passes through identical price increases on foreign brands. The retailer's markups on foreign brands are roughly three times its markups on domestic brands: the retailer may regard these higher markups as compensation for their greater fluctuation over time.

Incomplete data has limited the pass-through literature. Prices along the distribution chain, particularly import and wholesale prices, are typically unavailable. It is also difficult to obtain cost data amenable to comparison from foreign manufacturers. As a result, there is virtually no disaggregated empirical evidence on exchange-rate pass-through.[4] Most studies use price indexes that leave their estimates vulnerable to aggregation bias. The consensus in these studies is that firms pass through, on average, 50 percent of a

[4] Only one paper by Kadiyali (1997) estimates pass-through coefficients using product-level prices.

nominal exchange-rate change to import prices over the course of one year.[5] This paper uses product-level transaction prices, allowing for an empirical method based on a model of individual firms' price-setting behavior rather than aggregate price indexes.

The empirical method presented in this paper also offers an alternative to the standard reduced-form approach used to estimate exchange-rate pass-through. The standard approach has the weakness of producing different for researchers using identical data. That approach uses a specification that imposes a firm's markup adjustment through the choice of functional form.[6] Such a model cannot gauge the extent of the strategic pricing behavior that firms engage in to protect their margins.

The rest of the paper proceeds as follows. In the next section, I review the theoretical model. Section 3 discusses the market and the data, and section 4 sets out 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. The last section concludes.

[5] Goldberg and Knetter (1997).

[6] The assumption implicit in the standard approach is that the markup adjustment is exactly inversely proportional to the pass-through.

2 Model

This section describes the supply model and the random-coefficients model used to estimate demand. It then derives simple expressions to compute exchange-rate pass-through coefficients.

2.1 Supply

Consider a double-marginalization supply model in which manufacturers act as Bertrand oligopolists with differentiated products. Strategic interactions between manufacturers and the single retailer with respect to prices follow a sequential Nash model. Manufacturers set their prices first and the retailer then sets its prices taking the wholesale prices it observes as given. Thus, a double margin is added to the marginal cost to produce the product. To solve the model, one uses backwards induction and solves the retailer's problem first. The variety of potential interactions between manufacturers, retailers, and consumers makes any theoretical prediction about welfare effects contingent on fairly precise assumptions about consumer or firm behavior. In this model, I consider only one retailer as the data used for the empirical analysis have prices for only a single retail firm.

2.1.1 Retailer

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

$$\Pi_t = \sum_j (p^r_{jt} - p^w_{jt} - mc^r_{jt}) s_{jt}(p^r_t) - C_f \tag{1}$$

where p^r_{jt} is the price the retailer sets for product j, p^w_{jt} is the wholesale price paid by the retailer for product j, mc^r_{jt} is the the retailer's marginal cost for product j (excluding the wholesale price of the good), $s_{jt}(p^r)$ is the market share of product j which is a function of the prices of all J products, and C_f is a fixed cost of production. Assuming the retailer sets prices to maximize profits, the retail price p^r_j must satisfy the first-order profit-maximizing condition:

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

This gives us a set of J equations, one for each product. The markups can be solved for by defining $S_{jk} = -\frac{\partial s_{kt}(p^r_t)}{\partial p^r_{jt}} \quad j, k = 1, ..., J.$, and a $J \times J$ matrix Ω_{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:

$$s_t + \Omega_{rt}(p_t^r - p_t^w - mc_t^r) = 0 \tag{3}$$

as can the retailer's markup equation:

$$p_t^r = p_t^w + mc_t^r + (\Omega_{rt})^{-1} s_t \tag{4}$$

2.1.2 Manufacturers

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

$$\Pi_{wt} = \sum_{j \in \Gamma_{mt}} (p_{jt}^w - mc_{jt}^w) s_{jt}(p_t^r(p_t^w)) \tag{5}$$

where mc_{jt}^w is the marginal cost of the manufacturer. Assuming a Bertrand-Nash equilibrium in prices, the first-order conditions are:

$$s_{jt} + \sum_{k \in \Gamma_{mt}} (p_{kt}^w - mc_{kt}^w) \frac{\partial s_{kt}}{\partial p_{jt}^w} = 0 \text{ for } j = 1, 2, ..., J_t. \tag{6}$$

Let Ω_{wt} be the manufacturer's reaction matrix with elements $\frac{\partial s_{kt}(p^r(p^w))}{\partial p^w_{jt}}$, the change in each product's share with respect to a change each product's wholesale price. Multiproduct firms are represented by a manufacturer ownership matrix, T_w, with elements $T_w(j,k) = 1$ if both products j and k are produced by the same manufacturer, and zero otherwise. T_w post-multiplies the manufacturer reaction matrix Ω_{wt} element by element. The manufacturers' marginal costs are recovered by inverting the multiproduct manufacturer reaction matrix $\Omega_{wt}. * T_w$ for each market t:

$$p^w_t = mc^w_t + \left(\Omega_{wt}\left(p^r\left(p^w\right)\right). * T_w\right)^{-1} s_t(p^r_t\left(p^w_t\right)) \tag{7}$$

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 wholesale price. Each column of Ω_{pt} contains the entries of a response matrix computed without observing wholesale prices. This manufacturer response matrix is derived in Villas-Boas (2003). The (jth, kth) entry in Ω_{pt} is 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 wholesale price on each of the J products' retail prices which in turn each affect the kth product's retail market share, that is: $\sum_m \frac{\partial s^r_{kt}}{\partial p^r_{mt}} \frac{\partial p^r_{mt}}{\partial p^w_{jt}}$ for $m = 1, 2, ...J$.

The manufacturer of product j can use its estimate of the retailer's reaction function $R(p_j)$ 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 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 how the retailer will pass-through any price changes to the retail price, how other manufacturers will react to the retail price change, and how consumers will react to the retail-price changes.

2.2 Demand

The marginal-cost 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 exchange-rate pass-through in this market.[7]

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, and characteristics.

Suppose we observe $t=1, ..., T$ markets. I define a market in the next section. Let the indirect utility for consumer i in consuming product j in

[7]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.

market t take a quasi-linear form:

$$u_{ijt} = x_{jt}\beta - \alpha p_{jt} + \xi_{jt} + \varepsilon_{ijt} = V_{ijt} + \varepsilon_{ijt}, \quad i = 1, ..., I., \quad j = 1, ..., J., \quad t = 1, ..., T. \tag{8}$$

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:

$$\begin{pmatrix} \alpha_i \\ \beta_i \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \end{pmatrix} + \Pi D_i + \Sigma v_i \tag{9}$$

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 from that mean $\mu_{ijt}= [\Pi D_i \; \Sigma v_i]\, p_{jt} + [\Pi D_i \; \Sigma v_i]\, x_{jt}$:

$$u_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt} \tag{10}$$

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.[8] 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:

$$u_{i0t} = \xi_{0t} + \pi_0 D_i + \sigma_0 v_{i0} + \varepsilon_{i0t} \tag{11}$$

[8] 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 also makes the estimates of pass-through more credible given that the firms in my sample are constrained by the availability of goods other than those included in my sample. Even if the price of the outside good does not respond to price changes in the sample, it regardless remains a potential choice for consumers when faced with a price increase for products in the sample.

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:

$$s_{jt} = \int_{\zeta \in A_j} P^*(d\zeta) \tag{12}$$

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 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:

$$s_{ijt} = \frac{e^{\delta_{jt}}}{1 + \sum_{k=1}^{J_t} e^{\delta_{kt}}} \tag{13}$$

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:

$$s_{jt} = \int_{\mu_{it}} \frac{e^{\delta_{jt}+\mu_{ijt}}}{1+\sum_k e^{\delta_{kt}+\mu_{ikt}}} f\left(\mu_{it}\right) d\mu_{it} \tag{14}$$

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:

$$s_{jt} = \frac{1}{N}\sum_{i=1}^{N} \frac{e^{\delta_{jt}+\mu_{ijt}}}{1+\sum_k e^{\delta_{kt}+\mu_{ikt}}} \tag{15}$$

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.

2.3 Counterfactual Experiments: Pass-Through Coefficients

To recover exchange-rate 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. Let b be a constant between -1 and 1. Let $mc_{jt}^{w*}= mc_{jt}^{w}$ for those products that do not experience a marginal-cost shock, domestic products, and $mc_{jt}^{w*}= (1+b)mc_{jt}^{w}$ for those products that do experience a marginal-cost shock, foreign products.

Suppose an exchange-rate-induced marginal-cost shock hits the jth product. Taking the derived value for each manufacturer's marginal cost mc_{jt}^{w*}, let us search for a set of values for the vector p_t^{w*} that will solve the system of nonlinear equations:

$$p_{t}^{w*} = mc_{t}^{w*} + \left(\Omega_{wt}\left(p^{r}\left(p^{w*}\right)\right).*T_w\right)^{-1} s_t(p_t^{r*}\left(p_t^{w*}\right)) \tag{16}$$

where the (jth, kth) element of Ω_{wt} is $\frac{\partial s_{kt}(p_t^r(p_t^w))}{\partial p_{jt}^w}$. Taking the derivative of p_{jt}^{w*} with respect to mc_{jt}^{w} gives:

$$\frac{\partial p_{jt}^{w*}}{\partial mc_{jt}^{w}} = 1 + \left(\Omega_{wt} * T_w\right)^{-1} \frac{\partial s_t}{\partial p_t^r} \frac{\partial p_t^r}{\partial p_{jt}^{w*}} \frac{\partial p_{jt}^{w*}}{\partial mc_{jt}^{w}} + s_t \left(\Omega_{wt}.*T_w\right)^{-2} \frac{\partial \Omega_{wt}}{\partial p_{jt}^{w*}} \frac{\partial p_{jt}^{w*}}{\partial mc_{jt}^{w}} \tag{17}$$

Rearranging terms gives:

$$\frac{\partial p_{jt}^{w*}}{\partial mc_{jt}^{w}} = \frac{1}{\left(1 + \left(\Omega_{wt}.*T_w\right)^{-1} \frac{\partial s_t}{\partial p_t^r} \frac{\partial p_t^r}{\partial p_{jt}^{w*}} - s_t \left(\Omega_{wt}.*T_w\right)^{-2} \frac{\partial \Omega_{wt}}{\partial p_{jt}^{w*}}\right)} \tag{18}$$

Wholesale pass-through is given by: $PT^w = \frac{\left(p_{jt}^{w*} - p_{jt}^{w}\right)}{p_{jt}^{w} * b}$. The change in p_{jt}^{w*}

for a given change in mc^w_{jt} depends on the demand system's own- and cross-price elasticities, that is, on the manufacturer response matrix, Ω_{wt}, the relative market share of each good, s_t, the slope of the demand curve with respect to the wholesale price $\frac{\partial s_{jt}}{\partial p^r_t} \frac{\partial p^r_t}{\partial p^{w*}_{jt}}$, and the curvature of the demand curve, $\frac{\partial \Omega_{wt}}{\partial p^{w*}_{jt}}$. As a good's market share rises, its pass-through should rise. As its own-price elasticity falls in absolute value, its pass-through should also rise.

To compute pass-through at the retail level, I substitute the derived values of the vector p^{w*}_t into the system of J nonlinear equations for the retail firm, and then search for the retail price vector p^{r*}_t that will solve it:

$$p^{r*}_{jt} = p^{w*}_{jt} + mc^r_{jt} + \Omega_{rt} \left(p^{r*}_t\right)^{-1} s_t(p^{r*}_t \left(p^{w*}_t\right)) \tag{19}$$

which is just the first-order profit-maximizing condition for the retailer. Assuming the retailer's other marginal costs mc^r_{jt} are independent of the wholesale price, the change in the retail price for a given change in the wholesale price is given by:

$$\frac{\partial p^{r*}_{jt}}{\partial p^w_{jt}} = \frac{1}{\left(1 + \Omega^{-1}_{rt} \frac{\partial s_t}{\partial p^r_{jt}} - s_t \Omega^{-2}_{rt} \frac{\partial \Omega_{rt}}{\partial p^{w*}_{jt}}\right)} \tag{20}$$

p^{r*}_{jt} depends on the retailer response matrix, $\mathit{\Omega}_{rt}\left(p^{r*}\right)$, the market share of each good $s_t(p^{r*})$, and the curvature of the demand curve, given by $\frac{\partial\Omega_{rt}}{\partial p^{w*}_{jt}}$. Vertical pass-through, defined as pass-through along the distribution chain as a whole, is given by $PT^V = \frac{(p^{r*}_{jt} - p^r_{jt})}{p^r_{jt} * b}$. Retail pass-through, defined as pass-through by the retailer of just those costs passed on by the manufacturer is given by $PT^R = \frac{(p^{r*}_{jt} - p^r_{jt})}{p^r_{jt}} * \frac{p^w_{jt}}{p^{w*}_{jt} - p^w_{jt}}$.Pass-through by the manufacturers and the retailer will depend on the market share of each good, the curvature of the demand curve, and strategic interactions with other firms.

3 Market and Data

In this section I describe the beer market my data cover. I then present summary statistics for the data.

3.1 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 exemplifies one type of imported good: packaged goods imported for consumption. Such imports do not require any further production process before reaching consumers. Beer shipments to supermarkets in Illinois are handled by independent wholesale distributors for domestic brands and by subsidiary wholesale distributors for most foreign brands. The model abstracts from this additional step in the vertical chain, as the brewers set the prices of all distributors through a practice known as resale price maintenance and cover a large portion of the distributors' marginal costs through their pricing policies. This well-documented practice of resale-price maintenance makes the analysis of pricing behavior along the distribution chain relatively straight-forward.

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.[9] 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

[9] Canadian Trade Commissioner (2000).

considerably across states.

3.2 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. The data come from the *Kilts Center for Marketing* at the University of Chicago and include aggregate retail market shares and retail prices for 34 brands produced by 18 manufacturers. Summary statistics for prices, servings sold, and 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 aggregated data from each *Dominick's* store into one of three price zones. These zones are defined by *Dominick's* 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 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-,

Description	Mean	Median	Standard Deviation	Min	Max
Retail prices (cents per serving)	71.04	61.31	27.29	26.72	131.50
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
By pricing zone:					
Low	65.78	65.98	15.05	30.39	98.61
Medium	67.28	67.90	13.77	33.04	98.06
High	62.71	63.41	13.95	30.92	98.12
Market share of 34 products	18.46	17.34	7.38	7.01	36.12
By pricing zone:					
Low	11.17	10.49	3.10	6.79	17.38
Medium	24.11	23.53	6.06	14.54	36.12
High	20.10	19.12	5.43	12.53	31.73
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 share of the product in the potential market which I define as all beer sold at supermarkets in the zip codes in which one of the *Dominick's* stores in my sample is located. Source: *Dominick's*.

medium-, or high-price store. I then aggregate sales across the stores in each pricing zone. 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. The potential market 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 22.60 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 $\frac{(22.6*128)}{12*12} = 20.15$ 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 sales mainly consist of specialty brands, each with a relatively small market share. The share of *Dominick's*

	Brand	Month	Pricing Zone
Retail Price			
Domestic (%)	87.60	2.38	.20
Imports (%)	70.64	4.07	.01

Table 2: *Sources of price variation.* Each column shows the percentage of variance due to brand, month, or pricing-zone dummy variables controlling for the effects of the variables in the remaining columns. 4080 observations. Source: *Dominick's.*

total revenue from beer sales included in my sample is high, with a mean of 65.04 percent, and varies only slightly across the three pricing zones. The combined market share of products covered in the sample is on average 18.46 percent, though it is much higher in the medium and high pricing zones, at 24.11 percent and 20.10 percent, respectively, than in the low pricing zone, where it is only 11.17 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 regular purchases.

Table 2 reports the percent of price variation attributable to brand, month, and pricing zone dummies. After controlling for differences in prices across price zones and over time, most of the price variation is attributable to differences across brands.

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 *Con-*

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

sumer Reports study conducted in 1996. Table 3 reports summary statistics for the following characteristics: percent alcohol, calories, bitterness, maltiness, hops, sulfury, fruity, and floral. 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 aggregated the data across each pricing zone to get one set of demographics for each zone.

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.[10] 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 (2002), 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

[10] 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.

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 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:

$$s_t\left(x_t, p_{t,}\delta_t|\theta_2\right) = S_t \tag{21}$$

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 (*15*). 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.[11]

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

[11] See Nevo (2000b) for details.

unobserved product characteristics, d_j, and the error term $\Delta\xi_{jt}$ which now contains changes in unobserved product characteristics:

$$\Delta\xi_{jt} = \delta_{jt} - \beta_j d_j - \alpha p_{jt} \tag{22}$$

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 (*8*) and mean unobserved characteristics. The mean utility term here denotes the part of the indirect utility expression in equation (*10*) that does not vary across consumers.

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 in the brewing process as instruments. Input prices should be correlated with the retail price, which affects consumer demand, but are not themselves correlated with 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. I interact the hourly compensation variables, which vary by country and year, with indicator variables for each brand following Villas-Boas (2003). 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.[12] 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.[13] The model's first-stage results, reported in Table 4, indicate that foreign products' input prices appear to be effective as instruments. I discuss these results further in the next section.

5 Results

5.1 Demand Estimation: Logit Demand

Tables 4 and 5 report 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 4 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

[12] Staiger and Stock (1997) examine the properties of the IV estimator in the presence of weak instruments.

[13] Engel and Rogers (1996) examine the persistent deviations from the law of one price across national borders.

	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 4: *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.

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 dummy variables. 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*, 1991-1995; My calculations.

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. The first-stage F-test of the instruments, at 17.42, is significant at the 1-percent level.

Table 5 suggests the instruments may have some power. 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 (22). 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

Variable	Mean in Population	Interaction with: Unobservables	Age	Income
Constant	-12.664			
	(.478)			
Price	-21.743	1.407	3.157	.280
	(7.184)	(2.122)	(1.506)	(.136)
Bitterness	1.195			
	(.039)			
Hops	1.277			
	(.001)			
Sulfury/Skunky	-1.139			
	(.061)			
Percent Alcohol	-1.59	.028	-.143	-.014
	(.104)	(.759)	(.154)	(.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. Starred coefficients are significant at the 5-percent level. Asymptotically robust standard errors in parentheses. Source: My calculations.

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 that changes in brands' unobserved characteristics $\Delta\xi$ are independent of changes in brands' observed characteristics x: $E(\Delta\xi|x) = 0$.

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 former 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 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 the median own-price elasticities for the 34 products in the sample. Own-price elasticities are also reported for each pricing zone. Residents from the low-price zone have much higher demand elasticities in absolute value than do residents from the medium- and high-price zones, whose elasticities are virtually indistinguishable. The variation in the demand elasticities across the pricing zones is striking. The marginal utility of income, the coefficient on the price variable, appears quite high in the low-price zone. There is also considerable heterogeneity in the taste for foreign brands across the zones. Demand elasticities are much higher in absolute value for imported beers than for domestic beers in the low-price zone. This pattern is reversed in the medium- and high-price zones, where affluent consumers are willing to pay more for imported brands. The demand elasticities for foreign brands in the low-price zone are more than twice as large (in absolute value) as the demand elasticities for the same products in the medium- and high-price zones. The demand elasticity for *Amstel* is -4.73 in the medium-price zone, -5.26 in the high-price zone, and -11.65 in the

Product	Elasticities	By Zone:		
		Low	Medium	High
Domestic Brands				
Budweiser	-6.37	-7.645	-5.926	-5.956
Bud Light	-5.88	-7.636	-5.486	-5.571
Busch	-6.49	-7.630	-6.163	-6.038
Busch Light	-6.02	-7.015	-5.708	-5.626
Coors	-6.34	-7.627	-5.921	-5.922
Coors Light	-5.99	-7.494	-5.552	-5.598
Keystone	-5.85	-6.512	-5.723	-5.418
Michelob Light	-6.05	-8.154	-5.361	-5.611
Miller Genuine Draft	-5.91	-7.285	-5.573	-5.582
Miller High Life	-6.49	-7.712	-6.046	-6.080
Miller Lite	-5.61	-7.091	-5.276	-5.355
Milwaukee's Best	-6.09	-6.770	-5.901	-5.741
Milwaukee's Best Light	-6.27	-7.328	-5.877	-5.852
Old Milwaukee	-4.75	-5.562	-4.581	-4.325
Old Style	-6.25	-8.160	-5.777	-5.897
Old Style Classic	-6.21	-7.173	-5.874	-5.867
Rolling Rock	-5.95	-8.688	-5.080	-5.461
Special Export	-6.25	-8.458	-5.730	-5.992
Stroh's	-6.11	-6.957	-5.852	-5.629
European Brands				
Beck's	-5.71	-10.478	-4.657	-5.120
St. Pauli	-6.31	-11.760	-5.045	-5.603
Amstel	-6.06	-11.649	-4.729	-5.259
Grolsch	-6.70	-12.258	-5.091	-5.797
Heineken	-6.12	-11.440	-4.900	-5.378
Harp	-6.70	-12.928	-5.091	-5.536
Peroni	-6.06	-10.861	-4.845	-5.281
Bass	-6.85	-12.830	-5.172	-5.741
North American Brands				
Foster's	-6.39	-12.054	-4.991	-5.607
Guinness	-6.67	-13.411	-5.132	-5.623
Molson Golden	-6.73	-9.923	-5.620	-6.111
Molson Light	-5.21	-9.152	-4.323	-4.649
Corona	-6.04	-10.847	-4.814	-5.261
Tecate	-5.97	-10.947	-4.764	-5.305
Japanese Brands				
Sapporo	-6.22	-12.040	-4.877	-5.443

Table 7: *Median own-price demand elasticities.* Median across all 120 markets. 95 percent confidence intervals generated with bootstrap simulations. 4080 observations. 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 8: *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.

low-price zone. A domestic sub-premium beer like *Keystone Light* exhibits less variation in its demand elasticities across the price zones: the median demand elasticities for this brand are -6.51, -5.72, and –5.42 in the low-, medium- and high-price zones, respectively.

Table 8 reports a sample of the median own- and cross-price elasticities for several 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 higher than those between *Bud Light* and the domestic brands *Bud* at .0853 or *Miller High Life* at .0827.

Table 9 reports the retail price, the derived wholesale price, and the derived manufacturer marginal cost for each brand. Again, the results appear intuitive. Manufacturer marginal costs are roughly 20 cents higher for imported brands at 47 cents than for domestic brands at 27 cents, which likely reflects the cost of transporting the products from the foreign production site to the U.S. market. The median wholesale price for foreign brands, 71 cents, is nearly twice that of domestic brands, at 36 cents. (consistent with industry lore) The median retail price is 100 cents for imported brands and 49 cents for domestic brands.

Table 10 reports markups by brand. 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, consistent with industry lore. As reported in an appendix table, price-cost margins vary less across brands than do markups but exhibit similar qualitative patterns.

Figure 2 compares the observed and derived exchange rate over the sam-

Product	Retail Price	Wholesale Price	Manufacturer Marginal Cost
Domestic Brands			
Budweiser	51.14	37.22	28.84
Bud Light	53.17	37.27	27.61
Busch	47.21	35.58	26.87
Busch Light	43.48	31.61	23.49
Coors	49.06	35.37	27.10
Coors Light	51.69	35.98	27.18
Keystone	35.37	25.95	19.24
Michelob Light	59.25	41.63	30.54
Miller Genuine Draft	51.18	37.33	29.00
Miller High Life	50.99	37.44	28.21
Miller Lite	51.07	36.56	27.57
Milwaukee's Best	37.55	28.29	19.67
Milwaukee's Best Lite	47.63	35.04	25.08
Old Milwaukee	32.61	21.46	14.04
Old Style	59.28	42.25	31.59
Old Style Classic	45.52	34.31	26.07
Rolling Rock	71.35	46.77	33.09
Special Export	60.87	43.95	32.98
Stroh's	40.38	30.14	22.84
All Domestic Brands	48.97	36.03	26.94
European Brands			
Beck's	88.23	61.22	40.05
St. Pauli	106.83	72.05	48.82
Amstel	99.05	68.80	44.01
Grolsch	111.28	81.31	56.82
Heineken	99.08	69.08	45.22
Harp	116.50	81.08	56.89
Peroni	96.75	65.93	44.12
Bass	111.38	83.15	57.53
North American Brands			
Foster's	105.72	75.27	51.09
Guinness	117.10	84.50	58.93
Molson Golden	76.19	54.77	41.17
Molson Light	75.89	51.71	30.48
Corona	96.75	65.82	43.96
Tecate	96.28	63.09	40.60
Japanese Brands			
Sapporo	106.43	75.05	49.75
All Foreign Brands	99.99	70.67	46.86

Table 9: *Prices and marginal costs for the 34 products in the sample.* Median in cents per 12-ounce serving across 120 markets. 4080 observations. Source: My calculations.

Product	Markup Brewer cents	Retailer cents	Vertical cents
Domestic Brands			
Budweiser	8.59	13.42	22.01
Bud Light	9.65	15.30	24.95
Busch	8.27	11.52	19.79
Busch Light	7.97	11.46	19.43
Coors	8.28	12.98	21.26
Coors Light	9.16	14.20	23.36
Keystone	6.37	9.30	15.67
Michelob Light	10.61	17.57	28.18
Miller Genuine Draft	8.98	13.29	22.27
Miller High Life	9.66	13.38	23.04
Miller Lite	9.46	14.12	23.59
Milwaukee's Best	7.94	9.30	17.24
Milwaukee's Best Lite	9.77	12.89	22.66
Old Milwaukee	7.18	10.78	17.97
Old Style	10.04	15.44	25.48
Old Style Classic	7.61	11.34	18.95
Rolling Rock	11.95	19.70	31.65
Special Export	10.59	17.16	27.75
Stroh's	7.13	10.69	17.83
All Domestic Brands	8.72	12.31	21.10
European Brands			
Beck's	19.64	28.28	47.92
St. Pauli	19.96	29.88	49.84
Amstel	22.23	29.59	51.83
Grolsch	24.43	31.11	55.54
Heineken	20.70	28.40	49.11
Harp	23.86	31.22	55.08
Peroni	19.23	28.60	47.83
Bass	23.88	31.28	55.16
Other Foreign Brands			
Foster's	22.45	30.25	42.71
Guinness	25.10	31.93	57.03
Molson Golden	12.73	21.31	34.04
Molson Light	18.32	27.85	46.17
Corona	19.36	28.76	48.11
Tecate	17.79	27.69	45.48
Sapporo	24.11	30.87	54.98
All Foreign Brands	19.91	28.57	49.75

Table 10: *Median derived price-cost markups by product.* Median across 120 markets. The markup is price less marginal cost with units in cents per 12-ounce serving. Source: My calculations.

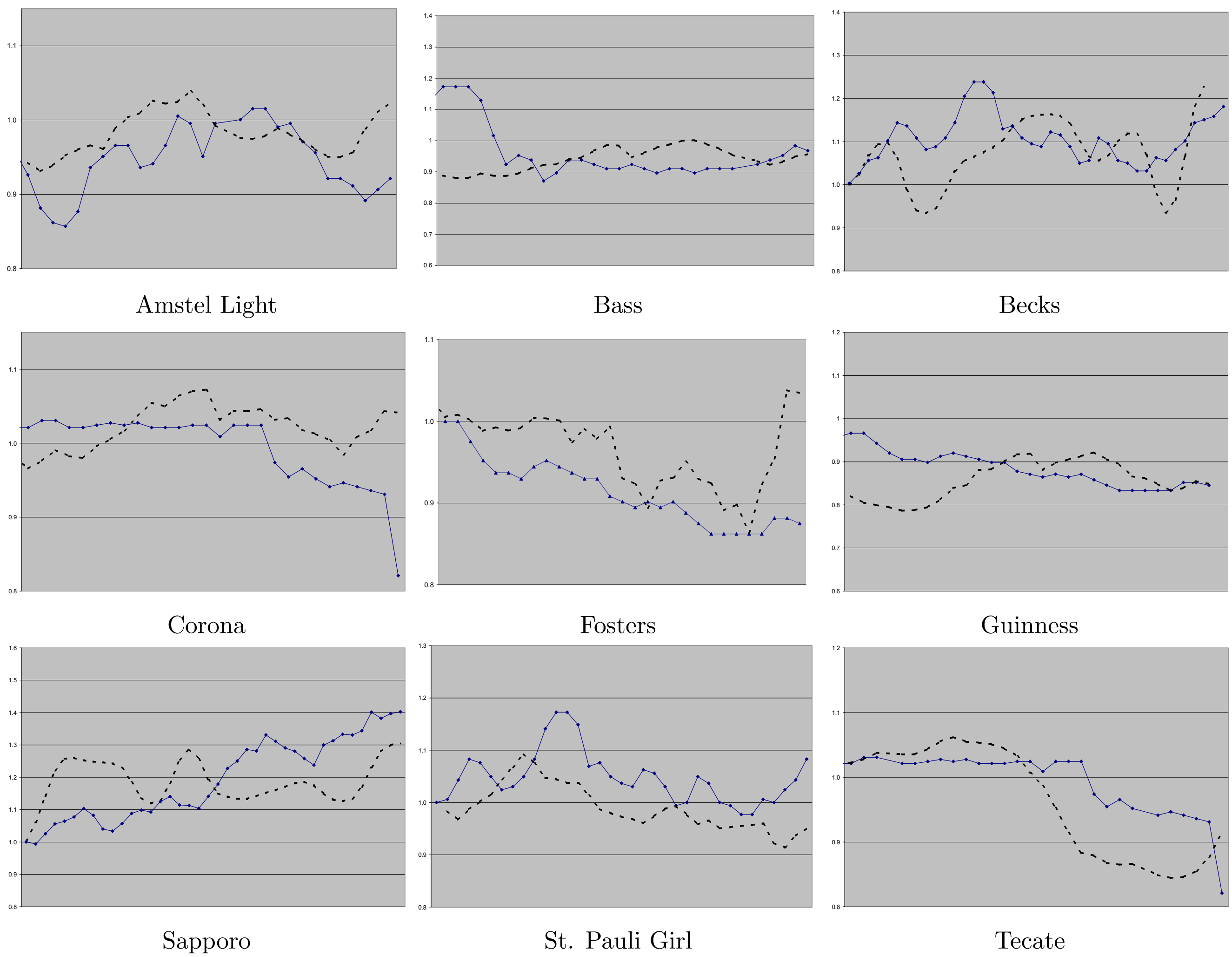

Figure 2. A comparison of observed and derived exchange rates. The derived exchange rate is a 12-month moving average and is the broken line in each figure. The time period is from July 1992 to December 1994. Source: My calculations: IMF.

ple period for most of the countries in the sample. The derived exchange rates are 12-month moving averages to remove seasonal fluctuations. The high correlation between the two variables suggests that the structural model captures exchange-rate movements for each of the sample's countries fairly well. Similarly, the correlation between the observed and the derived wholesale price is 87 percent across all brands.

6 Counterfactual Experiments

Using the full random-coefficients model and the derived marginal costs I conduct counterfactual experiments to analyze how firms and consumers react to changes in the exchange rate. This section presents and discusses the results from these experiments. First, I consider the effect of various exchange-rate changes on foreign brands' prices and price-cost margins. Second, I examine the effect of a 10-percent depreciation on domestic and foreign firms' markups, quantities sold, and total variable profits. Finally, I quantify how a variation in firms' pass-through behavior impacts the change in firms' profits and in consumer welfare following a 10-percent depreciation.

6.1 Foreign Brands' Pass-Through

The first counterfactual experiments consider how foreign manufacturers and the retailer adjust their prices following a 10-percent change in the nominal exchange rate. The second column of Table 11 reports each brand's vertical pass-through: the manufacturer's and retailer's joint pass-through of the original shock to the retail price. The first column reports manufacturers' pass-through of the exchange-rate shock to the wholesale price. The last column reports the retailer's pass-through of a wholesale-price change to the retail price.

I find some variation in firms' pass-through across brands. The median vertical pass-through of a 10-percent depreciation ranges from 28.15 percent for *Grolsch* to 78.68 percent for *Molson Golden*. The results are generally consistent with the predictions of the theoretical model discussed in section 2. The model predicts that as a brand's market share rises, its pass-through of an exchange-rate shock should also rise. The foreign brands with the highest market shares, *Guinness*, *Heineken*, *Amstel Light* and *Molson Golden*, are generally those with the highest pass-through.

A good example of how the own- and cross-price elasticities can work at cross purposes is *Molson Light*. Though *Molson Light* has a very low demand elasticity, its cross-price elasticities with respect to other foreign brands

	Wholesale	Vertical	Retail
Amstel	75.84	61.31	81.46
	59.99−86.66	45.65−68.87	78.91−85.03
Bass	75.96	57.15	77.40
	72.55−83.08	50.31−60.84	74.96−78.43
Beck's	65.03	57.92	85.37
	44.52−81.91	37.10−71.64	84.03−87.01
Corona	71.20	59.67	85.22
	52.84−84.80	42.54−72.75	83.06−86.33
Foster's	71.76	51.76	75.87
	61.84−80.79	44.05−60.24	74.33−78.58
Grolsch	52.78	28.15	66.15
	48.39−59.42	22.33−36.15	60.92−70.49
Guinness	85.13	64.45	79.17
	72.46−89.44	55.30−72.86	76.88−80.91
Harp	64.89	43.37	67.57
	58.57−74.78	36.26−50.13	65.70−72.94
Heineken	76.40	62.57	85.27
	84.42−55.86	43.66−72.32	83.72−86.72
Molson G	80.22	78.68	94.72
	75.49−86.94	69.80−85.92	92.67−98.46
Molson L	52.78	30.47	80.23
	28.56−70.97	14.95−49.22	75.83−83.62
Peroni	71.87	60.58	85.10
	52.71−84.85	42.62−73.25	83.18−86.41
Sapporo	57.48	33.97	67.36
	51.55−65.73	29.47−41.45	64.50−70.23
St. Pauli	78.12	57.65	80.40
	59.25−85.18	43.55−67.28	78.06−82.98
Tecate	54.31	32.75	78.32
	33.02−71.76	20.20−46.03	71.29−82.66

Table 11: *Counterfactual experiments: median pass-through of a 10-percent exchange-rate depreciation with 95% confidence intervals.* Median over 120 markets. Vertical pass-through: the retail price's percent change for a given percent change in the exchange rate. Manufacturer pass-through: the wholesale price's percent change for a given percent change in the exchange rate. Retail pass-through: the retail price's percent change for a given percent change in the wholesale price. 95% confidence intervals calculated with bootstrap simulations reported under each coefficient. Source: My calculations.

	Wholesale	Vertical	Retail
Appreciation			
Amstel	67.49 62.53−80.91	58.52 51.28−63.26	82.69 79.13−85.34
Bass	73.04 69.58−80.20	64.02 55.52−66.97	82.26 80.04−84.77
Beck's	65.39 57.45−74.20	53.42 43.18−58.22	82.33 80.02−84.19
Corona	66.63 61.39−75.14	55.91 50.12−61.76	82.25 79.58−84.25
Foster's	72.95 65.83−82.49	57.19 49.05−66.31	80.35 77.10−81.43
Grolsch	66.09 60.62−79.48	47.69 40.41−62.03	73.50 67.90−79.17
Guinness	72.95 67.79−77.25	60.43 57.13−64.00	82.82 78.88−84.50
Harp	71.41 63.32−83.03	56.24 47.57−64.70	77.75 74.70−81.82
Heineken	68.10 62.73−79.37	56.27 48.80−61.55	81.89 79.70−84.57
Molson G	92.05 79.03−105.21	63.52 51.33−76.18	88.73 74.61−91.87
Molson L	73.53 58.12−88.39	51.80 42.79−65.65	79.92 75.18−82.57
Peroni	67.07 62.16−76.20	56.17 50.29−62.06	82.56 79.94−84.39
Sapporo	67.53 60.69−79.71	51.83 44.98−60.46	76.49 68.44−81.21
St. Pauli	71.76 64.67−84.90	61.20 54.68−72.79	84.22 80.74−85.42
Tecate	72.24 63.35−87.76	54.34 45.98−65.34	81.33 71.65−84.36

Table 12: *Counterfactual experiments: median pass-through of a 10-percent exchange-rate appreciation with 95% confidence intervals.* Median over 120 markets. Vertical pass-through: the retail price's percent change for a given percent change in the exchange rate. Manufacturer pass-through: the wholesale price's percent change for a given percent change in the exchange rate. Retail pass-through: the retail price's percent change for a given percent change in the wholesale price. 95% confidence intervals calculated with bootstrap simulations reported under each coefficient. Source: My calculations.

are unusually high. As a result, its median vertical pass-through of 30.47 percent, median manufacturer pass-through of 52.78 percent, and median retail pass-through of 80.23 percent following a 10-percent depreciation are low compared to the median across foreign brands. *Molson Light*'s low pass-through indicates that its cross-price elasticity effect dominates its own-price elasticity effect.

6.2 Foreign Brands' Margin Adjustment

Table 13 reports how foreign brands' price-cost margins adjust following an exchange-rate shock. Foreign manufacturers' price-cost margins vary by more than do the retailer's price-cost margins on foreign brands. The median decline in foreign manufacturers' margins is 10.5 percent following a 10-percent depreciation: the median decline in the retailer's margins on foreign brands is only 5.9 percent. The median rise in foreign manufacturers' margins following a 10-percent appreciation is 13 percent: the median rise in the retailer's margins on foreign brands is only 3.81 percent. Foreign manufacturers appear to bear more of the cost (or reap more of the benefit) of a change in the nominal exchange rate than the retailer.

Product	Vertical	Retail	Wholesale
Depreciation			
Amstel	-6.00	-4.76	-8.80
Bass	-7.42	-6.33	-10.48
Beck's	-4.39	-3.77	-8.28
Corona	-4.74	-4.20	-7.62
Foster's	-8.31	-5.97	-11.85
Grolsch	-10.68	-7.91	-20.24
Guinness	-6.47	-6.70	-7.38
Harp	-8.96	-8.11	-14.19
Heineken	-4.65	-4.75	-7.71
Molson G	-3.22	-1.63	-7.63
Molson L	-6.75	-4.81	-12.52
Peroni	-4.76	-4.17	-7.75
Sapporo	-8.98	-7.04	-15.36
St. Pauli	-6.85	-5.86	-10.67
Tecate	-8.17	-5.87	-14.62
Appreciation			
Amstel	9.79	4.29	12.22
Bass	8.56	4.48	12.63
Beck's	12.63	2.95	18.69
Corona	10.27	3.81	15.43
Foster's	9.24	3.76	14.27
Grolsch	10.02	4.08	15.18
Guinness	8.11	4.68	13.07
Harp	7.48	4.53	11.98
Heineken	12.00	4.41	18.19
Molson G	31.34	-.49	11.93
Molson L	8.43	2.65	10.37
Peroni	10.43	3.57	16.21
Sapporo	8.37	4.44	14.81
St. Pauli	6.78	3.00	12.55
Tecate	8.57	2.14	11.06

Table 13: *Counterfactual experiments: changes in price-cost margins following an exchange-rate shock.* Median percent change in price-cost margins given the percent change in the exchange rate. Source: My calculations.

6.3 Are Imports Different?

Table 14 considers how domestic manufacturers and the retailer pass through a 10-percent rise in their marginal costs to their prices. The question this table addresses is whether the pass-through patterns we observe for foreign brands resemble those of domestic brands. Previous work on pass-through did not model the pricing decision of the retailer, 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. I find that the retailer almost fully passes through wholesale-price increases on domestic brands but only partially passes through identical price increases on foreign brands.

Domestic manufacturers' median wholesale pass-through is 77 percent: foreign manufacturers' median pass-through is 71 percent following a 10-percent depreciation. The retailer's median pass-through on domestic brands is 91 percent and 80 percent on foreign brands following a 10-percent depreciation. The retailer's markups on foreign brands are roughly three times its markups on domestic brands: the retailer may regard these higher markups as compensation for their greater fluctuation over time. The first two columns of Table 15 suggest that the retailer does shrink its profits by

Product	Wholesale %	Vertical %	Retail %
Budweiser	77.44 70.62−83.75	74.39 71.72−78.99	95.12 90.62−99.06
Bud Light	62.68 58.56−68.76	62.85 58.40−67.36	88.79 85.55−92.88
Busch	82.46 77.19−84.93	79.28 72.06−85.08	95.32 90.06−97.91
Busch Light	74.71 72.09−79.13	68.19 65.77−72.6	90.10 84.95−93.72
Coors	78.28 71.71−83.15	73.34 70.00−77.13	93.77 88.36−96.26
Coors Light	71.56 64.60−77.60	68.27 64.62−70.72	90.82 87.16−95.58
Keystone	87.26 82.77−91.27	76.77 68.74−84.25	83.49 82.30−85.97
Michelob Light	56.85 47.28−67.15	58.28 52.09−63.74	86.50 82.35−91.05
Miller Genuine Draft	76.13 71.22−81.53	72.56 69.34−77.86	95.17 90.88−100.07
Miller High Life	63.60 60.76−68.77	62.02 58.72−67.42	93.17 86.17−95.84
Miller Lite	68.22 63.07−73.52	66.39 62.38−68.37	90.83 87.78−94.67
Milwaukee's Best	80.63 76.17−89.35	74.73 68.93−80.65	89.56 86.13−94.54
Milwaukee's Best Lite	59.86 54.07−64.95	55.51 49.94 − 58.72	90.79 87.16−95.34
Old Milwaukee	68.42 61.22−72.20	51.39 48.34−55.29	73.60 71.56−78.31
Old Style	64.32 55.91−69.49	66.06 61.45−68.57	90.67 85.84−94.52
Old Style Classic	83.07 77.73−86.72	80.64 75.61−87.13	96.02 90.96−98.37
Rolling Rock	56.21 43.69−63.33	43.71 37.76−50.23	77.42 72.40−80.85
Special Export	62.40 55.54−66.74	62.49 55.33−67.11	87.64 85.79−91.73
Stroh's	83.99 79.98−88.23	77.41 73.84−85.41	91.31 88.08−94.76

Table 14: *Pass-through of a marginal-cost shock faced only by domestic brewers.* Percent change in price given a 10-percent change in marginal costs. Median pass-through over all 120 markets for each product. 4080 observations. Vertical pass-through: pass-through of the original shock to the consumer. Manufacturer pass-through: pass-through of the shock to its wholesale price. Retailer pass-through: pass-through to the retail price of only those costs passed on to it by the manufacturer. These measures are described further in the text. 95% confidence intervals calculated with bootstrap simulations are reported under each coefficient. Source: My calculations.

Product	Profit		Quantity	Markup	
	Manufacturer	Retail		Manufacturer	Retail
Domestic Brands					
Budweiser	.55	-5.25	-.26	1.34	-.55
Bud Light	7.74	4.94	6.34	-1.54	-1.54
Busch	-4.34	-11.15	-6.40	6.13	.45
Busch Light	-4.34	-11.35	-5.37	3.74	.18
Coors	-.98	-9.00	-7.60	3.32	-.16
Coors Light	3.92	-.06	2.08	.32	-.77
Keystone	-8.20	-21.36	-16.88	13.06	2.17
Michelob Light	15.28	16.64	14.91	-6.43	-3.36
Miller Genuine Draft	.76	-5.56	.30	.85	-.57
Miller High Life	6.03	2.74	6.84	-2.30	-1.55
Miller Lite	4.43	-.06	3.01	.30	-1.10
Milwaukee's Best	-15.31	-24.15	-15.46	11.90	-2.18
Milwaukee's Best Lite	2.78	.54	6.45	-2.76	-1.51
Old Milwaukee	-5.63	-14.91	-9.17	7.50	1.22
Old Style	-.03	8.63	12.03	4.27	-2.41
Old Style Classic	-5.25	-15.14	-6.71	5.11	.61
Rolling Rock	27.12	29.31	24.26	-7.50	-5.78
Special Export	13.48	13.71	16.02	-5.61	-3.40
Stroh's	-6.50	-16.42	-10.45	8.47	1.87
All Domestic Brands	1.70	-3.65	-.24	1.56	-.70
European Brands					
Beck's	-23.60	-16.26	-28.70	-1.83	-1.69
St. Pauli	-10.22	-14.96	-25.44	-9.35	-4.66
Amstel	-13.64	-12.36	-25.43	-8.19	-3.61
Grolsch	-4.44	-16.93	-22.90	-16.97	-3.26
Heineken	-23.81	-13.25	-27.78	-2.37	-1.72
Harp	-4.44	-31.42	-24.20	-13.38	-3.85
Peroni	-24.22	-18.74	-28.96	-2.96	-1.99
Bass	-18.55	-30.94	-27.17	-10.58	-3.98
Other Foreign Brands					
Foster's	-14.78	-18.27	-25.08	-13.25	-3.75
Guinness	-22.35	-33.64	-30.40	-6.11	-3.36
Molson Golden	-33.75	-25.04	-36.71	-1.60	2.25
Molson Light	-4.40	-.19	-18.87	-10.09	-4.02
Corona	-24.95	-20.55	-28.49	-2.52	-2.03
Tecate	-10.58	-13.55	-21.04	-11.88	-3.28
Sapporo	1.66	-10.47	-21.97	-13.12	-3.93
All Foreign Brands	-22.12	-18.49	-25.74	-8.69	-2.54

Table 15: *Percent changes in total variable profits, quantities, and markups after a 10% depreciation.* Percent change in total profits aggregated over all markets. Median percent change in total quantity sold and in the product markup over all markets. 4080 observations.

more than does the foreign manufacturer in some cases. This table reports the equilibrium effects of a 10-percent depreciation on firms' total variable profits, price-cost markups, and quantities sold. The first two columns give the percent change by brand in manufacturer and retailer total variable 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 markup by brand.

The retailer's profits shrink by the most for those brands with high price-cost markups such as *Grolsch*, *Corona*, or *Harp*. In the case of *Grolsch*, the retailer's profits shrink by 17 percent while the manufacturer's profits shrink by 4.5 percent following the shock. For *Corona* and *Harp*, the retailer's profits shrink by 21 percent and 31 percent, respectively, while the manufacturer's profits shrink by 25 percent and 4.4 percent, respectively. The retailer markup on foreign brands tends to be much higher than the wholesale markup, as Table 12 indicates. Columns 1 and 2 of Table 15 seem to indicate that the retailer loses a greater share of its profit than does the manufacturer following the depreciation. The retailer's profits on import-competing domestic brands increase following the shock: *Bud Light* by 5 percent, *Michelob Light* by 17 percent, and *Rolling Rock* by 29 percent. The retailer's choice to sell both domestic and foreign brands enables it to minimize the profit loss following the exchange-rate-induced cost shock by selling more domestic brands.7

6.4 Adjustment in Domestic and Foreign Firms' Profits

Comparing the first two columns of Table 15 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 indicate that declines in foreign brands' profits result more from declines in quantities sold than from declines in markups. Those foreign manufacturers who shrink their markups by more than foreign brands' median markup shrinkage of 8.69 percent lose less total profits than the foreign brands' median loss of 22.12 percent. By shrinking their markups somewhat aggressively, these foreign manufacturers lose less market share than foreign brands' median loss of 25.74 percent. The four brands with the smallest percent declines in manufacturer profits, *Sapporo, Molson Light, Grolsch,* and *Harp*, 1.66 percent, 4.40 percent, 4.44 percent, and 4.44 percent, respectively, are also the brands with the largest percent declines in their markups: 13.12 percent, 10.09 percent, 16.97 percent, and 13.38 percent, respectively, and the smallest percent decline in their quantities sold: 21.97 percent, 18.97 percent, 22.90 percent, and 24.20 percent, respectively.

6.5 Domestic Versus Foreign Manufacturers

The results suggest some strategic interaction between import-competing domestic manufacturers and foreign manufacturers following a depreciation: these domestic manufacturers increase their profits by lowering prices to take market share from foreign manufacturers. Domestic manufacturers' profits increase by 1.7 percent following a 10-percent depreciation, mainly from increases in market share rather than from increases in markups. The domestic brands with increased profits are the light or superpremium brands that compete most directly with imported beers.[14] As Column 1 of Table 15 shows, only superpremium or light beers' profits rise significantly: *Bud Light* by 7.74 percent, *Michelob Light* by 15.28 percents, *Rolling Rock* by 27.12 percent, and *Special Export* by 13.48 percent. Manufacturer profits increase by more than 1 percent for *Bud Light, Coors Light, Michelob Light, Miller High Life, Miller Lite, Milwaukee's Best Light, Rolling Rock*, and *Special Export*. The profits of such sub-premium beers as *Busch* or *Old Milwaukee* change by very little or decline slightly. Those brands in the sub-premium segment of the market are considered poor substitutes for foreign brands and so have little to gain from shrinking markups to try to capture

[14] Table **??** classifies the domestic brands in the *Dominick's* data according to their market segment: subpremium, premium, or superpremium.

Post-Depreciation Equilibrium	Percent Change
Retailer Profit	-5.04
Domestic Manufacturer Profit	1.71
Foreign Manufacturer Profit	-22.12
Consumer Surplus	-8.18
Total Domestic Welfare	-2.85

Table 16: *Percent changes in variable profits and consumer surplus following a 10% depreciation.* 4080 observations. Source: My calculations.

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

6.6 Consumer Welfare

Table 16 reports the effect of a 10-percent depreciation on firms' profits and on consumer welfare. I find that following the depreciation, foreign manufacturers suffer the most among the domestic actors, as their total profits decline by 22.12 percent. Domestic manufacturers benefit by the most as their total profits increase by 1.71 percent. Consumer surplus decreases by 8.18 percent following the depreciation and the retailer's total profits decline by 5.04 percent.

Table 16 also reports the percent change in total domestic welfare, defined as the sum of the domestic manufacturers' profits, the domestic retailer's profits, and the domestic consumer surplus, following each shock. To compute total domestic welfare, the change in consumer surplus is converted to a dollar figure by using the compensating variation measure of Small and Rosen (1981).[15] I find that total domestic welfare declines by 2.85 percent following a 10 percent depreciation.

7 Conclusion

This paper examines the welfare effects of a change in the nominal exchange rate using the example of the beer industry. I estimate a structural econometric model that makes it possible to compute manufacturers' and retailers' pass-through of a nominal exchange-rate change 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 a change in the nominal exchange-rate.

The results indicate that foreign manufacturers generally bear more of

[15] I describe the details of this compensating variation measure in Appendix B.

the cost (or reap more of the benefit) of a change in the nominal exchange rate than do domestic consumers, domestic manufacturers, or the domestic retailer. Following a 10-percent depreciation, foreign manufacturers' profits decline by 22 percent, while consumer surplus falls by only 8 percent and the retailer's profits fall by only 5 percent. The results suggest some strategic interaction between import-competing domestic manufacturers and foreign manufacturers following a depreciation. Domestic manufacturers with brands that are close substitutes for foreign brands increase their profits by lowering prices to take market share from foreign manufacturers. Domestic manufacturers' profits increase by 1.7 percent following the depreciation.

In future work, I plan to apply this model to assess the welfare effects of nominal exchange-rate fluctuations in other industries and economies, with some emphasis on developing economies. This paper's approach may be particularly suited to analyze nominal exchange-rates' welfare effects in developing countries given their often severe data constraints.[16]

Finally, analysis of the relationship between market structure and exchange-rate pass-through may be a promising avenue for future research. Recent work by Campa and Goldberg (2002) suggests that the variation in pass-through across countries is more affected by such microeconomic variables as

[16] As a result, only a handful of published studies estimate exchange-rate pass-through for developing economies.

the industry composition of each country's import bundle than by macroeconomic variables. Previous efforts to relate industrial organization variables to exchange-rate pass-through have proven inconclusive. Though several theoretical papers, most notably Dornbusch (1987), derive theoretical predictions for the impact of different market structures on pass-through, no empirical study has subsequently tested these models' predictions. In future work, I plan to extend this paper's model to examine how different vertical contracts between manufacturers and retailers affect exchange-rate pass-through.

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A Welfare Calculations

The structural model I use enables me to calculate the change in consumer welfare following an exchange-rate shock. This change can be given a dollar figure by using the compensating variation measure of Small and Rosen (1981) which for individual i is defined as:

$$CV_i = -\frac{\ln\left[\sum_{j=0}^{J} e^{V_{ij}^{post}}\right] - \ln\left[\sum_{j=0}^{J} e^{V_{ij}^{pre}}\right]}{\alpha_i} \tag{23}$$

where V_{ij}^{pre} is consumer i's indirect utility from consuming product j given its price before the exchange-rate shock, V_{ij}^{post} is her indirect utility from consuming the same product given its price after the exchange-rate shock, and α_i is her marginal utility of income which one must assume does not vary following the price change. V_{ij}^{post} and V_{ij}^{pre} are defined in equation (*8*) . This calculation assumes that the perceived characteristics of all the products, including the outside good, do not change over the period of the exchange-rate shock. I calculate the compensating variation for each of the 40 individuals I sample for each price zone. As the income effects for purchases of beer are minimal, this compensating variation measure equals the equivalent variation for each of the 40 individuals sampled in each price zone. The dollar value of the change in consumer surplus is given by the average compensating variation across these individuals multiplied by the population of the relevant market.

I calculate the change in total domestic welfare as the sum of this compensating variation measure, the change in domestic manufacturers' profits, and the change in the domestic retailer's profits following the exchange-rate shock.

B Supplementary Tables

	H_O Model Double Marginalization	Double Marginalization with Foreign Collusion
H_A Model		
1. Double Marginalization (DM)		10.25
2. DM with Foreign Collusion	.89	

Table 17: *Results from non-nested tests to determine which vertical contract model best explains the data.* Each column has the null model being tested and each row the alternative model against which it is being tested. Non-nested Cox-type tests can be discriminated using a Vuong (1989) and Villas-Boas (2002) two-step procedure and are distributed standard normal. One-sided test statistic at 5 percent significance levels is 1.65.

Product	Wholesale Price	Confidence Interval	Manufacturer Marginal Cost	Confidence Interval
Domestic Brands				
Budweiser	37.48	36.92-38.18	28.75	27.67-29.64
Bud Light	37.49	36.80-38.34	27.73	26.71-28.39
Busch	35.70	34.63-36.19	26.48	25.97-27.49
Busch Light	31.53	31.03-32.44	23.38	22.83-23.98
Coors	35.48	34.79-36.21	26.98	26.41-28.02
Coors Light	36.27	35.68-36.97	27.23	26.24-28.05
Keystone	25.86	25.40-26.31	19.04	18.60-19.69
Michelob Light	41.98	41.12-43.39	30.81	30.18-32.37
Miller Genuine Draft	37.46	36.90-38.26	28.91	27.97-29.81
Miller High Life	37.59	36.68-38.44	28.18	26.96-28.56
Miller Lite	36.60	36.06-37.61	27.54	26.71-28.52
Milwaukee's Best	28.26	27.25-28.96	19.42	19.06-20.66
Milwaukee's Best Lite	35.13	34.63-35.50	24.84	24.34-25.72
Old Milwaukee	21.54	20.97-22.38	13.89	13.38-15.37
Old Style	42.72	41.76-44.05	31.63	30.91-32.55
Old Style Classic	34.23	33.15-35.23	25.88	25.54-26.73
Rolling Rock	47.31	45.70-48.58	33.69	32.37-35.81
Special Export	44.25	43.22-45.58	32.90	31.82-34.44
Stroh's	30.02	29.51-30.45	22.64	22.06-23.22
All Domestic Brands	36.02	35.79-36.24	26.77	26.50-27.05
European Brands				
Beck's	62.70	60.49-65.55	41.94	39.06-44.62
St. Pauli	73.41	71.01-75.62	50.47	47.07-55.81
Amstel	70.26	66.65-72.68	45.86	42.67-52.07
Grolsch	82.58	80.93-86.19	58.74	56.29-62.01
Heineken	70.70	67.72-72.40	47.10	45.05-53.25
Harp	82.95	78.59-85.27	59.43	52.46-62.11
Peroni	67.08	63.89-70.31	45.52	42.71-49.61
Bass	83.83	81.73-87.86	60.55	57.06-64.50
North American Brands				
Foster's	76.45	73.64-79.73	53.23	49.11-58.01
Guinness	85.49	83.20-89.54	61.32	56.36-65.33
Molson Golden	55.19	54.08-59.09	42.10	40.37-44.80
Molson Light	51.55	48.81-56.75	32.50	28.60-38.48
Corona	67.14	64.11-70.26	45.40	42.49-49.61
Tecate	64.02	61.32-65.77	41.83	39.51-45.44
Japanese Brands				
Sapporo	76.31	74.54-79.75	53.48	47.84-55.69
All Foreign Brands	71.30	70.35-72.34	48.69	47.68-49.88
All Brands	43.58	42.81-44.54	32.22	31.80-32.65

Table 18: *95-percent confidence intervals for the median of the derived marginal costs for the 34 products in the sample.* Median in cents per 12-ounce serving across 120 markets. Confidence intervals calculated using 10,000 bootstrap samples (with replacement). 4080 observations. Source: My calculations.

Product	Margin		
	Man.	Ret.	Vert.
	%	%	%
Domestic Brands			
Budweiser	22.51	26.70	43.44
Bud Light	24.20	29.64	47.54
Busch	22.66	25.68	42.83
Busch Light	25.20	27.65	46.10
Coors	22.93	27.69	44.16
Coors Light	24.12	29.21	45.52
Keystone	24.72	26.83	45.12
Michelob Light	24.76	29.77	48.28
Miller Genuine Draft	23.01	26.58	43.28
Miller High Life	25.09	26.58	44.26
Miller Lite	24.49	28.26	45.77
Milwaukee's Best	27.23	25.66	45.24
Milwaukee's Best Lite	26.77	27.52	46.93
Old Milwaukee	33.46	34.71	56.80
Old Style	23.53	28.35	46.44
Old Style Classic	22.02	25.87	42.17
Rolling Rock	26.87	30.99	49.90
Special Export	23.71	28.59	46.03
Stroh's	23.57	26.98	43.94
All Domestic Brands	24.42	27.39	45.50
European Brands			
Beck's	33.15	31.91	55.46
St. Pauli	31.14	29.16	51.70
Amstel	33.89	30.88	55.08
Grolsch	30.34	27.38	49.74
Heineken	31.86	30.04	53.40
Harp	30.64	27.32	50.10
Peroni	32.93	30.43	54.00
Bass	29.47	26.90	48.81
Other Foreign Brands			
Foster's	31.78	28.81	51.68
Guinness	30.59	27.47	50.24
Molson Golden	23.78	28.69	45.95
Molson Light	38.40	35.62	61.71
Corona	33.20	30.54	54.21
Tecate	33.65	31.72	54.95
Sapporo	32.66	29.60	53.33
All Foreign Brands	30.72	29.70	51.72

Table 19: *Median derived price-cost margins by product.* Median across 120 markets. The margin is markup divided by price with units in percentages. Source: My calculations.

Country	Mean	Median	Std	Minimum	Maximum
Canada	19.33	19.21	.74	17.79	19.33
Germany	35.09	35.16	2.65	31.65	38.32
Holland	38.31	38.84	2.00	35.58	40.57
Ireland	8.21	8.27	.45	7.63	8.78
Italy	25397.40	25678	1621.49	23161	26853
Japan	1615	1619	63.68	1533	1688
Mexico	2111.48	8.59	2895.06	6.35	5670
United Kingdom	7.84	7.86	.24	7.48	8.14
United States	15.01	15.12	.58	14.14	15.63

Table 20: *Instruments: Hourly wages in local-currency terms.* Annual data. Hourly compensation for production workers in food, beverage, and tobacco manufacturing industries, SIC 20 and 21. Source: *Foreign Labor Statistics*, Bureau of Labor Statistics, U.S. Department of Labor.

Product	Elasticities	Confidence Intervals
Domestic Brands		
Budweiser	-6.37	-6.57 to -6.11
Bud Light	-5.88	-6.19 to -5.70
Busch	-6.49	-6.70 to -6.24
Busch Light	-6.02	-6.26 to -5.83
Coors	-6.34	-6.53 to -6.11
Coors Light	-5.99	-6.23 to -5.73
Keystone	-5.85	-5.98 to -5.63
Michelob Light	-6.05	-6.35 to -5.81
Miller Genuine Draft	-5.91	-6.05 to -5.71
Miller High Life	-6.49	-6.69 to -6.27
Miller Lite	-5.61	-5.85 to -5.50
Milwaukee's Best	-6.09	-6.28 to -5.88
Milwaukee's Best Light	-6.27	-6.49 to -6.05
Old Milwaukee	-4.75	-4.94 to -4.59
Old Style	-6.25	-6.64 to -6.08
Old Style Classic	-6.21	-6.35 to -6.01
Rolling Rock	-5.95	-6.36 to -5.72
Special Export	-6.25	-6.77 to -6.15
Stroh's	-6.11	-6.32 to -5.86
European Brands		
Beck's	-5.71	-6.39 to -5.46
St. Pauli	-6.31	-7.11 to -5.88
Amstel	-6.06	-6.86 to -5.76
Grolsch	-6.70	-7.78 to -6.29
Heineken	-6.12	-6.96 to -5.73
Harp	-6.70	-7.56 to -6.10
Peroni	-6.06	-6.82 to -5.59
Bass	-6.85	-7.59 to -6.34
North American Brands		
Foster's	-6.39	-7.34 to -6.04
Guinness	-6.67	-7.36 to -6.18
Molson Golden	-6.73	-7.19 to -6.36
Molson Light	-5.21	-5.76 to -4.83
Corona	-6.04	-6.77 to -5.55
Tecate	-5.97	-6.63 to -5.57
Japanese Brands		
Sapporo	-6.22	-7.08 to -5.91

Table 21: *Median own-price demand elasticities.* Median across all 120 markets. 95 percent confidence intervals generated with bootstrap simulations. 4080 observations. Source: My calculations.