Vertical Contracts and Exchange-Rate Pass-Through*

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April, 2002

Abstract

This paper presents a method to evaluate how manufacturers' and retailers' strategic interactions may determine their pass-through of exchange-rate-induced marginal-cost changes to their products' prices. The approach consists of a "front-end" estimation, in which demand functions and possible supply functions are estimated, and a "back-end" analysis in which the original estimates are used to simulate a market equilibrium, including the degree of exchange-rate pass-through, under various restrictions on firms' strategic conduct. This detailed model enables counterfactual policy experiments to derive pass-through coefficients under various strategic conduct scenarios. The methodology is applied to study exchange-rate pass-through in one market, the imported beer market.

*Preliminary and Incomplete. I am grateful to my advisors Maury Obstfeld and Aviv Nevo for their guidance. I also thank George Akerlof, David Romer, Catherine Wolfram, Marta Wosinska, Janet Yellen and participants in the Industrial Organization Lunch and the Macro-International Lunch for their comments. Financial support from a U.C. Berkeley Dean's Fellowship and from the Social Science Research Council is gratefully acknowledged. Address: Department of Economics, University of California, Berkeley, 549 Evans Hall No. 3880, Berkeley, California 94720-3880; email: rheller@econ.berkeley.edu.

1 Introduction

Policymakers are often interested in whether domestic or foreign firms absorb the impact of a particular trade policy, such as a tariff or quota. International macroeconomists are increasingly interested in how linkages between real and financial markets may affect the determination of the exchange rate and of other macroeconomic variables. Exchange-rate pass-through links financial markets to goods markets, at least in theory. A distribution chain that spans several countries makes firms in the supply chain vulnerable to fluctuations in their margins due to changes in trade policy or to volatility in exchange rates. This paper focuses on the vertical relationships that determine whether upstream or downstream firms absorb the marginal cost shocks associated with crossing national borders.

This paper presents a method to evaluate how manufacturers' and retailers' strategic interactions may determine their pass-through of exchange-rate-induced marginal-cost changes to their products' prices. Exchange-rate pass-through is defined as the percent change in the local-currency price of an imported good given a one-percent change in the exchange rate. The approach consists of a "front-end" estimation, in which demand functions and possible supply functions are estimated, and a "back-end" analysis in which the original estimates are used to simulate a market equilibrium, including the degree of exchange-rate pass-through, under various restrictions on firms' strategic conduct. This detailed model enables counterfactual policy experiments to derive pass-through coefficients under various strategic conduct scenarios. The methodology is applied to study exchange-rate pass-through in one market, the imported beer market.

1.1 Organization of Paper

This paper seeks to answer two questions about exchange-rate pass-through: first, what are the brand-level pass-through coefficients? That is, how do firms adjust their markups following an exchange-rate shock? I address this first set of questions with both a reduced-form and a structural model. Second, why do we observe these pass-through coefficients? What firm conduct determines these markup adjustments? This second set of questions can only be explored with a structural model of the industry. The next section of the paper reviews related work from the macro-international literature. The third section introduces the reduced-form model. The fourth section introduces the structural model. The model consists first, of estimates of a brand-level demand system, and second, of the use of those estimates with a model of industry conduct to simulate exchange-rate pass-through. The structural model allows me to 1. recover retail and wholesale margins without observing input costs; 2. conduct counterfactual policy experiments; 3. analyze welfare effects. The fifth section describes the scanner data from the beer market used in the estimation. The sixth section reports results from estimation of both the reduced-form and the structural model. The seventh section concludes.

2 Does Pass-Through Matter?

Efforts to resolve some of the outstanding puzzles in international macroeconomics rest on assumptions about exchange-rate pass-through that are difficult to justify given the contradictory results in the pass-through literature. Aggregate data support the hypothesis of complete pass-through, while microeconomic data support the hypothesis of incomplete pass-through.

Current exchange-rate pass-through studies are characterized by several major failings. First, there are no published papers or working papers that estimate pass-through coefficients along a good's distribution chain, that is, as it moves from import through wholesale to retail markets.[1] Current work regards the pass-through process as a black box, noting only the initial effect on import prices or the final effect on consumer prices. Second, pass-through studies use highly aggregated data, e.g. by 2- or 3-digit SIC code, making them vulnerable to aggregation bias. There are only a couple of brand-level pass-through studies. Third, most pass-through studies use unit values to proxy for import prices.[2] A unit value is the total value of a shipment of goods divided by the total quantity of goods shipped. A number of studies have catalogued the problems with unit-values. They are generally poor proxies for prices.[3] Alterman (1991) argues that the use of unit values to proxy for import prices distorts estimates of pass-through coefficients.[4] Fourth, most pass-through studies use a log-linear specification for their pricing equation.[5] This is puzzling, as the log-linear speci-

[1] McCarthy (1997) does look at the distribution chain using aggregate data.

[2] E.g. Dornbusch (1987), Krugman (1987), and Knetter (1989).

[3] Alterman (1991) surveys this literature.

[4] Alterman summarizes these criticisms: First, unit-value indexes do not control for product mix. Price changes may reflect variation in a category's product mix rather than in its product prices. Second, unit-value indexes do not control for quality change in goods. Third, the data used in unit-value indexes are not randomly chosen. That is, some commodities may be more amenable to unit-value calculations than others. Fourth, unit-value indexes are often calculated at an aggregated level, (e.g. one-digit SIC level) that is, without any commodity detail.

[5] E.g. Goldberg and Knetter (1997), Feenstra (1989).

fication can be restrictive with respect to firm conduct. The log-linear specification assumes a constant elasticity of the dependent variable, price, with respect to each independent variable, including the exchange rate. A one-percent change in the exchange rate must always be followed by a constant percent change of the price – the pass-through elasticity cannot vary for different values of the exchange rate or price. So if $\frac{\partial p}{\partial mc}\frac{mc}{p} = k$ then when the marginal effects $\frac{\partial p}{\partial mc}$ are unusually large the markup $\frac{p}{mc}$ must be adjusted to be unusually large by the same proportion to maintain a constant pass-through elasticity. The firm's markup adjustment is thus imposed by the choice of functional form. If the marginal effect increases by ten percent the markup must also increase by ten percent. A linear specification allows pass-through elasticities to vary, but must normalize exchange rates across countries to make any estimated coefficients meaningful.

2.1 Does an Industry's Organization Determine Its Pass-Through?

Efforts to relate industrial organization (IO) variables to exchange-rate pass-through have proven inconclusive. Dornbusch (1987) and Feingold (1986) try to tie exchange-rate pass-through coefficients to various cross-industry indicators. Both studies use a cross-industry comparative-statics methodology known as the structure-conduct-performance paradigm (SCPP) that has been somewhat discredited in the IO literature. Its hallmark is a reduced-form cross-sectional study of many industries to establish the relationship between structure, conduct, and performance for each.

Dornbusch (1987) was the first paper to explore how industrial organization models might improve our understanding of the determinants of exchange-rate pass-through. He tries to identify whether individual industries differ systematically in their response to exchange-rate fluctuations, and, in the spirit of the SCPP approach, whether a cross-sectional analysis of such "market structure" variables as market concentration, import penetration, or product substitutability account for these differences. Dornbusch argues that pass-through should be high in industries with low markups (for him, low market concentration), high import penetration, and low product substitutability.

Feinberg (1986) explores several implications of the Dornbusch paper in a reduced-form analysis of exchange-rate pass-through to producer prices in 41 German industries. Feinberg tests for a relationship between market concentration, proxied for by a Herfindahl index, import penetration, and exchange-rate pass-through. He finds no significant economic relationship of either variable to exchange-rate pass-through. In a related study of the United States, he argues that U.S. industries with high market concentration exhibit low pass-through (1989).

Such cross-industry comparative statics may not provide much useful information. Individual industries exhibit idiosyncrasies that cannot be captured in such a static cross-industry analysis. And no clear identification strategy underlies market-power estimates produced by cross-industry comparative statics.[6] The structural model in this paper uses the comparative statics of industry equilibrium to identify pass-through, markup-adjustment, and market-power parameters.

3 Reduced-Form Model

In this section, I introduce the reduced-form model.

3.1 Derivation of Pricing Equation

This model draws on work by Feenstra (1989). Let the local currency price of an imported variety of a differentiated product be p_i^f, and the local currency price of the domestic variety, p_i^d. Let I be the total expenditure on all varieties of this good. Let this differentiated product be weakly separable in the consumer's utility function from other goods: Demand for this good is then given by $x_i^f(p_i^f, p_i^d, I)$.

Each period, a foreign firm sets its product's local currency price after learning the value of the exchange rate to maximize expected profits in its own currency. Let s^f be the spot exchange rate, that is, the units of domestic currency per unit of foreign currency. The firm treats the total expenditure on all varieties, I, as exogenous to its pricing decision. The firm may set its price in local or foreign currency terms. Given the timing of when the foreign firm learns about the exchange rate, variation in the currency it uses to invoice does not change the results of the model. The total cost function for the foreign firm in its own currency is given by $C\left(x_i^f, w^f\right)$, where w^f denotes input prices, and x, quantity produced. Let the total cost function be homogeneous of degree one in input prices, so $C\left(x_i^f, w^f\right) = \phi(x)\, w^f$. A foreign firm maximizes its profits in its own currency by solving the following problem each period:

[6] For more on this argument, see Bresnahan (1988).

$$\max_{p_i^f} \left[p_i^f x_i^f \left(p_i^f, p_i^d, I \right) - \phi \left(x_i^f \right) w^f e^f \right] \tag{1}$$

where e^f is the bilateral exchange rate. The first-order condition for (1) is:

$$\phi' \left(x_i^f \right) w^f e^f = p_i^f \left(1 + \frac{\partial p_i^f}{\partial x_i^f} \frac{x_i^f}{p_i^f} \right) = p_i^f \left(1 - \frac{1}{\eta} \right) \equiv r_i^f \left(p_i^f, p_i^d, I \right) \tag{2}$$

where $\eta = -\frac{\partial x_i^f}{\partial p_i^f} \frac{p_i^f}{x_i^f}$, the positive demand elasticity, and $r_i^f \left(p_i^f, p_i^d, I \right)$ is the foreign firm's marginal revenue. If

$$\phi'' \left(x_i^f \right) \frac{\partial x_i^f}{\partial p_i^f} w^f e^f - \left(1 + \frac{\partial p_i^f}{\partial x_i^f} \frac{x_i^f}{p_i^f} \right) = \phi'' \left(x_i^f \right) \frac{\partial x_i^f}{\partial p_i^f} w^f e^f - \frac{\partial r_i^f}{\partial p_i^f} \neq 0 \tag{3}$$

that is, if the change in marginal cost is not equal to the change in marginal revenue for any given change in the price p_i^f, then each value of p_i^f is associated with a unique set of values of $w^f e^f$, p_i^d, and I, and so we can invert (3) to get a pricing equation we will estimate, for now, denoted simply as:

$$p_i^f = \pi \left(w^f e^f, p_i^d, I \right) \tag{4}$$

3.2 Empirical Implementation

The data we observe from the beer industry are prices and quantities for each brand over time. It is difficult to say whether a plot of these data represents shifts in the brand's marginal-cost curve or demand curve. To show the effect of a tariff or an exchange-rate change on prices and quantities, we must identify shifts of the marginal-cost curve in the data. That is, in an imperfectly competitive market, a depreciation of the home country's currency causes an upward shift of the marginal-cost curve for foreign firms. Foreign firms then increase prices and reduce quantities sold causing a leftward shift of foreign brands' marginal-cost curve.

One cannot identify marginal-cost shocks' impact on prices or quantities if the demand curve is shifting at the same time. However, if the marginal-cost curve shifts more frequently, and over a wider range, than does the demand curve, then price-quantity observations will mainly provide information about shifts in the marginal-cost curve and movements along the demand curve. Changes in the main components of beer manufacturers' marginal cost can be frequent and volatile: these include malt barley prices and fuel costs. They almost certainly fluctuate more than such common demand-curve shifters as changes in consumer preferences or income. So the assumption that the marginal-cost curve shifts more than does the demand curve appears reasonable for this industry.[7]

This assumption does not in itself insure identification, however. We want to explain the variation in the price-quantity data that follows from exchange-rate fluctuations shifting some foreign brands' marginal-cost curve, holding all else constant. We must control for any shifts in the demand curve that may be correlated with exchange-rate fluctuations and for any variables other than the exchange rate or the exchange-rate-marginal-cost interaction that may shift the marginal-cost curve. In the next section, I set out a specification for the model's pricing equation and discuss in greater detail how to control for extraneous marginal-cost and demand shocks.

3.3 Pricing Equation Specification

I consider several specifications for the pricing equation (4) for imported beer brand i in period t. The first specification has the exchange rate e and foreign marginal costs w interacted:

$$p_{it}^{f} = c_t + \sum_{j=1}^{k} \alpha_j \left(w_{it}^{f} e_{t-j}^{f} \right) + \gamma p_{it}^{d} + \delta I_t + \varepsilon_t \qquad (5)$$

The second log-linear specification also has the exchange rate e and foreign marginal costs w interacted:

$$\ln p_{it}^{f} = \ln c_t + \sum_{j=1}^{k} \alpha_j \ln \left(w_{it}^{f} e_{t-j}^{f} \right) + \gamma \ln p_{it}^{d} + \delta \ln I_t + \varepsilon_t \qquad (6)$$

with α as the pass-through coefficient. The third log-linear specification has the exchange rate and foreign marginal costs entering separately:

$$\ln p_{it}^{f} = \ln c_t + \sum_{j=1}^{k} \alpha_j \ln e_{t-j}^{f} + \beta \ln w_{it}^{f} + \gamma \ln p_{it}^{d} + \delta \ln I_t + \varepsilon_t \qquad (7)$$

with α as the pass-through coefficient. As in equation (5), p_{it}^{d} is the price of a competing brand, I_t is the total expenditure on the good, and ε_t is a regression disturbance. c_t is

[7] I assume that the demand and supply curves do not shift in a correlated fashion.

a constant.[8] The third specification allows a symmetry test of whether $\sum_{j=1}^{k} \alpha_j$ and β are equal.[9] If the null hypothesis of symmetric pass-through is rejected, this implies foreign firms pass-through exchange-rate-induced marginal costs differently than they do other marginal costs, and the first and second specifications are rejected.

Marginal Cost This variable is included in the pricing equation to control for supply shocks that may affect the price of an imported brand. Good proxies for marginal cost include foreign input prices for beer manufacturing, including wages and the prices of malt, hops, glass containers, fuel, shipping, and advertising as well as foreign wholesale prices for the same brand.

Exchange Rate I will consider various lags of the spot exchange-rate to approximate firms' experience of exchange rates over a production period. The exchange rate is specified as a function of the current and past monthly-average spot rates:

$$e_t^f = \sum_{j=1}^{k} \beta_j s_{t-j} \tag{8}$$

I include up to eleven monthly exchange-rate lags. Many industry studies assume exchange-rate movements to be exogenous.[10] The firm may treat the exchange rate as exogenous, but in reality it may be endogenous. I will test the null hypothesis of exogeneity. I will also consider possible instruments for the exchange rate. Recall that a valid instrument will be correlated with the exchange rate but not with macroeconomic disturbances in the U.S., such as demand shocks, that could affect both the exchange rate and an imported beer's price. Possible instruments include foreign current accounts and foreign interest rates.

Competing Brand's Price This variable is included in the pricing equation to control for demand shifts that may affect the price of an imported brand. Suppose our pricing equation is for Heineken, a Dutch brand. A competing brand may be a domestic brand, such as Coors, or another foreign country's brand, say a German brand like Beck's. If a competing brand's price is lowered, demand will rise for Heineken, causing its price to increase. The firm treats p_{it}^d, the price of a competing brand, as exogenous but in reality

[8] Feenstra (1989) proposes c_t as a time trend to control for quality change over time. As quality change is much less of an issue in the beer industry than in the auto industry, analyzed by Feenstra, I make c_t a simple constant.

[9] Following Feenstra (1989), a test of the pass-through of an import tariff would use the following specification: $p_{it}^f = c_t + \sum_{j=1}^{k} \alpha_j \left(w_{it}^f e_{t-j}^f \right) + \varphi(1+\tau) + \gamma p_{it}^d + \delta I_t + \varepsilon_t$ where τ is an ad valorem tariff and φ is the tariff pass-through coefficient.

[10] For example, Dornbusch (1987).

it may be endogenous. Some demand shocks will drive up the prices of all beers, such as a renewed interest in beer over wine. So Beck's price variable (or alternatively, Coors's) may be correlated with the residual and its coefficient will be biased. A good instrument should be correlated with supply-side variables that affect the price of Beck's (or alternatively, of Coors) but not the price of Heineken. Promising instruments for Coors include input prices (wages, malt barley) for U.S. malt manufacturing that should be correlated with the prices of domestic beer but not of Dutch beers. Potential instruments for Beck's include German input prices (wages, malt barley) in malt manufacturing.

Expenditure This variable is included in the pricing equation to control for demand shifts that may affect the price of an imported brand. The firm treats I_t, the total expenditure on beer, as exogenous but in reality it may be endogenous. The total expenditure on beer may be determined by an imported beer's price as well as be a determinant of it. We want the variation in total U.S. (or Chicago-area) beer expenditure that affects the price of Heineken, but is not itself affected by the price of Heineken. Promising instruments include such macroeconomic variables as U.S. consumer prices and U.S. private consumption – these variables should be correlated with total expenditure on beer without being affected in turn by the price of Heineken.

Regression Disturbance ε_t is a regression disturbance.

3.4 Other Hypothesis Tests

I will test first, for the symmetry of marginal cost and exchange-rate pass-through; second, for the symmetry of pass-through following exchange-rate depreciations and appreciations; and third, for the symmetry of pass-through over time (sensitivity analysis).

4 Structural Model

The structural model of the beer industry lets me: 1. Recover the real economic price-cost margins along the distribution chain. I can compare these derived margins with the accounting margins to see how each adjusts following exchange rate fluctuations. 2. Recover the wholesale price-cost margin. Accounting data for price-cost margins for foreign manufacturers is generally not available; 3. Conduct a series of policy experiments with respect to industry conduct and exchange-rate pass-through. Methods developed in the IO field to estimate product mark-ups for a differentiated-goods industry (e.g. Nevo (2001), Berry, Levinsohn, and Pakes (1995)) can be adapted to analyze how exchange-rate fluctuations affect prices and markups in a single industry.

4.1 Demand

Market demand is derived from a discrete choice model of consumer behavior.[11] 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.

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 is the product's price, x are product characteristics observed by the econometrician and the consumer, and ξ are product characteristics observed by the producer and consumer but not by the econometrician. The indirect utility for consumer i in consuming product j is given by a scalar value $\mathrm{U}\left(x_j, \zeta_i, p_j, \xi_j; \theta\right)$ where θ is a vector of parameters to be estimated. Consumer i chooses good j if and only if:

$$U\left(x_j, \zeta_i, p_j, \xi_j; \theta\right) \geq U\left(x_r, \zeta_r, p_r, \xi_r; \theta\right), \ for\ r = 0, 1, ...J, \tag{9}$$

where r=0 is an outside option (the option of purchasing beer from other supermarkets, restaurants, or bars in the Chicago area or purchasing more specialized beers such as those produced by microbreweries) and r>0 is a competing product. If we define A_j as the values of individual consumer characteristics ζ that induce purchase of good "j", the market share of good "j", as a function of the characteristics of all goods in the market, is:

$$s_j(p, x, \xi; \theta) = \int_{\xi \in A_{\mathrm{j}}} P_0(d\zeta) \tag{10}$$

where $P_0(d\zeta)$ is the density of consumer characteristics ζ in the population. Individual attributes may be observed or unobserved. To allow for the presence of unobserved individual characteristics, one makes assumptions on their distribution across the population.

[11] Multiple choices cannot be included given the aggregate structure of my data.

This share equation predicts each product's market share as a function of the product's characteristics, prices, and unknown parameters. One then estimates what parameters minimize the structural error as defined by Berry (1994), an estimation procedure that implicitly minimizes the distance between observed and predicted market shares, after transforming the relevant GMM objective function so the structural error enters it linearly. If we assume utility has a quasi-linear form, we can write it as:

$$u_{ijt} = \alpha \left(y_i - p_{jt}\right) + x_{jt}\beta + \xi_{jt} + \varepsilon_{ijt}, \quad i = 1, ..., I \quad j = 1, ..., J \quad t = 1, ..., T \tag{11}$$

where we need to specify a distribution for ε_{ijt}. I initially identify ε_{ijt} with the i.i.d. Type I extreme value distribution. This restricts heterogeneity in consumer preferences to enter through the additive error term. The probability of individual i purchasing product j at time t is given by the multinomial logit expression:

$$s_{ijt} = \frac{e^{\delta_{\mathrm{jt}}}}{1 + \sum_k e^{\delta_{\mathrm{jt}}}} \tag{12}$$

where δ_{jt} =x$_{jt}\beta - \alpha p_{jt} + \xi_{jt}$ is the mean utility common to all consumers. The price elasticities of the market shares s$_{jt}$ have a simple closed-form solution:

$$\frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \begin{cases} \alpha p_{jt} \left(1 - s_{jt}\right) & \text{if j=k} \\ -\alpha p_{kt} s_{kt} & \text{otherwise} \end{cases} \tag{13}$$

Second, to allow more general substitution patterns, I identify ε_{ijt} with the Type I extreme value distribution but allow heterogeneity in consumer preferences to enter through an additional term μ_{it}. The probability of individual i purchasing product j at time t no longer has a closed form solution and is given by the integral over the taste terms μ_{it} of the multinomial logit expression:

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

and must be calculated by simulation. The price elasticities of the market shares s$_{jt}$ will then be given by:

$$\frac{\partial s_{jt}}{\partial p_{kt}}\frac{p_{kt}}{s_{jt}} = \begin{cases} -\frac{p_{jt}}{s_{jt}} \int \alpha_i s_{ijt}\left(1 - s_{ijt}\right) dP_0(d\zeta) \text{ if j=k} \\ -\frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} s_{ikt} dP_0(d\zeta) \text{ otherwise} \end{cases}$$

The method of simulated moments (MSM) is the standard estimation procedure used to solve a mixed-logit model. One estimates demand by choosing parameters that minimize the distance between predicted and observed market shares. This is a nonlinear procedure with respect to the demand parameters. There is also the problem that price is an endogenous variable in the estimation. Berry (1994) introduces a method to construct a demand side equation that is linear with respect to the endogenous variables' parameters, so instrumental variables procedures can be used to solve the problem. Berry proposes to recover mean utility by minimizing the distance between the predicted and observed market shares. For the logit model, mean utility has a simple analytic form: $\delta_{jt} = \log(s_{jt}) - \log(s_{0t})$, that is, as the difference between the log of a good's market share and the log of the share of the outside good. Estimation of demand relates the mean utility from consuming a product to its price, p, its observed characteristics, x_{jt}, its constant unobserved product characteristics, d_j, and to changes in its unobserved product characteristics, ξ_{jt}.

$$\delta_{jt} = d_j + \beta x_{jt} - \alpha p_{jt} + \xi_{jt} \tag{16}$$

One must instrument for the endogeneity of price, as it will be correlated with changes in unobserved characteristics (characteristics observed by the consumer but not by the econometrician). Estimation of the pass-through model with the logit demand helps to test how well my proposed instruments perform before turning to the mixed logit estimation. My instruments are beer input prices, that is, the prices of malt barley, glass containers, electric power, and aluminum cans and the hourly wages in beverage manufacturing. Table 5 indicates these 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 control for the impact of unobserved (by the econometrician, not by firms or consumers) changes in product characteristics on their consumption choices. It is a good sign that the price coefficient goes from -3.67 in the OLS estimation to -5.22 in the IV estimation. Both the first-stage F-test of the instruments, at 39.42, and the Hausman exogeneity test, at 415, are significant at the .01 percent level.

4.2 Supply

I propose to model firms, both manufacturers and retailers, as Bertrand oligopolists with differentiated products. Initially, I assume a double-marginalization supply model and then test for different degrees of exchange-rate pass-through at the wholesale and retail level. Contracting behavior between manufacturers and retailers follows a sequential Nash model. Manufacturers set their prices first and retailers then set their prices given the wholesale prices they observe. To solve the vertical model, one solves the retailer's problem first. In this model, I have only one retailer. So let there be one retail firm that produces all of the market's J differentiated products. The profits of the retail firm at time t are given by:

$$\Pi_{rt} = \sum_{j \in J} (p_{jt}^r - p_{jt}^w - mc_{jt}^r) M_t s_{jt}(p^r) - C_f \tag{17}$$

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, mc_{jt}^r 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 products, M_t is the size of the market, and C_f is a fixed cost of production. Given a Bertrand-Nash equilibrium in prices, the retail price p_j^r must satisfy the first-order condition:

$$s_{jt}(p^r) + \sum_{j \in J} (p_{jt}^r - p_{jt}^w - mc_{jt}^r) \frac{\partial s_{rt}(p^r)}{\partial p_{jt}} = 0 \tag{18}$$

This gives us a set of J equations with price-cost margins for each product. Stacking the first-order conditions for all J products and rearranging terms, one can solve for the retailer's implied price-cost margin as a function of demand-side parameters for each period. The markups can be solved for by defining $S_{jr} = -\frac{\partial s_{rt}(p^r)}{\partial p_{jt}}$ j, r=1,...,J, and a J×J matrix Ω called the retailer reaction matrix with the jth, rth element equal to S_{jr} , the first derivative of each product's market share with respect to each product's retail price. In vector notation,

$$s_t(p^r) - \Omega_{rt}((p_t^r - p_t^w - mc_t^r) = 0 \tag{19}$$

The markup equation will be:

$$-(\Omega_{rt})^{-1} s_t(p^r) = p_t^r - p_t^w - mc_t^r \tag{20}$$

This system of J simultaneous equations must each hold exactly in equilibrium if each firm has perfect information. Let there be M manufacturers that each produce some subset κ of the market's J differentiated products. The manufacturer chooses the wholesale price p^w_{jt} assuming the retailer behaves according to (17). The manufacturer's profit function is:

$$\Pi_{wt} = \sum_{j \in \kappa} (p^w_{jt} - mc^w_{jt}) s_{jt}(p^r\left(p^w\right)) \tag{21}$$

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

$$s_{jt}(p^r\left(p^w\right)) + \sum_{j \in \kappa} (p^w_{jt} - mc^w_{jt}) \frac{\partial s_{jt}\left(p^r\left(p^w\right)\right)}{\partial p^w_{jt}} = 0 \text{ for j=1,2,...,N}_{t.} \tag{22}$$

Let Ω_{wt} be the manufacturer's reaction matrix with elements $\frac{\partial s_{\mathrm{wt}}(p^{\mathrm{r}}(p^{\mathrm{w}}))}{\partial p^{\mathrm{w}}_{\mathrm{jt}}}$, the derivative of each product's share with respect to each product's wholesale price. It follows that the manufacturers implied price-cost margin will be given by:

$$-\left(\Omega_{wt}\right)^{-1} s_t(p^r_t\left(p^w_t\right)) = p^w_t - mc^w_t \tag{23}$$

To get Ω_{wt} note that $\Omega_{wt} = \Omega_{rt}\Omega_{pt}$ where Ω_{pt} is a matrix of derivatives of each retail price with respect to each wholesale price. This matrix can be computed directly from my data.

How are pass-through coefficients recovered in the structural model? For each industry conduct scenario described below above, I simulate the effect of a rise in marginal costs for foreign firms on prices by computing a new equilibrium. By recomputing the equilibrium with constraints on industry conduct, marginal cost changes, and the like, I can test a number of hypotheses about the relation of industry conduct to exchange-rate pass-through.

5 Price-Cost Margins for Industry Conduct Scenarios

This section presents expressions to recover retailer and manufacturer price-cost margins for each model of industry conduct. It begins with the supply model of double marginalization. Price-cost margins for the other supply models are derived by changing the manufacturer and retailer ownership matrices. The manufacturer and retailer ownership matrices (T_w and T_r) have elements $T_w\left(j,k\right) = 1$ if both products j and k are produced by the same manufacturer, and zero otherwise, and $T_r\left(j,k\right) = 1$ if both products j and k are sold by the same retailer, and zero otherwise.

Consider a simple model of four manufacturers, A_1, B_1, B_2, and C_1 producing goods in three foreign countries, A, B, and C. Manufacturer A_1 produces one good A_1 in country A. Manufacturer B_1 produces one good B_1 and Manufacturer B_2 produces one good B_2, both in country B. And Manufacturer C_1 produces one good C_1 in country C. Countries A and B participate in a common free trade area.

5.1 Double Marginalization Scenarios

5.1.1 Scenario One: Manufacturers from the Same Country Tacitly Collude

Suppose we rewrite the first order condition (17) in matrix notation. Let $[N * M]$ be an element-by-element multiplication of two matrices of identical dimensions. Then (17) can be rewritten

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} * \begin{bmatrix} \frac{\partial s_{A_1}}{\partial p^r_{A_1}} & \frac{\partial s_{B_1}}{\partial p^r_{A_1}} & \frac{\partial s_{B_2}}{\partial p^r_{A_1}} & \frac{\partial s_{C_1}}{\partial p^r_{A_1}} \\ \frac{\partial s_{A_1}}{\partial p^r_{B_1}} & \frac{\partial s_{B_1}}{\partial p^r_{B_1}} & \frac{\partial s_{B_2}}{\partial p^r_{B_1}} & \frac{\partial s_{C_1}}{\partial p^r_{B_1}} \\ \frac{\partial s_{A_1}}{\partial p^r_{B_2}} & \frac{\partial s_{B_1}}{\partial p^r_{B_2}} & \frac{\partial s_{B_2}}{\partial p^r_{B_2}} & \frac{\partial s_{C_1}}{\partial p^r_{B_2}} \\ \frac{\partial s_{A_1}}{\partial p^r_{C_1}} & \frac{\partial s_{B_1}}{\partial p^r_{C_1}} & \frac{\partial s_{B_2}}{\partial p^r_{C_1}} & \frac{\partial s_{C_1}}{\partial p^r_{C_1}} \end{bmatrix} \begin{bmatrix} p^r_{A_1} - p^w_{A_1} - mc^r_{A_1} \\ p^r_{B_1} - p^w_{B_1} - mc^r_{B_1} \\ p^r_{B_2} - p^w_{B_2} - mc^r_{B_2} \\ p^r_{C_1} - p^w_{C_1} - mc^r_{C_1} \end{bmatrix} = - \begin{bmatrix} s_{A_1} \\ s_{B_1} \\ s_{B_2} \\ s_{C_1} \end{bmatrix} \tag{24}$$

By inverting the first two matrices, one can solve for the retail price-cost margins for each brand:

$$\begin{bmatrix} p^r_{A_1} - p^w_{A_1} - mc^r_{A_1} \\ p^r_{B_1} - p^w_{B_1} - mc^r_{B_1} \\ p^r_{B_2} - p^w_{B_2} - mc^r_{B_2} \\ p^r_{C_1} - p^w_{C_1} - mc^r_{C_1} \end{bmatrix} = - \left[\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} * \begin{bmatrix} \frac{\partial s_{A_1}}{\partial p^r_{A_1}} & \frac{\partial s_{B_1}}{\partial p^r_{A_1}} & \frac{\partial s_{B_2}}{\partial p^r_{A_1}} & \frac{\partial s_{C_1}}{\partial p^r_{A_1}} \\ \frac{\partial s_{A_1}}{\partial p^r_{B_1}} & \frac{\partial s_{B_1}}{\partial p^r_{B_1}} & \frac{\partial s_{B_2}}{\partial p^r_{B_1}} & \frac{\partial s_{C_1}}{\partial p^r_{B_1}} \\ \frac{\partial s_{A_1}}{\partial p^r_{B_2}} & \frac{\partial s_{B_1}}{\partial p^r_{B_2}} & \frac{\partial s_{B_2}}{\partial p^r_{B_2}} & \frac{\partial s_{C_1}}{\partial p^r_{B_2}} \\ \frac{\partial s_{A_1}}{\partial p^r_{C_1}} & \frac{\partial s_{B_1}}{\partial p^r_{C_1}} & \frac{\partial s_{B_2}}{\partial p^r_{C_1}} & \frac{\partial s_{C_1}}{\partial p^r_{C_1}} \end{bmatrix} \right]^{-1} \begin{bmatrix} s_{A_1} \\ s_{B_1} \\ s_{B_2} \\ s_{C_1} \end{bmatrix} \tag{25}$$

The price-cost margins for all J products in the full sample requires solving the equivalent J-by-J model. In vector notation, this can be written:

$$p^r - p^w - mc^r = - [T_r * \Omega_r]^{-1} s(p) \tag{26}$$

Manufacturers assume the retailer follows (23) when setting its prices. Suppose manufacturers from the same country tacitly collude in setting their products' prices. The manufacturers' first order conditions given by (21) can be rewritten in vector notation:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \frac{\partial s_{A_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_2}}{\partial p^w_{A_1}} & \frac{\partial s_{C_1}}{\partial p^w_{A_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_2}}{\partial p^w_{B_1}} & \frac{\partial s_{C_1}}{\partial p^w_{B_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_2}}{\partial p^w_{B_2}} & \frac{\partial s_{C_1}}{\partial p^w_{B_2}} \\ \frac{\partial s_{A_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_2}}{\partial p^w_{C_1}} & \frac{\partial s_{C_1}}{\partial p^w_{C_1}} \end{bmatrix} \begin{bmatrix} p^w_{A_1} - mc^w_{A_1} \\ p^w_{B_1} - mc^w_{B_1} \\ p^w_{B_2} - mc^w_{B_2} \\ p^w_{C_1} - mc^w_{C_1} \end{bmatrix} = - \begin{bmatrix} s_{A_1} \\ s_{B_1} \\ s_{B_2} \\ s_{C_1} \end{bmatrix} \tag{27}$$

The manufacturers' price-cost margins will be given by:

$$\begin{bmatrix} p^w_{A_1} - mc^w_{A_1} \\ p^w_{B_1} - mc^w_{B_1} \\ p^w_{B_2} - mc^w_{B_2} \\ p^w_{C_1} - mc^w_{C_1} \end{bmatrix} = - \left[\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \frac{\partial s_{A_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_2}}{\partial p^w_{A_1}} & \frac{\partial s_{C_1}}{\partial p^w_{A_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_2}}{\partial p^w_{B_1}} & \frac{\partial s_{C_1}}{\partial p^w_{B_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_2}}{\partial p^w_{B_2}} & \frac{\partial s_{C_1}}{\partial p^w_{B_2}} \\ \frac{\partial s_{A_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_2}}{\partial p^w_{C_1}} & \frac{\partial s_{C_1}}{\partial p^w_{C_1}} \end{bmatrix} \right]^{-1} \begin{bmatrix} s_{A_1} \\ s_{B_1} \\ s_{B_2} \\ s_{C_1} \end{bmatrix} \tag{28}$$

The price-cost margins for all J products in the full sample requires solving the equivalent J-by-J model. In vector notation, this can be written:

$$p^w - mc^w = - \left[T_w * \Omega_w \right]^{-1} s(p) \tag{29}$$

The price-cost margins for the other industry conduct scenarios can be recovered by changing the ownership matrices in (24) and (27).

5.1.2 Scenario Two: Manufacturers from Same Free Trade Zone Tacitly Collude

Suppose manufacturers from the same free trade zone tacitly collude in setting prices. The manufacturer ownership matrix would reflect that the products from countries A and B would be priced as if they were produced by one firm. The ownership matrix for the retailer would be the same as in the first scenario: Manufacturers again assume the retailer follows (23) when setting its prices. Suppose manufacturers from the same country tacitly collude in setting their products' prices. The manufacturers' first order conditions given by (21) can now be rewritten in vector notation:

$$\begin{bmatrix} 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \frac{\partial s_{A_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_2}}{\partial p^w_{A_1}} & \frac{\partial s_{C_1}}{\partial p^w_{A_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_2}}{\partial p^w_{B_1}} & \frac{\partial s_{C_1}}{\partial p^w_{B_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_2}}{\partial p^w_{B_2}} & \frac{\partial s_{C_1}}{\partial p^w_{B_2}} \\ \frac{\partial s_{A_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_2}}{\partial p^w_{C_1}} & \frac{\partial s_{C_1}}{\partial p^w_{C_1}} \end{bmatrix} \begin{bmatrix} p^w_{A_1} - mc^w_{A_1} \\ p^w_{B_1} - mc^w_{B_1} \\ p^w_{B_2} - mc^w_{B_2} \\ p^w_{C_1} - mc^w_{C_1} \end{bmatrix} = - \begin{bmatrix} s_{A_1} \\ s_{B_1} \\ s_{B_2} \\ s_{C_1} \end{bmatrix} \tag{30}$$

The manufacturers' price-cost margins will be given by:

$$\begin{bmatrix} p^w_{A_1} - mc^w_{A_1} \\ p^w_{B_1} - mc^w_{B_1} \\ p^w_{B_2} - mc^w_{B_2} \\ p^w_{C_1} - mc^w_{C_1} \end{bmatrix} = - \left[\begin{bmatrix} 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \frac{\partial s_{A_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_1}}{\partial p^w_{A_1}} & \frac{\partial s_{B_2}}{\partial p^w_{A_1}} & \frac{\partial s_{C_1}}{\partial p^w_{A_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_1}}{\partial p^w_{B_1}} & \frac{\partial s_{B_2}}{\partial p^w_{B_1}} & \frac{\partial s_{C_1}}{\partial p^w_{B_1}} \\ \frac{\partial s_{A_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_1}}{\partial p^w_{B_2}} & \frac{\partial s_{B_2}}{\partial p^w_{B_2}} & \frac{\partial s_{C_1}}{\partial p^w_{B_2}} \\ \frac{\partial s_{A_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_1}}{\partial p^w_{C_1}} & \frac{\partial s_{B_2}}{\partial p^w_{C_1}} & \frac{\partial s_{C_1}}{\partial p^w_{C_1}} \end{bmatrix} \right]^{-1} \begin{bmatrix} s_{A_1} \\ s_{B_1} \\ s_{B_2} \\ s_{C_1} \end{bmatrix} \tag{31}$$

The price-cost margins for all J products in the full sample requires solving the equivalent J-by-J model. In vector notation, this can be written:

$$p^w - mc^w = - \left[T_w * \Omega_w \right]^{-1} s(p) \tag{32}$$

The price-cost margins for the other industry conduct scenarios can be recovered by changing the ownership matrices in (24) and (27).

5.1.3 Scenario Three: All Foreign Manufacturers Tacitly Collude

All manufacturers producing abroad collude in setting their prices. The foreign manufacturer ownership matrix would represent all foreign brands as produced by one firm.

5.1.4 Scenario Four: All Manufacturers Tacitly Collude

All manufacturers producing domestically and abroad tacitly collude in setting their prices. The full manufacturer ownership matrix would be all ones. This market structure is equivalent to a singe horizontally and vertically integrated monopoly.

5.1.5 Scenario Five: No Foreign Manufacturers Collude

Suppose no foreign manufacturers tacitly collude. The manufacturer ownership matrix would be the identity matrix except where two products were produced by the same company. The higher price-cost margins of imported brands relative to domestic brands would be explained by greater product differentiation of the former.

5.2 Stackelberg-Nash Scenarios

5.2.1 Scenario Six: Stackelberg Manufacturers, Competitive Retailers

Manufacturers would act as Stackelberg leaders in the sense that they would set their prices first after which retailers would choose their prices. The interesting question in this scenario is how manufacturer pass-through behavior changes given a competitor facing a perfectly competitive market, that is, with price equal to marginal cost.

5.2.2 Scenario Seven: Stackelberg Retailers, Competitive Manufacturers

A Stackelberg retailer sets prices first in this scenario followed by the manufacturer.

5.3 Efficient Vertical Contracts

5.3.1 Scenario Eight: Efficient Vertical Pricing

Manufacturers and retailers would behave as if they were maximizing profits for one firm. Both ownership matrices would be all ones. Given the data on the beer market, this scenario is observationally equivalent to the fourth scenario. A dataset with more than one retailer would allow for tests about both the vertical and the horizontal integration affect passthrough behavior.

5.3.2 Scenario Nine: Competitive Retailer, Competitive Manufacturers

Manufacturers and retailers immediately and fully pass-through all exchange-rate-induced marginal-cost changes to prices. As this model clearly leads to full pass-through, I do not test it empirically.

6 Market and Data

In this section I first discuss the imported beer market in the United States. Second, I describe my data for this market. I have an unusually rich scanner data set with weekly retail and wholesale prices for each product sold over six years for a large supermarket chain.

6.1 Imported Beer Market

Beer imports to the United States go back at least to the late nineteenth century. The Netherlands started exporting Heineken Beer to the U.S. market in 1894. Following Prohibition, the invention of the metal beverage can in 1935 allowed brewers to build national brands without bearing the high fixed costs of maintaining local centers to collect deposit-return glass bottles. By 1970, imported beers made up under one percent of the total U.S. consumption of beer. 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.

Beer exemplifies one type of imported good: packaged goods imported for consumption. Such imports do not pass through any further production process before reaching consumers. Beer imports to supermarkets do not pass through independent wholesale distributors, as do those imports going to convenience stores or specialty liquor stores. This makes analysis of the distribution chain relatively simple for this industry. Manufacturers ship beer directly to supermarket chains who serve as their own distributors — building shelf displays, rotating products, and the like.

Supermarkets account for 60 percent of all beer purchased for home consumption. Consumers purchase 20 percent at convenience stores or gas stations and another 17 percent at specialty retailers. As my data consider only one metropolitan statistical area, there is no variation in the regulations on alcohol retailing. Such regulations differ considerably across states.

During the 1990s supermarkets increased the selection of beers they offered as well as the total shelf space devoted to beer. A recent A.C. Nielsen study shows that beer is the tenth most frequently purchased item and the seventh most profitable item for the average U.S. supermarket. Storage costs are low, as the product is often shipped directly to the retail store (as opposed to the chain's central distribution center).

6.2 Dominick's Finer Foods

Dominick's Finer Foods was the second-largest supermarket in the Chicago metropolitan area in the mid 1990s. They had over 100 stores and a market share of roughly 25 percent. As I only include stores that report prices for the full sample period, my data contain about half the stores. The data go for 217 weeks from the week of June 6, 1991 until the week of May 1, 1995. The data include unit sales, retail price, profit margin (over the wholesale price), and a deal code. I also have information on total sales and customer demographics by store. I collect monthly manufacturers' cost data from U.S. and foreign government agencies, including malting barley prices, average weekly labor costs, electricity costs, and the like. The main sources for my manufacturer cost data are Eurostat, Statistics Canada, and the U.S. Department of Agriculture.

One can invert the data on profit per dollar of revenue to calculate Dominick's wholesale costs. The wholesale price series is a moving average of the amount paid by Dominick's for their entire inventory – It gives the average acquisition cost (AAC) for each item in current inventory. Retail prices are set once a week: the average acquisition cost is calculated at the same time according to the formula:

$$\text{AAC}_{t+1}\text{=(New Inventory}_t\text{)*(Wholesale Price}_t\text{)} + \text{(Final Inventory}_{t-1}\text{)*AAC}_t$$

This is not exactly equal to the marginal cost of each item, that is, the replacement cost, and could introduce distortions into the model. Dominick's may purchase more from manufacturers during trade deals, for example. This would result in a lower average acquisition cost relative to replacement cost for the weeks that followed: the wholesale price reported by Dominick's would be lower than the true wholesale price. As supermarkets regard beer as a product with a limited shelf life, this distortion poses less of a problem than for products without expiration dates.

Promotions occur infrequently in the Dominick's data. I find no coupon promotions and some sales. The effects of sales are apparent in the price-quantity data. I report summary statistics for the Dominick's data in Tables 1 and 2. Most of the variation in prices is across brands or time. There is little variation across stores, justifying aggregating across stores in my logit model. Products in the full sample exhibit considerable variation in the markup over wholesale prices by Dominick's, as well as in the correlation between the wholesale and the retail price over time. A comparison of the Dominick's data with data for national imports of beer, as reported in Table 1, shows that each country's market share in the Dominick's data is roughly comparable to its national import share.

7 Results

This section describes exchange-rate pass-through results from both the reduced form and the logit model. As illustrated in Tables 6a and 6b, reduced-form pass-through coefficients are generally low and insignificant. The coefficients on marginal cost and the exchange rates are very close in most of the regressions, justifying interacting the two in my structural model. The coefficients' magnitudes may rise once marginal cost and the exchange rate are interacted. Most notably, they become significant consistently only in this specification.

The remaining tables report results from the logit model. The logit model has two drawbacks compared to the more flexible mixed logit. First, it calculates margins as a negative function of price. A product with a high price will have a lower margin, all else equal, than will a product with a low price. Second, cross-price elasticities depend on the market share of each good, not their distance from one another in characteristics space. Two products with very different characteristics, say Bass Ale and Sapporo, may have similar market shares. This will mean that they will have higher cross-price substitution elasticities than will Kirin (another Japanese brand) and Sapporo if Kirin has a much smaller market share than does Sapporo, an unlikely result.

7.1 Retail Estimates of Marginal Cost

The problems with the logit demand estimation result in unrealistically high margins for those brands with low average prices, such as Stroh's, Milwaukee's Best, or Old Milwaukee, as illustrated in the final two columns of Table 7. Table 8 reports that the estimates of retail marginal cost are generally much lower than the wholesale prices for many cheap American brands. Imported brands' estimated marginal costs are generally higher than or roughly equal to their wholesale prices. As most imported brands have higher than average prices, the logit demand system returns unrealistically low margins for them. The marginal costs of those imported brands with average prices, such as amstel or molson golden, fall below their average wholesale prices, like average-price domestic brands.

7.2 Wholesale Estimates of Marginal Cost

Table 9 reports wholesale marginal costs derived under the assumption that each firm considers all the brands in its portfolio when setting prices. Again, the wholesale margins of those products with low wholesale prices are unrealistically high, in particular, those of Stroh's, Old Milwaukee, the Old Style brands, and the Milwaukee's Best brands. Like the retail estimates, the estimated wholesale margins for imported brands on average seem too small, while those for domestic brands seem too high.

Table 4 sets out the median and mean own-price brand elasticities from the logit demand. In the mixed-logit estimation, I expect the elasticities of imported brands to fall in absolute terms relative to those in Table 3. The elasticities of domestic firms should rise in absolute terms relative to those in Table 4. Column 3 of Table 4 compares my own-price elasticity estimates to those from a paper by Hausman, Leonard, and Zona (1994) also on the beer market. I expect my mixed-logit own-price elasticity estimates will be lower for costly beers and higher for cheap beers, as they find.

7.3 Counterfactual Experiments

In this section, I illustrate the type of counterfactual experiments that can be conducted with this model. I use the model to explore the effect on pass-through of various strategic interactions between first, two Dutch brewers (with brands Heineken, Amstel, and Grolsch), and second, all European brewers in my sample. From 1991 to 1997, one firm owned the Heineken and Amstel brands while a second independent firm owned the Grolsch brand. A 20 percent appreciation in the (then) guilder against the dollar (equivalent to a 20 percent depreciation of the dollar against the (then) guilder) leads to somewhat different pass-through patterns across the three brands.

As illustrated in Table 10a, Grolsch and Heineken brands pass-through more of the marginal-cost change to their wholesale prices, at 82.28 percent and 79 percent, respectively, than does Amstel, at 61 percent. Amstel's margin shrinks by less, however, at -11.03 percent, relative to -14.11 percent for Grolsch and -13.54 percent for Heineken. Table 10b reports how this cost increase is passed through further down the distribution chain. All three brands do not fully pass-through the cost increase in wholesale prices to retail prices in the short run. Amstel again has the lowest pass-through, at 45.34 percent, Grolsch is now 67.23 percent, and Heineken is 63.06 percent. These numbers appear similar to the 50 percent average passthrough across industries reported by Goldberg and Knetter (1997).

Tables 11, 12, and 13 consider the impact on prices and pass-through of a change in strategic interaction between the two Dutch firms. The two firms now tacitly collude following an exchange-rate fluctuation. As one can see in Table 11, this has little direct impact on prices, though the margin of the formerly independent brand, Grolsch, rises by almost one percent. Table 12 considers the effect of a 20 percent exchange rate depreciation on prices given the tacit collusion now between the Dutch firms. Pass-through rises by 1.5 percent for Amstel, by 1.12 percent for Grolsch, and by .19 percent for Heineken relative to the pass-through in the no-collusion scenario. Pass-through rises by almost the exact same amounts at the retail level for the three brands. Table 13 also illustrates that margins shrink at the retail stage following an exchange-rate fluctuation. Amstel shrinks by the least, at -9.13 percent, while Grolsch and Heineken shrink by -12.62 percent and -11.90 percent respectively.

It is notable that for each brand the profit margin of the retailer shrinks by less than that of the wholesaler. This may be because the wholesaler has a larger markup (certainly that is what this version of the model finds) than does the retailer, and wants to avoid further reduction of the margins of the supermarket, perhaps because of a long-term contract with the supermarket, or a desire to ensure the supermarket will be in business in the future.

A second experiment tests how pass-through coefficients respond to European firms tacitly colluding following an exchange rate depreciation. As illustrated in Tables 14 on, this change in firm conduct generally raises firms' margins. Margins shrink following an exchange-rate depreciation by more at the wholesale than the retail level. Unlike in the case of Dutch collusion, however, pass-through actually falls after firms begin to tacitly collude.

8 Future Work

In future work, I plan to test the welfare effects of these pass-through patterns on foreign and domestic consumers.

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Table 1. Dominick's Market Shares Compared with U.S. Market Shares

Country	Dominick's	U.S. Imports
Canada	15.2%	27.6%
Germany	23.2%	9.5%
Ireland	4.5%	3.3%
Italy	14.4%	0.3%
Japan	0.6%	1.5%
Mexico	15.1%	19.1%
Netherlands	24.8%	28.8%
United Kingdom	2.2%	4.8%
Total	100%	94.8%

Source: Brewer's Almanac and Dominick's Data.

Table 2a. Summary of Brand Characteristics in the Full Sample

	Median	Mean	Std	Min	Max
Calories	147.4	147.9	17.9	96	181.7
% Alcohol	5.13	5.18	.76	3.96	6.85

Prices per serving. One serving is 12 ounces.

Table 2b. Information about Prices in the Dominick's Sample

	Retail		Wholesale		Both
	Mean	Std	Mean	Std	Correlation
Bud Light	.59	.09	.49	.04	.61
Budweiser	.58	.09	.49	.04	.72
Busch Light	.54	.13	.43	.08	.93
Busch	.54	.14	.41	.08	.92
Coors Light	.58	.08	.49	.03	.45
Coors	.55	.09	.48	.04	.37
Michelob	.56	.08	.47	.02	.43
Michelob Light	.63	.07	.51	.03	.46
Milwaukee's Best Light	.46	.14	.37	.11	.96
Milwaukee's Best	.42	.13	.33	.11	.92
Miller Genuine Draft	.57	.08	.48	.04	.55
Miller High Life	.57	.10	.48	.06	.72
Miller Lite	.61	.10	.49	.04	.65
Old Milwaukee	.37	.08	.30	.05	.80
Old Style Classic	.53	.10	.47	.07	.62
Old Style	.59	.09	.48	.06	.55
Rolling Rock	.69	.07	.58	.02	.37
Special Export	.63	.06	.52	.02	.26
Stroh's	.46	.07	.38	.04	.75

Prices per serving. One serving is 12 ounces.

Table 2c. Information about Prices in the Dominick's Sample

	Retail Mean	Std	Wholesale Mean	Std	Both Correlation
Canada					
Foster's	1.06	.10	.81	.04	.25
Molson Golden	.84	.13	.72	.04	.47
Molson Light	.83	.12	.72	.04	.53
Moosehead Beer	.76	.07	.66	.00	-.11
Moosehead Ice	.92	.14	.77	.08	.76
Germany					
Beck's	1.01	.14	.85	.07	-.07
St. Pauli Girl	1.07	.24	.82	.20	.89
Ireland					
Guinness	1.25	.20	1.01	.12	.73
Harp	1.17	.15	.95	.03	.70
Italy					
Peroni	.97	.11	.81	.03	.25
Japan					
Sapporo	1.05	.12	.79	.04	.51
Mexico					
Corona	.97	.11	.81	.03	.25
Tecate	.90	.12	.71	.09	.47
Netherlands					
Amstel Light	1.03	.11	.89	.03	.41
Grolsch	1.16	.19	.79	.09	.77
Heineken	1.05	.11	.87	.05	.24
United Kingdom					
Bass	1.23	.16	1.00	.05	.56

Prices per serving. One serving is 12 ounces.

Table 3. Aggregation for Final Sample of Beer Products

Aggregation	**Number of Products**
Original Price and Volume Sales Data (Univeristy of Chicago Business School) p1=price in cents per unit by product defined by UPC q1=units sold for each product defined as UPC in different sizes (1 unit is a 12 oz beer can or bottle)	97
1. Define price per ounce and units sold in ounces p2=p1/size1 is price per ounce q2=q1*size1 is quantity of total ounces sold	
2. If same product in different sizes (with different UPC) aggregate Let n be the number of UPCs corresponding to the same product j. Let $size_j$ j=1,2,…,n be the sizes of the n UPCs. $p3=\sum_j (p2_j\, size_j) / \sum_j (size_j)$ $q3=\sum_j (q2_j)$	36
4. In terms of servings (1 serving=12 oz)	
5. Keep products in full sample	31

Table 4. Own-Price Demand Elasticities

	median elasticity	mean elasticity	hausman elasticity
amstel	-3.76	-3.77	
bass	-4.71	-4.66	
beck's	-4.25	-4.30	
bud	-2.75	-2.80	-4.20
bud light	-2.85	-2.88	
busch	-2.66	-2.63	-6.05
busch light	-2.61	-2.62	
coors	-2.78	-2.87	-4.90
coors light	-2.81	-2.84	-4.60
corona	-4.23	-4.25	
fosters	-4.56	-4.49	
grolsch	-5.46	-5.33	
guinness	-5.31	-5.29	
harp	-5.59	-5.53	
heineken	-4.96	-4.88	
michelob	-3.29	-3.27	
miller genuine draft	-2.70	-2.71	-4.45
miller high life	-2.77	-2.79	
miller lite	-2.72	-2.73	
milwaukee's best	-2.50	-2.49	-6.21
milwaukees best light	-2.61	-2.66	
molson golden	-3.16	-3.18	
old milwaukee	-1.98	-1.96	-5.28
old style	-2.68	-2.66	
old style classic	-2.49	-2.48	
peroni	-3.88	-3.86	
rolling rock	-3.52	-3.53	
sapporo	-3.77	-3.78	
special export	-3.24	-3.20	
st pauli girl	-3.44	-3.52	
stroh's	-2.24	-2.24	
all brands	-3.10	-3.43	

Table 5. Results from Logit Demand

Variable	OLS	IV
Price	-3.67	-5.22
	(.11)	(.39)
R^2	.99	–
1st-Stage R^2	–	.99
1st-Stage F-test	–	39.82
		$p > F$ = 0.00
Hausman Exogeneity Test	–	415
		$p > \chi^2$ = 0.00
	–	

Items in parentheses are robust standard errors. Data contain 6727 observations.

Table 6a. Pass-Through Coefficients for Beck's Beer

Variable	Retail Price OLS	OLS	IV	IV	Wholesale Price OLS	OLS	IV	IV	Retail Price
Constant	-3.83	-1.52	-19.78	-1.66	-.84	-.34	-1.45	-1.35	.10
	(4.67)	(.62)	(14.29)	(1.37)	(6.29)	(.26)	(6.79)	(.68)	(.03)
Competing Price	.19	.21	.16	.11	-.06	.10	-.10	-.07	
	(.11)	(.09)	(.19)	(.23)	(.08)	(.04)	(.15)	(.14)	
Marginal Cost	.87		4.26		.17		.30		1.09*
	(1.00)		(3.04)		(1.34)		(1.45)		(.18)
Exchange Rate	.33		-.45		.20		.24		
	(.20)		(.75)		(.33)		(.34)		
Interaction		.37		.40		.06		.29	
		(.14)		(.32)		(.05)		(.15)	

72 monthly observations. *Wholesale price is marginal cost in this column. Standard errors in parentheses.

Table 6b. Pass-Through Coefficients for Bass Ale

	Retail Price				Wholesale Price				Retail Price
Variable	OLS	OLS	IV	IV	OLS	OLS	IV	IV	
Constant	-2.30	-1.26	-5.82	-2.52	-1.88	-1.26	-3.87	-3.51	.17
	(1.28)	(.88)	(3.39)	(8.43)	(.65)	(.43)	(2.11)	(12.53)	(.01)
Competing Price	.18	.16	.16	-.27	-.01	-.001	-.13	-.30	
	(.09)	(.10)	(.18)	(3.45)	(.05)	(.05)	(.13)	(3.05)	
Marginal Cost	.57		1.49		.41		.79		1.11*
	(.30)		(.90)		(.15)		(.53)		(.30)
Exchange Rate	-.22		-1.76		-.03		.02		
	(.50)		(1.99)		(.33)		(1.06)		
Interaction		.29		.54		.25		.68	
		(.17)		(1.61)		(.08)		(2.32)	

72 monthly observations; 3 month lags. *Wholesale price is marginal cost in this column. Standard errors in parentheses.

Table 7. Derived Estimates of Marginal Cost for the Retailer

	median marginal cost	mean marginal cost	median markup	mean markup	median margin	mean margin
amstel	52.76	53.06	19.15	19.15	26.63	27.11
bass	70.94	70.02	19.14	19.15	21.25	22.25
beck's	62.22	63.27	19.15	19.15	23.53	23.50
bud	33.55	34.43	19.15	19.15	36.33	36.03
bud light	35.47	36.01	19.15	19.15	35.06	34.98
busch	31.78	31.28	19.15	19.15	37.60	38.57
busch light	30.76	30.94	19.15	19.15	38.37	38.98
coors	34.12	35.78	19.14	19.14	35.94	35.62
coors light	34.66	35.14	19.15	19.15	35.59	35.71
corona	61.81	62.17	19.15	19.15	23.65	23.79
fosters	68.20	66.86	19.14	19.15	21.92	22.86
grolsch	85.38	82.98	19.14	19.14	18.32	19.29
guinness	82.46	82.04	19.15	19.15	18.84	19.13
harp	87.81	86.71	19.14	19.14	17.90	18.26
heineken	75.77	74.27	19.15	19.15	20.17	20.66
michelob	43.75	43.46	19.15	19.15	30.44	30.91
miller genuine draft	32.65	32.75	19.16	19.16	36.98	37.09
miller high life	33.87	34.24	19.15	19.15	36.12	36.16
miller lite	33.01	33.22	19.15	19.15	36.72	36.79
milwaukee's best	28.68	28.50	19.15	19.15	40.03	41.46
milwaukees best light	30.89	31.84	19.15	19.15	38.26	38.18
molson golden	41.40	41.81	19.15	19.15	31.62	32.08
old milwaukee	18.83	18.37	19.15	19.15	50.42	51.72
old style	32.14	31.78	19.15	19.15	37.33	38.16
old style classic	28.47	28.28	19.15	19.15	40.22	40.85
peroni	55.19	54.72	19.15	19.15	25.76	26.49
rolling rock	48.24	48.36	19.15	19.15	28.41	28.91
sapporo	52.94	53.20	19.14	19.14	26.56	27.28
special export	42.79	42.16	19.15	19.15	30.92	31.54
st pauli girl	46.66	48.14	19.14	19.14	29.09	29.13
stroh's	23.74	23.83	19.15	19.15	44.66	44.88

Prices are in cents per serving.

Table 8. Comparison of Original Wholesale Prices and Derived Marginal Costs Faced by the Retailer

	median marginal cost	median wholesale price	mean marginal cost	mean wholesale price
amstel	52.76	61.52	53.06	63.00
bass	70.94	79.27	70.02	77.00
beck's	62.22	75.39	63.27	74.00
bud	33.55	48.33	34.43	49.00
bud light	35.47	48.65	36.01	49.00
busch	31.78	43.40	31.28	43.00
busch light	30.76	43.34	30.94	44.00
coors	34.12	49.73	35.78	50.00
coors light	34.66	49.89	35.14	50.00
corona	61.81	71.56	62.17	71.00
fosters	68.20	72.87	66.86	71.00
grolsch	85.38	79.61	82.98	79.00
guinness	82.46	86.79	82.04	86.00
harp	87.81	89.24	86.71	89.00
heineken	75.77	80.78	74.27	80.00
michelob	43.75	51.86	43.46	53.00
miller genuine draft	32.65	47.16	32.75	47.00
miller high life	33.87	47.43	34.24	48.00
miller lite	33.01	47.43	33.22	48.00
milwaukee's best	28.68	41.12	28.50	40.00
milwaukees best light	30.89	43.00	31.84	43.00
molson golden	41.40	53.55	41.81	54.00
old milwaukee	18.83	32.60	18.37	33.00
old style	32.14	47.29	31.78	47.00
old style classic	28.47	47.18	28.28	46.00
peroni	55.19	65.23	54.72	65.00
rolling rock	48.24	58.55	48.36	58.00
sapporo	52.94	60.57	53.20	61.00
special export	42.79	53.63	42.16	54.00
st pauli girl	46.66	55.01	48.14	55.00
stroh's	23.74	36.05	23.83	37.00

Prices are in cents per serving.

Table 9. Derived Estimates of Marginal Cost for Manufacturers, Actual Ownership Structure

	median marginal cost	mean marginal cost	median markup	mean markup	median margin	mean margin
amstel	38.14	38.85	23.46	23.89	38.01	39.76
bass	60.74	57.77	18.40	19.27	23.32	26.84
beck's	54.70	52.81	21.49	21.47	27.95	29.47
bud	15.17	15.94	33.10	32.82	68.45	67.87
bud light	16.58	17.65	31.76	31.68	65.75	64.87
busch	11.59	10.58	31.68	32.50	73.27	76.91
busch light	10.27	9.82	33.13	33.65	76.18	79.63
coors	16.25	17.45	33.13	32.83	67.15	67.31
coors light	16.65	16.79	33.04	33.15	66.68	67.51
corona	51.20	49.93	20.71	20.83	28.78	29.86
fosters	55.11	52.71	17.86	18.62	24.33	27.29
grolsch	65.40	63.83	14.20	14.96	17.83	19.90
guinness	70.92	69.43	16.01	16.25	18.21	19.26
harp	74.52	73.36	15.03	15.33	16.76	17.51
heineken	63.05	62.51	17.45	17.87	21.71	22.37
michelob	25.60	26.39	25.84	26.23	50.11	50.50
miller genuine draft	13.08	13.08	34.13	34.24	72.19	72.82
miller high life	14.83	15.17	32.52	32.54	68.53	68.66
miller lite	13.97	14.02	33.53	33.58	70.47	70.96
milwaukee's best	5.46	3.53	35.63	36.89	86.57	97.85
milwaukees best light	9.83	9.43	33.17	33.11	77.13	80.34
molson golden	24.70	24.51	28.91	29.33	53.98	56.30
old milwaukee	-13.52	-14.31	46.04	47.20	141.72	146.82
old style	11.09	10.33	35.63	36.40	76.54	79.13
old style classic	3.74	3.04	42.42	43.08	92.13	94.58
peroni	43.10	41.77	22.70	23.34	34.48	36.95
rolling rock	34.14	33.51	24.47	24.90	41.86	43.57
sapporo	38.86	37.98	22.08	22.68	35.93	39.15
special export	26.74	26.26	26.65	27.19	49.85	51.18
st pauli girl	31.24	31.25	23.74	23.77	43.53	44.79
stroh's	-2.48	-2.06	38.90	39.11	107.01	106.66

Prices are in cents per serving.

Table 10a. Impact of a 20% Exchange-Rate Depreciation on Wholesale Margins of Dutch Beers

Brand	New Median Wholesale Price	Old Median Wholesale Price	Percent Change	Pass-Through
Amstel	69.12	61.52	12.36%	61.80%
Grolsch	92.71	79.61	16.46%	82.28%
Heineken	93.54	80.78	15.80%	79.00%
	New Mean Wholesale Price	Old Mean Wholesale Price	Percent Change	Pass-Through
Amstel	70.51	63.00	11.92%	59.59%
Grolsch	91.56	79.00	15.90%	79.48%
Heineken	92.88	80.00	16.10%	80.49%
	New Median Wholesale Margin	Old Median Wholesale Margin	Percent Change	Sign of Change
Amstel	33.82%	38.01%	-11.03%	-
Grolsch	15.32%	17.83%	-14.11%	-
Heineken	18.77%	21.71%	-13.54%	-

Prices are in cents per serving.

Table 10b. Impact of a 20% Exchange-Rate Depreciation on Retail Margins for Dutch Beers

Brand	New Median Retail Price	Old Median Retail Price	Percent Change	Pass-Through
Amstel	78.42	71.90	9.07%	45.34%
Grolsch	118.57	104.52	13.45%	67.23%
Heineken	106.89	94.91	12.61%	63.06%
	New Mean Retail Price	Old Mean Retail Price	Percent Change	Pass-Through
Amstel	78.77	72.21	9.08%	45.41%
Grolsch	115.78	102.12	13.37%	66.87%
Heineken	105.15	93.42	12.56%	62.81%
	New Median Retail Margin	Old Median Retail Margin	Percent Change	Sign of Change
Amstel	24.42%	26.63%	-8.30%	-
Grolsch	16.14%	18.32%	-11.90%	-
Heineken	17.92%	20.17%	-11.16%	-

Prices are in cents per serving.

Table 11. Impact of Collusion Between Dutch Brewers on Wholesale Margins

Brand	New Median Wholesale Price	Old Median Wholesale Price	Percent Change	
Amstel	61.63	61.52	.18%	
Grolsch	79.74	79.60	.18%	
Heineken	80.81	80.78	.04%	
	New Mean Wholesale Price	Old Mean Wholesale Price	Percent Change	
Amstel	62.85	62.74	.18%	
Grolsch	78.94	78.79	.19%	
Heineken	80.41	80.38	.04%	
	New Median Wholesale Margin	Old Median Wholesale Margin	Percent Change	Sign of Change
Amstel	38.12%	38.01%	.29%	+
Grolsch	17.98%	17.89%	.85%	+
Heineken	21.74%	21.71%	.14%	+

Prices are in cents per serving.

Table 12. Impact of Collusion Between Dutch Brewers on Wholesale Pass-Through

Brand	New Median Wholesale Price	Old Median Wholesale Price	Percent Change	Sign of Change from Tacit Collusion
Amstel	69.25	69.12	.18%	+
Grolsch	92.86	92.71	.16%	+
Heineken	93.57	93.54	.03%	+
	Passthrough	Percent Change in Passthrough	Percent Change in Markup	Sign of Change from Tacit Collusion
Amstel	62.70%	1.44%	1.48%	+
Grolsch	83.20%	1.12%	.99%	+
Heineken	79.15%	.19%	.20%	+
	New Median Wholesale Margin	Old Median Wholesale Margin	Percent Change	Sign of Change from Tacit Collusion
Amstel	33.92%	33.82%	.31%	+
Grolsch	15.45%	15.32%	.87%	+
Heineken	18.80%	18.77%	.14%	+

Prices are in cents per serving.

Table 13. Impact of Collusion Between Dutch Brewers on Retail Pass-Through

Brand	New Median Retail Price	Old Median Retail Price	Percent Change	Sign of Change from Tacit Collusion
Amstel	78.52	78.42	.13%	+
Grolsch	118.71	118.57	.12%	+
Heineken	106.91	106.89	.002%	+
	Pass-Through	Percent Change in Pass-Through	Percent Change in Markup	Sign of Change from Tacit Collusion
Amstel	46.00%	1.46%	1.48%	+
Grolsch	67.88%	.97%	.99%	+
Heineken	63.18%	.20%	.20%	+
	New Median Retail Margin	Old Median Retail Margin	Percent Change	Sign of Change from Tacit Collusion
Amstel	24.20%	24.42%	-.91%	-
Grolsch	16.01%	16.14%	-.81%	-
Heineken	17.77%	17.92%	-.84%	-

Prices are in cents per serving.

Table 14a. Impact of a 20% Exchange-Rate Depreciation on Wholesale Margins of European Beers

Brand	New Median Wholesale Price	Old Median Wholesale Price	Percent Change	Pass-Through	New Median Margin	Old Median Margin	Percent Change	Sign of Change
Amstel	69.12	61.52	12.37%	61.83%	33.82%	38.01%	-11.03%	-
Bass	91.29	79.27	15.18%	75.88%	20.22%	23.32%	-13.30%	-
Becks	86.26	75.39	14.43%	72.13%	24.43%	27.95%	-12.60%	-
Grolsch	92.71	79.60	16.46%	82.32%	15.32%	17.83%	-14.11%	-
Guinness	100.82	86.97	16.17%	80.84%	15.65%	18.21%	-14.06%	-
Harp	104.18	89.24	16.74%	83.69%	14.37%	16.76%	-14.27%	-
Heineken	93.54	80.78	15.80%	78.98%	18.77%	21.71%	-13.54%	-
Peroni	73.90	65.23	13.29%	66.45%	30.48%	34.48%	-11.59%	-
St. Pauli Girl	61.32	55.01	11.47%	57.37%	39.11%	43.53%	-10.15%	-

Prices are in cents per serving.

Table 14b. Impact of a 20% Exchange-Rate Depreciation on Retail Margins for European Beers

Brand	New Median Retail Price	Old Median Retail Price	Percent Change	Pass-Through	New Median Margin	Old Median Margin	Percent Change	Sign of Change
Amstel	78.43	71.90	9.08%	45.38%	24.41%	26.63%	-8.32%	-
Bass	100.85	90.08	11.95%	59.77%	18.98%	21.25%	-10.68%	-
Becks	90.35	81.37	11.03%	55.17%	21.19%	23.53%	-9.94%	-
Grolsch	118.57	104.52	13.45%	67.23%	16.15%	18.32%	-11.85%	-
Guinness	114.94	101.60	13.12%	65.62%	16.66%	18.84%	-11.60%	-
Harp	121.17	106.96	13.74%	68.72%	15.74%	17.90%	-12.08%	-
Heineken	106.89	94.91	12.61%	63.06%	17.92%	20.17%	-11.20%	-
Peroni	81.67	74.33	9.87%	49.33%	23.45%	25.76%	-8.98%	-
St. Pauli Girl	71.15	65.80	8.13%	40.66%	26.91%	29.09%	-7.52%	-

Prices are in cents per serving.

Table 15. Impact of Collusion Between European Brewers on Wholesale Margins

Brand	New Median Wholesale Price	Old Median Wholesale Price	Percent Change	New Median Margin	Old Median Margin	Percent Change	Sign of Change
Amstel	62.46	61.52	1.52%	39.53%	38.01%	4.00%	+
Bass	79.53	79.27	.34%	23.64%	23.32%	1.35%	+
Becks	77.06	75.39	2.21%	30.14%	27.95%	7.84%	+
Grolsch	80.17	79.60	.76%	18.54%	17.83%	3.98%	+
Guinness	87.01	86.97	.27%	18.46%	18.21%	1.37%	+
Harp	89.39	89.24	.15%	16.89%	16.76%	.78%	+
Heineken	81.04	80.78	.31%	22.05%	21.71%	1.53%	+
Peroni	65.21	65.23	-.04%	34.44%	34.48%	-.12%	-
St. Pauli Girl	54.81	55.01	-.36%	43.19%	43.53%	-.78%	-

Prices are in cents per serving.

Table 16. Impact of Collusion Between European Brewers on Wholesale Pass-Through

Brand	No Collusion Pass-Through	Temp Collusion Pass-Through	Percent Change	Full Collusion Pass-Through	Percent Change	No Collusion Median Margin	Full Collusion Median Margin	Percent Change	Sign of Change
Amstel	61.83%	69.92%	12.60%	61.07%	-1.23%	33.82%	34.69%	2.60%	+
Bass	75.88%	77.52%	2.17%	75.63%	-.33%	20.22%	20.44%	1.08%	+
Becks	72.13%	83.01%	15.09%	70.39%	-2.42%	24.43%	25.86%	5.82%	+
Grolsch	82.32%	85.87%	4.32%	81.72%	-.72%	15.32%	15.83%	3.35%	+
Guinness	80.84%	82.31%	1.81%	80.80%	-.06%	15.65%	15.83%	1.15%	+
Harp	83.69%	84.36%	.80%	83.39%	-.36%	14.37%	14.47%	.67%	+
Heineken	78.98%	80.57%	2.01%	78.76%	-.27%	18.77%	19.01%	1.24%	+
Peroni	66.45%	66.50%	.07%	66.74%	.42%	30.48%	30.46%	-.08%	-
St. Pauli	57.37%	55.73%	-2.86%	57.72%	.61%	39.11%	38.92%	-.48%	-

Prices are in cents per serving.

Table 17. Impact of Collusion Between European Brewers on Retail Pass-Through

Brand	No Collusion Pass-Through	Temp Collusion Pass-Through	Percent Change	Full Collusion Pass-Through	Percent Change	No Collusion Median Margin	Full Collusion Median Margin	Percent Change	Sign of Change
Amstel	45.38%	39.91%	-12.05%	32.62%	-28.12%	24.41%	24.66%	1.01%	+
Bass	59.77%	51.74%	-13.44%	50.14%	-16.11%	18.98%	19.26%	1.46%	+
Becks	55.17%	47.18%	-14.48%	37.14%	-32.69%	21.19%	21.50%	1.46%	+
Grolsch	67.23%	57.38%	-14.64%	54.00%	-19.67%	16.15%	16.43%	1.77%	+
Guinness	65.62%	56.44%	-13.98%	55.06%	-16.09%	16.66%	16.93%	1.65%	+
Harp	68.72%	58.66%	-14.64%	58.05%	-15.53%	15.74%	16.02%	1.80%	+
Heineken	63.06%	54.32%	-13.68%	52.83%	-16.23%	17.92%	18.20%	1.58%	+
Peroni	49.33%	43.73%	-11.36%	43.67%	-11.47%	23.45%	23.69%	1.03%	+
St. Pauli	40.66%	36.69%	-9.76%	38.31%	-5.79%	26.91%	27.11%	.74%	+

Prices are in cents per serving.