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**Measuring Effects of Domestic Market Structure
on Trade Performance:
An Application of Error Correction Model
to the U. S. Beer Industry**

by

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Introduction

Domestic industry structure has been recognized by several scholars as an important determinant of international competitiveness (Zysman and Tyson 1983, Porter 1990, Adams and Brock 1988, White 1974). While some scholars and businessmen assert bigness and corporate consolidation is an essential prerequisite for global competitiveness, Porter regards "firm rivalry" in its home markets as the most important determinant of success in global markets. In addition to these practical debates, White demonstrated theoretically that market structure could indeed influence trade flows.

Based on this conceptual reasoning, several empirical studies have included market structure variables as major explanatory variables when explaining a country's trade flows. In most cases, either exports or imports have been regressed on variables representing industry concentration, product differentiation, and scale economies along with other traditional variables (Baldwin 1971, Pagoulatos and Sorenson 1976, Koo and Martin 1984, Glejser et al. 1980, Lyons 1989, and Henderson and Stuart 1990). These cross sectional analyses, however, do not control for the influence of industry specific factors. An analysis of data from one industry may provide a better understanding of the relationship between domestic market structure and performance in global markets.

This paper tests Porter's hypothesis using time series techniques. Data were developed for the U.S. beer industry in which seller concentration has increased sharply since 1967. Econometric analysis is based upon time series data for the period 1962-1990.

The Impact of Domestic Competition on Global Performance

Domestic competition is often cited as an important influence on the success of firms or industries in global markets. Some researchers and business executives have asserted that U.S. antitrust policy hampers the competitiveness of U.S. firms in international markets. Antitrust regulations in the U.S. are regarded as a major hinderance for U.S. firms trying to rationalize their production facilities and to cooperate in R & D (Zysman and Tyson, 1983; Baldrige, 1986). Devotees of this point of view emphasize "the reality of global competition and global market definitions" and "the potential efficiency gains from business combinations" (The President's Commission on Industrial Competitiveness, 1985: 192). In fact, they strongly recommend that U.S. antitrust law should recognize the potential efficiency gains from mergers. Corporate consolidation and bigness is believed to be an essential prerequisite for global competitiveness (Adams and Brock, 1988: 3).

A contrasting point of view contends that the lack of effective domestic competition in some industries has resulted in bloated costs, few innovations and non-responsiveness to customer preferences which has made the industries vulnerable to the market penetration of foreign firms (Marion, 1992: 46). The U.S. auto and steel industries are good examples. Adams and Brock (1988), after examining firms and competition policies in Europe and Japan, concluded that "merger-induced corporate giantism is not likely the key to promoting operating efficiency, technological innovation, and international competitiveness" (p. 45).

Emphasizing the "creation" of factor advantages rather than static factor endowments, Porter (1990) regards "firm rivalry" in a nation as the most important determinant of success

in global markets. The presence of strong local rivals is arguably a "final and powerful stimulus to the creation and persistence of competitive advantage" (p. 82). In Porter's view, domestic competition is believed to be qualitatively different from competition with foreign firms. Local competition facilitates information feedback and creates visible pressure on competitors. The lack of local rivalry is therefore more likely to lead to inefficient use of resources and lower incentives to engage in R & D activities.

Thus, we are faced with two competing hypotheses explaining the effect of domestic market structure on global performance. The first is the proposition that sustained domestic competition is necessary for improving the performance of a nation's firms and industries in global markets. The second is that global performance can be enhanced by the efficiency of large firms, often formed through firm consolidations and by lax antitrust policy. Debates on the appropriate nature of domestic competition policy often focus on these hypotheses. In the end, empirical analysis is needed to determine whether domestic competition has an important influence on global performance.

Structural Changes in U.S. Beer Industry

In the U.S. beer industry, an increase in industry concentration was associated with the decrease in total number of breweries until 1982. According to the Census of Manufactures, the total number of plants in SIC 2082 (Malt Beverages) was 222 in 1963 and 109 in 1982. The number of independent companies also declined from 171 to 67 during the same period. The trend, however, was reversed in the 1980s. The number of companies more than doubled to 160 by 1992 (Table 1). This sharp change was largely driven by the emergence of microbreweries which serve a special market niche for high quality beer. While there were

Table 1. The Numbers of Companies and Plants in SIC 2082, Malt Beverages.

Year	Independent Companies	Separate Plants	CR4
1963	171	222	34
67	125	185	40
72	108	131	52
77	81	131	64
82	67	109	77
87	101	134	87
92	160	194	90

Source: U.S. Census of Manufactures, various years.

only 29 microbreweries in 1987, the number increased to 123 by 1990 (*North American Brewers Resource Directory*, 1992).

The four-firm concentration ratio of U.S. beer manufacturers increased from 34 in 1963 to 90 in 1992, nearly tripling in 30 years (Table 1). The continued growth in concentration at the same time microbreweries have grown sharply reflects the minuscule volume of microbreweries. Microbreweries tend to compete in a distinct submarket from the major brewers; in 1994, microbrews accounted for about 1.4 percent of the U. S. market (Fabricant 1995).

Anheuser-Busch is clearly the market leader and strengthened its leader position in the 1980s and early nineties. Miller, after being acquired by Philip Morris, rose to challenge Anheuser-Busch and remains a strong number 2 firm. The dominance of Anheuser-Busch and

Miller is largely attributable to internal growth. The shares of Stroh and Heileman jumped in 1982 due to a series of mergers, but have decreased since then. Other than the top two brewers, only Coors has been able to maintain or increase market share since 1970 (*The U.S. Beer Market-Impact Databank Review and Forecast*).

Although some contend that economies of scale is the reason for increasing industry concentration (Elzinga 1990), product differentiation strategies of leading brewers, such as Anheuser-Busch and Miller, are more likely responsible for the increase in four-firm concentration beyond 50 percent. The acquisition of Miller Brewing Company by Philip Morris created a new environment in the beer industry. After the acquisition in 1969-1970, Philip Morris initiated a policy of subsidizing the expansion of Miller in 1971-1972. The company adopted a market segmentation strategy that developed separate brands for different segments of the beer market and created strong brand identity through advertising (Connor et al. 1985: 254). Miller spent large sums on advertising, most of which was financed by subsidization from Philip Morris. Measured media advertising expenditures increased from \$ 9.4 million dollars in 1970 to \$ 149 million in 1982 and to \$ 202.2 million in 1987 (Connor et al and *Impact Databank Review and Forecast*, various years). In particular, the advertising campaign was highly successful in the "light" segment. The success of this strategy is reflected in Miller's market share, which increased from 4.2 percent in 1970 to 8.7 percent in 1975 and to 21.5 percent in 1980, making Miller the second largest brewer in the U.S.¹ Miller's aggressive advertising efforts and its success forced other brewers to follow the same

¹Other minor factors affecting Miller's success may have been quality improvement and new packaging (Elzinga, 1990).

strategy. Anheuser-Busch, the top brewer, responded aggressively. By 1992, Anheuser-Busch and Miller together accounted for 78 percent of U. S. beer production.

While the largest two brewers enjoyed economies of scale in advertising and first mover advantages in light beer, other brewers were disadvantaged by the new market environment. Small regional brewers were especially disadvantaged by the heavy emphasis on television advertising (Connor et al., 1985). Large national brewers can make best use of network TV commercials which cover the whole nation. In addition, the effectiveness of advertising light beer was greater for the first movers. The earlier a brand of light beer was introduced, the more effective was its advertising (Rosenbaum 1987). Because smaller brewers were at a disadvantage in both instances, the share of the U.S. beer market accounted for by brewers other than the largest eight brewers decreased sharply from 35.3 percent in 1970 to 8.6 percent in 1980 and to just 2.2 in 1990 (*The U.S. Beer Market-Impact Databank Review and Forecast*).

In sum, the emergence of a new market environment heavily dominated by advertising contributed to industry restructuring. While the top two firms increased their market share, most other brewers lost market share². Troubled brewers were frequently involved in mergers in the late seventies and eighties.

Performance of U.S. Brewers in Global Markets

In the U.S. beer industry, imports exceeded exports by a large margin during the whole period of 1962-1990. The trends of U.S. beer exports, imports, and net exports as

² Coors was an exception. The company increased market share from 6.0 in 1970 to 8.0 in 1980 and to 10.2 in 1992.

percentages of total world exports are shown in figure 1.³ Throughout the whole period, U.S. export shares were low and stable, ranging from 0.2 percent to 5.8 percent. Import shares were relatively stable at about 20 percent from 1962 to 1977, then increased sharply during 1978 - 1984⁴. Import shares peaked at 56 percent in 1984, then declined to 40 percent in 1990. Therefore "net export" shares were largely determined by the trends in imports⁵. Net export share reached a low of -53.3 percent in 1984 but improved to -33.8 percent in 1990. Although there was some improvement in the late 1980s, figure 1 indicates that U.S. brewers did not compete well against foreign counterparts throughout the whole period. However, international trade did not play a major role in the U.S. beer industry. Imports did not exceed 8 percent of the value of shipment of U. S. brewers, and exports were less than 1 percent throughout the whole period⁶.

³ The shares are constructed from U.N. trade data. Using import values reported by individual countries, world exports and U.S. exports were calculated. Accordingly, U.S. exports are overvalued in this data set compared to other data sources. Export share (XS), import share (MS), and net export share (NXS) are calculated as follows:

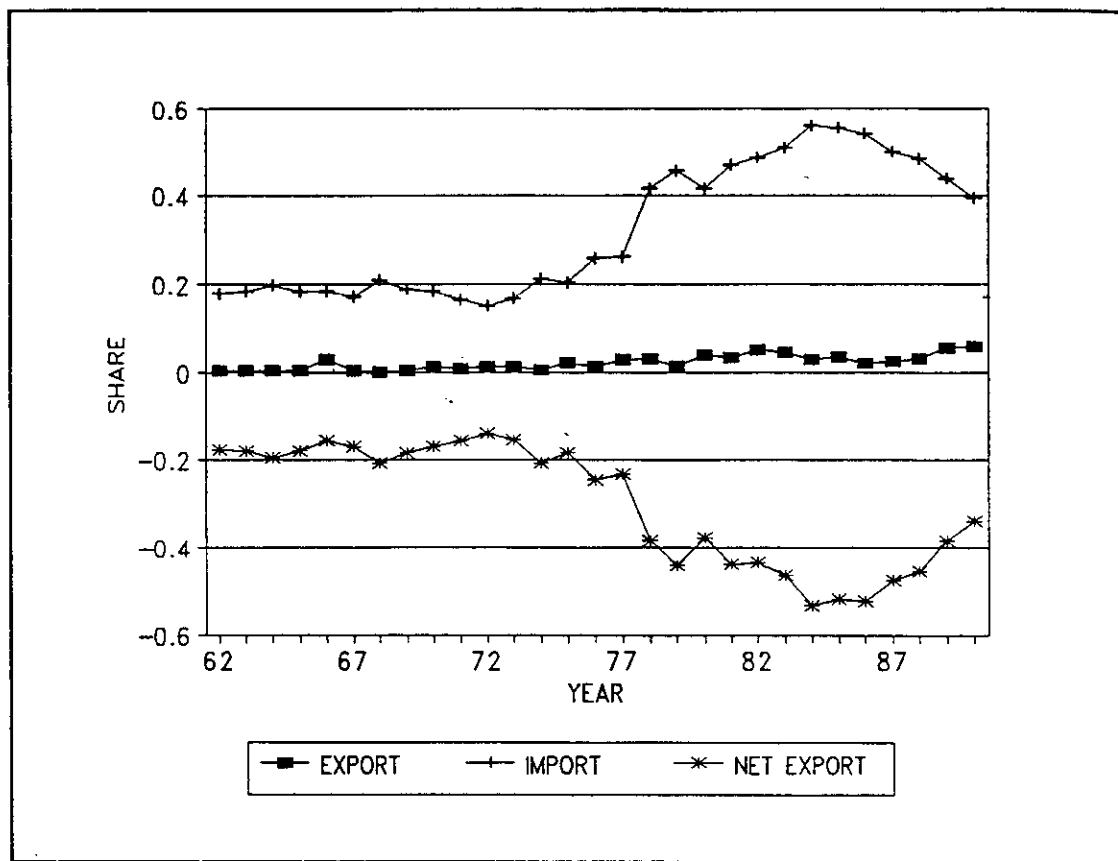
$$XS = \frac{X_i}{\sum_j M_j}, MS = \frac{M_i}{\sum_j M_j}, NXS = \frac{X_i - M_i}{\sum_j M_j}$$

⁴ The largest four exporters to the U.S. market in 1990 were the Netherlands, Canada, Mexico, and Germany.

⁵ Some researchers focus only on exports when discussing trade performance. However, the existence of intra-industry trade allows net export share to be a more reliable measure of trade performance than any measures based upon either exports or imports.

⁶ In terms of volume, imports have been less than 5 percent of U.S. consumption throughout the whole period, having the same trends as those measured by values. Higher shares of import in value terms are due to the higher price of imported beer.

Figure 1. U. S. Exports, Imports, and Net Exports of Beer as Percentages of World Exports, 1962-1990



Source: U. N. Trade Data as summarized in Kim.

Although exports were much smaller than imports, U.S. brewers have increased exports in recent years. U.S. share of total world beer exports increased from 2 percent in 1986 to 5.8 percent in 1990⁷. Exports, however, may underestimate the performance of U.S. brewers in international markets. Anheuser - Busch, Miller, and Coors developed licensing agreements with foreign brewers during the 1980s.⁸

Data and Econometric Model

To econometrically examine the effect on trade performance of market structure, net export share (NXS) is regressed on industry concentration and other explanatory variables using annual data for 1962-1990. Explanatory variables used in the estimation are constructed as follows.

Four-firm concentration (CR): Seller concentration in the U.S. is measured by the four-firm concentration ratio. It is hypothesized to have a negative sign. Annual shipments of major brewers and total industry shipments were obtained from *Impact Databank Review and Forecast*, various years. When measuring market shares of individual firms, only domestic beer shipments were taken into account. Imported beer is not excluded.

Relative price of imported beer (RP): Relative price is constructed by dividing the domestic beer price index by the imported beer price index for various years. If the price of imported beer declines relative to the price of domestic beer, imports should be encouraged

⁷ The largest four importers of U.S. beer were Japan, Canada, Hong Kong, and Mexico (6.8 percent).

⁸ Through licensing agreements, a producer can make and sell another producer's brand. The licensee then pays the licensor a royalty for producing and marketing the licensor's brand.

and net export share should decline. The variable is therefore expected to have a negative sign. Import price index was calculated from the U.N. trade data; U.S. import values of beer were divided by corresponding quantities. Domestic price index was based upon U. S. Bureau of Labor Statistics, *Producer Price Indexes*, various issues. The base year for both indexes is 1967.

Income Growth Rates (IGR): Since imported beer is a luxury good, its sales are expected to be sensitive to the level of real personal income. If incomes in the U.S. increase and consumers purchase more imported beer, *net exports* would decline unless the increase in imports are offset by an increase in exports. Since personal income is highly correlated with CR_4 ($r=0.99$), *income growth rate* is used as a proxy for personal income in this estimation. It is also expected to be negatively related to net exports. Income growth rate is constructed based upon disposable personal income expressed in 1987 dollars. The data are taken from *Economic Report of the President*.

The estimation of an econometric model using time series data can encounter problems if in levels the variables are not stationary; the estimation in levels does not generate residuals which are uncorrelated with each other. Such a regression may have a low Durbin-Watson, a high R^2 , and apparently high significance of the coefficients (Engle and Granger 1987). Since standard errors are highly unreliable under this situation, conclusions based on the estimated coefficients can be misleading.

In the current study, nonstationarity of the variables was first checked by Dickey-Fuller unit root test⁹. Although the variables are not stationary in levels, a linear combination of these variables can be stationary. If each element of a time series vector Y_t achieves stationarity after differencing but a linear combination $\alpha'Y_t$ is stationary, the time series Y_t is referred to as cointegrated with cointegrating vector α (Engle and Granger 1987). In the multivariate case, researchers often adopt the maximum likelihood method to test for cointegration. The number of cointegrating vectors is tested based on the likelihood ratio developed by Johansen and Juselius (1990).

The test procedures is basically to identify the rank of the coefficient matrix Φ in the following unrestricted vector autoregressive (VAR) model:

$$Y_t = \Phi_1 Y_{t-1} + \dots + \Phi_k Y_{t-k} + \mu + \theta D + \epsilon_t$$

where, μ is a constant term, and D is a vector of dummy variables. ϵ_t denotes a white noise error term. When time series are a non-stationary process, equation (1) is usually expressed in the first differenced form with a term taking account of the error process. Using the first difference operator (Δ), the above representation can be rewritten as:

⁹ For a time series Y_t , the augmented Dickey-Fuller regression is:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^k \gamma_j \Delta Y_{t-j} + \epsilon_t \quad (1)$$

where, ϵ_t represents error term. The number of lags k is selected to ensure the error terms are white noise. Based on the least square estimation, test statistics are constructed for the null hypothesis $\alpha_1 = 0$, the existence of unit root in Y_t . Asymptotic critical values are reported in Fuller (1976).

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \dots + \Gamma_{k-1} \Delta Y_{t-k+1} + \Phi Y_{t-k} + \mu + \theta D + \varepsilon_t$$

where, $\Gamma_i = -(I - \Phi_1 + \dots - \Phi_i)$, ($i=1, \dots, k-1$) and $\Phi = -(I - \Phi_1 \dots - \Phi_k)$ which contains information about long-run relationships between the variables in the data. In this representation, the existence of cointegrating vectors is related to the rank of matrix Φ . Johansen and Juselius (1990) argued that if the matrix Φ has full rank ($= k$), the time series vector Y_t is stationary in levels, and if $\text{rank}(\Phi)=0$, equation (2) corresponds to first differenced model (growth model). In contrast, the most interesting case is when the rank of Φ is greater than zero and less than p . In this case, there exist r possible linear combinations of Y_t , which are stationary even though Y_t itself is not stationary.

The rank of Φ is tested by the likelihood ratio (trace) in this analysis. Trace statistics for the null hypothesis of r cointegrating vectors are given by:

$$-2\ln(Q) = -T \sum_{i=r+1}^k \ln(1 - \lambda_i) \quad (3)$$

where, T is the sample size and λ_i is the eigenvalue related to finding maximum likelihood estimator¹⁰. Johansen and Juselius also provided the asymptotic critical values (p. 208).

If the cointegration test indicates that at least one cointegrating vector exists among the variables, there is also a corresponding error correction mechanism (ECM). The ECM is to

¹⁰ Eigenvalues, λ_i are determined by the following characteristic equation:

$$|\lambda S_{kk} - S_{k0} (S_{00})^{-1} S_{0k}| = 0$$

where $S_{ij} = T^{-1} \sum R_{it} R_{jt}'$ for $t=1, \dots, T$, and $i, j = 0, k$. The R_{0t} and R_{kt} are the residuals obtained by regressing ΔY_t and ΔY_{t-k} on $\Delta Y_{t-1}, \dots, \Delta Y_{t-k+1}$, D , and 1 , respectively. For a full discussion of the mathematical derivation, see Johansen and Juselius.

employ a specification that uses a combination of growth rates and levels. It reveals short-run dynamics as well as long-run equilibrium. In addition, the specification is often sufficient to obtain white noise error terms, leading to minimal biases when forecasting (Malley 1990).

In the ECM, the dependent variable is the first order difference in net export share. The variables on the right hand side of the equation are lagged variables of independent as well as dependent variables, and the first differences of independent variables. Since one period lag is appropriate, the model was estimated in the following form:

$$\begin{aligned} \Delta NXS = & \beta_0 + \beta_1 NXS_{t-1} + \beta_2 RP_{t-1} + \beta_3 \Delta RP + \beta_4 CR_{t-1} + \beta_5 \Delta CR \\ & + \beta_6 IGR_{t-1} + \beta_7 \Delta IGR + e_t \end{aligned} \quad (4)$$

where, Δ represents the difference between current and one year lagged variables.

Results

All time series used in the current model are stationary after first differencing. The null hypotheses of unit root are accepted in all series¹¹. Since the series are not stationary in levels, the estimation of the model in levels results in low Durbin-Watson statistics, evidence of serial correlation among error terms. The cointegrating regression is estimated as follows:

$$\begin{array}{ccccccc} NXS = & 0.39 & - & 1.04 & RP & - & 0.006 & CR & + & 0.002 & IGR \\ & (0.06) & & (0.17) & & & (0.0005) & & & (0.006) \end{array}$$

$$R^2 = 0.90 \quad \text{D.W.} = 0.84$$

Standard errors are reported in parentheses.

¹¹ The results of Dickey-Fuller test are not reported due to space limitations. The results are available from the author upon request.

In the above equation, the coefficients of RP (relative price of imported beer) and CR (four-firm concentration ratio) are highly significant. However, inference from these results may be misleading since this regression may be spurious.

The Johansen and Juselius test for cointegration was carried out for the variables used in the export share and import share equations as well as the net export share equation. The number of lags was determined by an F test for a two-lag model versus a one-lag model. The F statistic for the difference between a one-lag and a two-lag systems was 0.95, which is less than the critical value at 10 percent significance level. Hence, the one-lag model was used for calculating the test statistics. The cointegration tests suggest that there are at most one cointegrating vector among the variables used in the models. At most one cointegrating vector is found in all equations of net export share, export share and import share (table 2).

Table 2. Maximum Likelihood Tests for the Number of Cointegrating Vectors: A Four Variable and One-lag System of the U.S. Beer Trade Model.

Null hypothesis	NXS	Trace statistic XS	MS	Critical Value ¹
$r \leq 0$	88.6	56.2	97.1	48.42
$r \leq 1$	29.5	24.3	30.6	31.26
$r \leq 2$	13.6	9.8	15.9	17.84
$r \leq 3$	2.1	0.2	2.1	8.08

¹ The critical values are for the null hypotheses at the 5 percent significance level (Johansen and Juselius, 1990: p. 208).

The results based upon error correction models are reported in table 3. Three equations were estimated using different dependent variables: the first order differences in net export

Table 3. Least Square Estimates of Error Correction Models for U.S. Beer Trade.

Explanatory Variable	Dep. Variable ¹		
	ΔNXS	ΔXS	ΔMS
Dep. Variable (t-1)	-36.70 ^b (16.91)	-68.05 ^c (21.60)	-29.93 ^b (13.55)
RP(t-1)	-30.64 (35.67)	4.25 (4.65)	24.03 (20.71)
ΔRP	-117.71 ^c (29.45)	-6.50 (6.01)	80.05 ^c (17.51)
CR(t-1)	-0.27 ^c (0.09)	0.05 ^b (0.02)	0.24 ^b (0.09)
ΔCR	0.15 (0.37)	0.26 ^b (0.12)	0.06 (0.35)
IGR(t-1)	-0.69 (0.63)	-0.13 (0.19)	0.57 (0.55)
ΔIGR	-0.29 (0.44)	-0.02 (0.13)	0.33 (0.39)
Int.	16.20 (10.13)	-0.30 (1.59)	-13.91 (7.24)
R^2	0.64	0.52	0.59
Durbin-Watson	1.97	2.00	1.92

¹ Dependent variables are first differences in U.S. net export share of world exports, export share, and import share, respectively.

Standard errors are reported in parentheses.

Estimates and standard errors are multiplied by 100.

^{a, b, c} Different from zero at the 10, 5 and 1 percent significance levels, respectively.

share (ΔNXS), export share (ΔXS), and import share (ΔMS). Among explanatory variables, the most significant one is the relative price of domestic beer to imported beer in first differences. Relative price in first differences has a negative and significant coefficient in the net export share equation. The relative price is positively related to import share, but not significantly to export share. The results imply that increased price of domestic beer relative to imports magnified imports of foreign beer into the U.S and consequently, aggravated *net* exports.

The four-firm concentration ratio of U.S. brewers in first differences is not significantly related to net export share. However, CR_4 in one year lagged levels has a significant negative coefficient in the net export share equation. These results suggest that the level of concentration is negatively related to changes in net export share, although changes in industry concentration have little short-run impact on trade performance. The results in Table 3 indicate industry concentration is positively and significantly related to both the change in export share and the change in import share. Apparently the export propensity of U.S. brewers improved as industry concentration increased. However, *net exports* depend upon both exports and imports. Because increased concentration is linked to both expanded exports and increased imports, the net effect depends on the relative size of the coefficients. The coefficient on CR_4 is much larger in the import share equation than in the export share equation. Considering both exports and imports, we can infer that seller concentration negatively affected trade performance in the U.S. beer industry case.

Income growth rates also have the expected sign, but are not significant. Although income growth rates both in lagged level and in first differences have positive signs in the

import share equation, this result provides weak support for the hypothesis that beer imports increase when the per capita income is growing.

In sum, empirical results indicate that the trade performance of the U.S. beer industry is negatively affected by changes in the relative prices of domestic vs. imported beer and also by domestic seller concentration.

Conclusions

The econometric results in this paper indicate that domestic seller concentration is negatively related to the trade performance of the U.S. brewers *vis a vis* foreign brewers. It is also shown that increased concentration aggravated *net* exports by encouraging imports rather than restricting exports. The negative relationship between industry concentration and trade performance can be partly explained by the fact that domestic beer prices increased disproportionately compared to imported beer prices during 1972-1984 when the U.S. beer industry was rapidly consolidating. During that period, domestic beer price increased 86.9 percent, whereas imported beer prices, adjusted for exchange rates, increased only 43.5 percent.¹² This difference in the rates of price increases may reflect the increased domestic market power possessed by U.S. brewers.

In a differentiated product industry such as beer, intraindustry trade may confound measures of international competitiveness. For example, we found concentration in the U. S. beer industry was positively related to both exports and imports. *Net exports* deducts imports

¹² Since imported beer price is expressed in terms of U.S. dollars, the relative price of domestic beer to imported beer may partly reflect changes in exchange rates. To control for the effect of exchange rates, imported prices were adjusted for exchange rates.

from exports before computing a country's share of global trade. In the present case, although both beer imports and exports increased with increased concentration, imports grew at a faster rate; net exports therefore declined with increased concentration.

The growth in imports appears to reflect in part the desire of American consumers for greater product variety. The growth of imports and microbreweries has continued and may appeal to the same submarket. By 1994, imports accounted for about 5.6 percent of the U. S. beer market while microbrews held 1.4 percent of the market.

In the beer case, it appears that increased concentration allowed leading U.S. brewers to sell their products at higher prices compared to imported beer. As a result, foreign brewers found more room to penetrate the U.S. market. Decreased product variety caused by the demise of small local or regional brewers might also have provided more opportunities for imports.

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