

8-10-2012

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Gokhale, J., & Tremblay, V. J. (2012). Competition and Price Wars in the U.S. Brewing Industry. *Journal of Wine Economics*, 7(2). Retrieved from <https://commons.erau.edu/db-accounting/3>

Journal of Wine Economics, Volume 7, Number 2, 2012, Pages 226–240 <https://doi.org/10.1017/jwe.2012.16>. © American Association of Wine Economists, 2012

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Competition and Price Wars in the U.S. Brewing Industry*

Jayendra Gokhale^a and Victor J. Tremblay^b

Abstract

The behavior of the macro or mass-production segment of the U.S. brewing industry appears to be paradoxical. Since the end of Prohibition in 1934, the number of independent brewers has continuously declined while the major national brewers, such as Anheuser-Busch, Miller, and Coors, have gained market share. In spite of this decline in the number of competitors, profits and market power have remained low in brewing. Iwasaki *et al.* (2008) explain this result by providing evidence that changes in marketing and production technologies favored larger brewers and forced the industry into a war of attrition, in which only a handful of firms could survive. This led to fierce competition, especially from the 1960s through the mid 1980s. Since the late 1990s, the war appears to have subsided. Thus, the purpose of this study is to determine whether price competition diminished after the mid-1990s. We find evidence that competition has diminished but not enough to substantially increase market power. (JEL Classification: D22, L11, L66)

I. Introduction

The U.S. brewing industry shows two paradoxical features in its macro, or mass-production, segment. First, industry concentration has risen steadily since the end of Prohibition. The number of independent macro brewers reached a peak in 1935 at 766 firms and since then has continuously declined to about 20 firms today. This is reflected in the rise in the four-firm concentration ratio (CR_4) and the Herfindahl-Hirschman index (HHI), two common measures of industry concentration.¹

*The authors thank Patrick Emerson, Todd Pugatch, Liz Schroeder, Dan Stone, Carol Tremblay, and an anonymous referee for their helpful comments on an earlier version of the paper.

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¹ CR_4 is defined as the market share of the largest four firms in the industry. HHI is defined as the sum of the squared market shares of all firms in the industry and ranges from 0 to 10,000. To make HHI compatible with CR_4 , we divide HHI by 100 so that it ranges from 0 to 100.

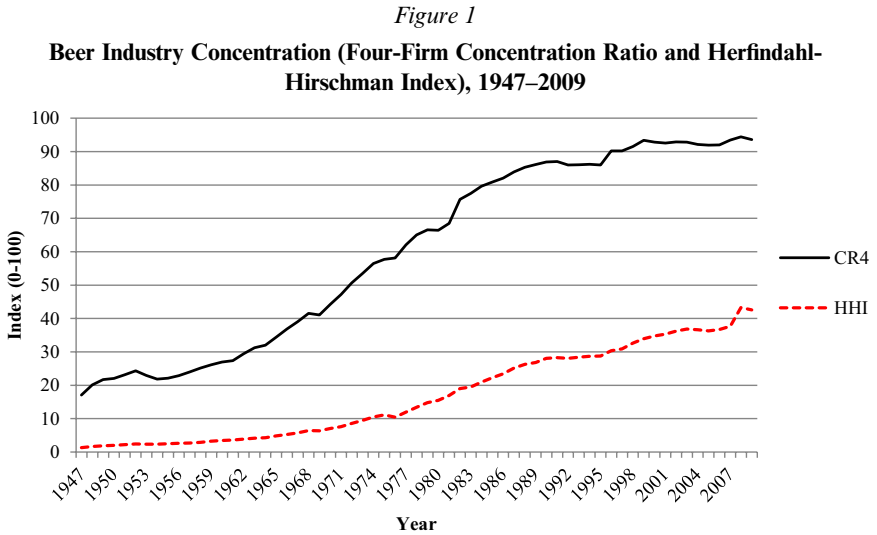


Figure 1 documents this increase for the period 1947–2009.² Second, in spite of rising concentration, profits have remained low, and previous studies have failed to detect the presence of market power.³ A firm has market power when it can profitably maintain price above marginal cost.

This appears to be a paradox because many static models of oligopoly suggest that profits and market power will rise with a fall in the number of competitors, which is inconsistent with the trend in brewing. Nevertheless, not all models predict this outcome. For example, price equals marginal cost in the Bertrand model when products are homogeneous goods and there are two or more competitors. Furthermore, Tremblay and Tremblay (2011a) and Tremblay *et al.* (2011) demonstrate that price can equal marginal cost even in a monopoly setting when the incumbent firm competes in output and there exist one or more potential entrants that compete in price.

In the brewing industry, Tremblay and Tremblay (2005) speculate that firm profits remained low from the 1960s through the late 1990s because brewers were forced into a generalized war of attrition (Bulow & Klemperer, 1999). In such a war,

² We ignore the craft and import segments of the market. The main reason for this is that most import and craft brands of beer are poor substitutes for regular domestic lager, such as Budweiser, Coors Banquet, and Miller High Life. In addition, when Iwasaki *et al.* (2008) include this segment as a demand determinant, its effect is never significant. Thus, we focus only on the macro segment of the beer market. See Tremblay and Tremblay (2005, 2011) for more complete descriptions of the import and micro segment of the U.S. beer industry.

³ For a review of the evidence, see Tremblay and Tremblay (2005).

Table 1
**The Market Share of the National Brewers, Minimum Efficient Scale (MES),
the Number of Brewers (*N*), and the Cost-Minimizing Number of Competitors (*N**)
in the U.S. Brewing Industry**

Year	<i>Market Share of National Brewers (percent)</i>	<i>MES-Output (million barrels)</i>	<i>MES-MS (percent)</i>	<i>N</i>	<i>N*</i>	<i>K</i>
1950	16	0.1	0.1	350	840	0
1960	21	1.0	1.5	175	87	88
1970	45	8.0	6.4	82	16	66
1980	59	16.0	9.0	40	11	29
1990	79	16.0	8.4	29	12	17
2000	89	23.0	14.0	24	7	17
2009	93	23.0	14.0	19	7	12

Notes: MES-Output measures minimum efficient scale measured in millions of (31-gallon) barrels. MES-MS represents the market share needed to reach minimum efficient scale. *N* is the number of macro brewers. *N** represents the cost-minimizing industry structure (i.e., the number of firms that the industry can support if all firms produce at minimum efficient scale). $MES-MS = (\text{Industry Output})/MES$. $N^* = 100/MES-MS$; rounding errors explain the discrepancy in calculations. $K = N - N^*$ when $(N - N^*) > 0$ and 0 otherwise.

Sources: Steinberg (1980), *the Statistical Abstract of the United States*, Tremblay *et al.* (2005), and Tremblay and Tremblay (2005).

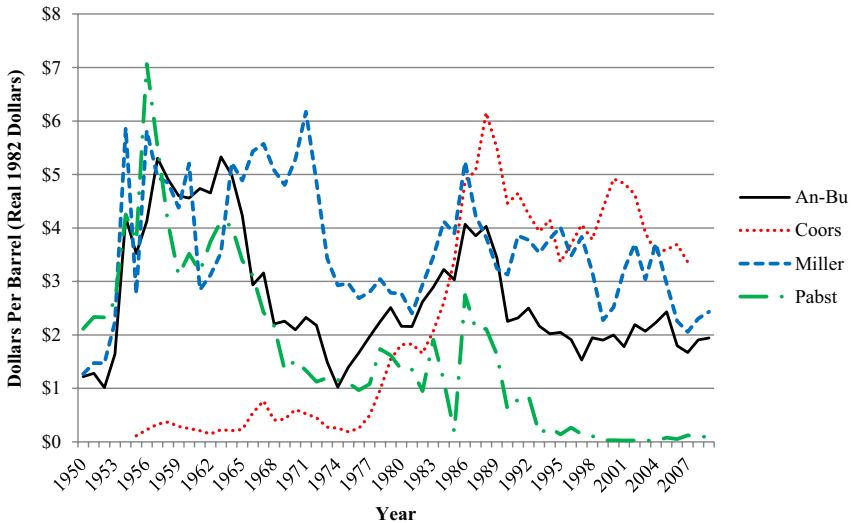
N firms compete in a market that will profitably support *N** firms in the long run. If $N > N^*$, some firms must exit from the market for it to reach long-run equilibrium. As documented in Tremblay and Tremblay (2005), two events caused *N** to rise in brewing. In the 1950s and 1960s, the advent of television gave a marketing advantage to large national producers, which were the only firms with enough resources to profitably advertise on television.⁴ In addition, increased mechanization beginning in the 1970s reduced the cost of large-scale production. These changes gave larger beer producers a marketing and production advantage.

Table 1 shows how the market share of the national beer producers⁵ grew over time and how changes in marketing and production economies affected optimal firm size. It lists estimates of the minimum efficient scale (MES) needed to take advantage of all scale economies in marketing and production for various years. MES-Output measures annual minimum efficient scale in millions of (31-gallon) barrels. MES-MS measures the market share needed to reach MES-Output. *N** measures the number of firms needed to produce industry output if each firm produces at MES. This is called the efficient or cost-minimizing industry structure (Baumol *et al.*, 1982). As the table shows, over time MES grew and *N** fell.

⁴At that time, all television ads were national in scope. No spot or local television advertising was available. This made it too costly for local or regional brewers to advertise on television.

⁵For most of the post-World War II era, the major national producers included the Anheuser-Busch, Schlitz, Pabst, Miller, and Coors brewing companies. In the early 1980s, Schlitz went out of business, and Pabst played less of a dominant role. Coors became a national brewer in 1991. For further discussion of the evolution of the major brewers, see Tremblay and Tremblay (2005, 2011b).

Figure 2
Advertising Per Barrel of Leading U.S. Brewers, 1950–2009



The intensity of the war is reflected in the number of firms that must exit the industry for the efficient structure to be reached in the long run. It is defined as $K = N - N^*$ when $(N - N^*) > 0$ and 0 otherwise. The value of K was largest in 1960s and 1970s, a period known as the “beer wars.” This is aptly described in *Newsweek* (September 4, 1978, 60):

After generations of stuffy, family-dominated management, when brewers competed against each other with camaraderie and forbearance, they are now frankly at war. Marketing and advertising, not the art of brewing, are the weapons. Brewers both large and small are racing to locate new consumers and invent new products to suit their taste. Two giants of the industry, Anheuser-Busch of St. Louis and Miller Brewing Company of Milwaukee, are the main contenders.

This description is remarkably accurate, as the facts show that the war was fought with advertising, the introduction of new brands, and tough price competition. Figure 2 plots the advertising intensity of the major brewers, measured as advertising spending per barrel. It shows that advertising spending was quite high from the mid-1950s through the late 1960s, a period in which television advertising became a prominent tool of the national brewers. In 1950, only 9 percent of households had a television set, a proportion that increased to 87 percent by 1960 and 95 percent by 1970.⁶ Advertising spending rose once again in the 1980s, a period in which the Coors Brewing Company made large investments in advertising in

⁶Today, about 98 percent of households have one or more television sets.

Table 2
**Major Domestic Beer Brands of the Anheuser-Busch, Coors, Miller,
 and Pabst Brewing Companies**

<i>Year</i>	<i>Anheuser-Busch</i>	<i>Coors</i>	<i>Miller</i>	<i>Pabst</i>
1950	2	1	1	1
1960	4	1	1	9
1970	3	1	4	5
1980	5	2	3	10
1990	10	10	9	17
2000	29	14	21	54
2010	55	–	61*	33

*This reflects the brands for both Miller and Coors, as the companies formed a joint venture in 2008 to form MillerCoors.

Sources: Tremblay and Tremblay (2005) for 1950–2000 and company web pages for 2010.

order to expand into new regions of the country and thereby become a national brewer.⁷

Brewers also fought for market share by introducing new brands. Table 2 lists the number of brands offered by the leading brewers. In 1950, most brewers offered a single flagship brand. The Anheuser-Busch Brewing Company is the lone exception, as it had continuously produced a flagship brand, Budweiser, and a super-premium brand, Michelob, since the end of Prohibition. Brand proliferation became apparent by the late 1970s, and by 1990 the major brewers each offered 9 or more different brands of beer.

Iwasaki et al. (2008) formally tested for the effect of the war of attrition on concentration and price competition. They found that advertising and rising MES contributed to increases in industry concentration. In spite of rising concentration, they found that the war reduced price-cost margins during the 1960s through the early 1990s. Unfortunately, their work does not shed light on the extent to which market power has changed since the late 1990s.

One might have expected the intensity of the war to diminish by the 2000s for several reasons. First, little room is left for consolidation. In 2002, Miller was purchased by South African Breweries to form SABMiller. In 2008, Anheuser-Busch was purchased by Belgium's InBev to form Anheuser-Busch InBev, and Coors and SABMiller established a joint venture called MillerCoors. Second, Pabst gave up the production of beer in 2001, contracting with Miller to produce all its beer. Finally, the remaining macro brewers have retreated to niche markets, competing more with the micro than the macro brewers.

The purpose of this paper is to determine whether the degree of competition has fallen in the final stages of industry consolidation. Two methods are used. The first is

⁷Coors reached national status in 1991.

the new empirical industrial organization technique, which uses regression analysis to estimate the markup of price over marginal cost. The second is a new technique developed by Boone (2008), which compares the variable profits of efficient firms with less efficient firms over different regimes of competition. The main advantage of Boone's technique is that it avoids measurement problems associated with accounting data. The evidence shows that competition has decreased from the late 1990s to 2008 but not enough to substantially increase market power.

II. Estimation of the Degree of Competition

In this section, we review the two methods that are used to estimate the degree of competition in brewing. The first is called the new empirical industrial organization technique.⁸ The empirical model derives from a general first-order condition of profit maximization. To illustrate, assume a market with N firms, where firm i 's inverse demand is $p_i(q_1, q_2, q_3, \dots, q_N)$, p_i is firm i 's price, and q_i is firm i 's output. The firm's long-run total cost function is $C(q_i, \underline{w})$, where \underline{w} is a vector in input prices; marginal cost is $MC = \partial C / \partial q_i$. Solving the firm's first-order condition for price produces an equation called an optimal price equation (supply relation or markup equation):

$$p_i = \frac{\partial c}{\partial q_i} - \theta \frac{\partial p_i}{\partial q_i} q_i, \quad (1)$$

where θ is a behavioral parameter of market power. We will see subsequently that choosing different values of θ will produce different oligopoly equilibria.

This specification is related to the Lerner (1934) index of market power (\mathcal{L}). To illustrate, assume that firms produce homogeneous goods, such that $p_i = p$ and $\partial p_i / \partial q_i = \partial p / \partial Q$, where Q is industry output. Under these conditions, Equation (1) can be rearranged as

$$\mathcal{L} = \frac{p - MC}{p} = -\theta \frac{\partial p}{\partial Q} \frac{Q}{p} \frac{q_i}{Q} = \frac{ms_i \theta}{\eta} = \frac{\theta}{N \cdot \eta} \quad (2)$$

where ms_i is the market share of firm i , which equals $1/N$ when the market is in equilibrium because of symmetry. When price equals marginal cost, market power is nonexistent and $\mathcal{L} = 0$; \mathcal{L} increases with market power. This specification describes a variety of possible cooperative and noncooperative equilibria.

- In a competitive or Bertrand equilibrium with homogeneous goods, $p = MC$, which implies that $\theta = 0$ and $\mathcal{L} = 0$.

⁸For a review of the derivation and history of this technique, see Bresnahan (1989) and Tremblay and Tremblay (2012). For a discussion of its strengths and weaknesses, see Slade (1995), Genesove and Mullin (1998), Corts (1999), Perloff et al. (2007), and Tremblay and Tremblay (2012).

- For a monopolist, $\theta = N = 1$ and $\mathcal{L} = 1/\eta$.
- In the Cournot equilibrium, $\theta = 1$ and $\mathcal{L} = ms_i/\eta = 1/(N \cdot \eta)$. Notice that when $N = 1$, $\mathcal{L} = 1/\eta$, which is the simple monopoly outcome.
- In a perfect cartel, $\theta = N$ and $\mathcal{L} = 1/\eta$.

If the market outcome ranges from competitive to cartel, then $0 \leq \theta \leq N$ and $0 \leq \mathcal{L} \leq 1/\eta$. One can think of θ as an indicator of the “toughness of competition,” as described by Sutton (1991).

In its empirical form, Equation (1) is transformed into the following equation.

$$p = \langle MC \rangle + \lambda q_i, \quad (3)$$

where $\langle MC \rangle$ is an empirical specification of the marginal cost function and $\lambda = \theta(\partial p/\partial Q)$ is a market power parameter to be estimated. With appropriate data, Equation (3) is either estimated with firm demand as a system of equations or as a single equation using an instrumental variables technique given that firm output is an endogenous variable. The Lerner index is calculated from parameter estimates and mean values of the data.

The second method that we use to estimate the degree of competition in brewing was developed by Boone (2008). The main advantages of his method are that it requires relatively little data and it avoids the use of accounting cost and profit data, which are poor proxies for their economic counterparts.⁹ In order to use Boone’s method, firms must not be equally efficient. This is a reasonable assumption in brewing, in which some firms have rather antiquated equipment, are unable to advertise nationally, and may not be scale efficient. With dissimilar levels of efficiency, Boone shows that an increase in competition punishes inefficient firms more harshly than efficient firms. In other words, increasingly tougher competition causes the least efficient firms to exit first.

To test for a change in industry competitiveness, one must derive what Boone calls an index of relative profit differences (RPD). RPD compares the variable profits of different firms within an industry. Let $\pi_i^v(E_i, \theta)$ equal firm i ’s variable profit, which is a function of its efficiency level (E_i) and the behavioral parameter (θ). Variable profit equals total revenue minus total variable cost. To illustrate this idea, consider a market with three firms, where firm 1 is most efficient and firm 3 is least efficient ($E_1 > E_2 > E_3$). Recall that θ ranges from 0 (competitive) to N (cartel), where the degree of competition increases as θ falls. With this notation,

$$RPD \equiv \frac{\pi_1^v - \pi_3^v}{\pi_2^v - \pi_3^v}. \quad (4)$$

⁹For further discussion of this issue, see Fisher and McGowan (1983) and Fisher (1987).

Under the conditions of the model, an increase in competition will lead to an increase in RPD, $\partial \text{RPD} / \partial \theta < 0$. In other words, an increase in competition harms the least efficient firms the most, such that $(\pi_1^v - \pi_3^v)$ increases relative to $(\pi_2^v - \pi_3^v)$. Thus, if RPD rises (falls) over time, we can conclude that competition has increased (decreased) and market power has fallen (risen).

Boone's index has several desirable qualities. First, by using variable profits, it circumvents the measurement problems associated with accounting profits.¹⁰ Second, data are needed for no more than three firms in the industry. The only difficulty is that firms must be ranked in terms of their relative efficiency. One approach is to use data envelopment analysis to characterize a firm's technology and relative inefficiency, as suggested in Färe et al. (1985, 2008). Boone suggests a simple alternative in which the firm with lowest average variable costs is most efficient.

In brewing, previous studies can be used to rank the relative efficiency of firms. In terms of scale efficiency, Tremblay and Tremblay (2005) found that only the industry leader and national brewer, Anheuser-Busch, has been consistently scale efficient. Miller, another national brewer, has been scale efficient since the late 1970s. The third largest brewer, Coors, was marginally scale efficient by the early 1990s when it became a small national brewer. None of the smaller regional brewers were scale efficient. In terms of marketing efficiency, the advent of television gave the large national brewers an advantage. This is confirmed by Färe et al. (2004), who found that Anheuser-Busch was the most efficient, while the smallest regional brewers and failing firms were the least efficient. Taken as a whole, this implies that the rank order from most to least efficient firms is: Anheuser-Busch, Miller, Coors, and local brewers.

III. Data and Empirical Results

The data set used in our regression analysis consists of annual observations from 1977 to 2008 for eleven U.S. brewing companies. These include all macro brewers that were publicly owned: Anheuser-Busch, Coors, Falstaff, Genesee, Heileman, Miller, Olympia, Pabst, Pittsburg, Schlitz, and Stroh. Firm variables include price, marginal cost, output, total revenue, and variable profit (total profit minus total variable cost). All firm data derive from the annual trade publication *Beer Industry Update*.

The industry data used in the study include the measures of industry concentration (HHI and CR₄) and a measure of the intensity of the beer wars (WAR). The

¹⁰That is, one does not need to estimate the appropriate depreciation rate of durable assets that are needed to convert accounting profits to economic profits.

concentration indices are updated from Tremblay and Tremblay (2005). WAR is defined as N^*/N . With this definition, the intensity of the war of attrition increases as WAR decreases.¹¹ The number for firms (N) is updated from Tremblay and Tremblay (2005). The efficient number of firms (N^*) equals Q/MES , where industry production (Q) is obtained from *Beer Industry Update*. An estimate of minimum efficient scale (MES) is derived from Tremblay and Tremblay (2005).

Given that output is an exogenous variable, we also use two market demand variables that serve as instruments in the optimal price equation. These are per-capita disposable income (in 1982 dollars) and a demographics variable, the proportion of the population that ranges in age from 18 to 44.¹² Demand studies show that this is the primary beer-drinking age group (see Tremblay and Tremblay, 2005). Table 3 displays the descriptive statistics of the firm, industry, and demand variables.

We first investigate the relative profit differences (RPD). The data allow us to investigate RPD for only two trios of macro producers: for Anheuser-Busch, Miller, and Genesee (A-M-G) and for Anheuser-Busch, Coors, and Genesee (A-C-G).¹³ Unfortunately, this provides estimates only from 1978 to 1999. To obtain estimates through 2006, we also include a hybrid brewer, the Boston Beer Company.¹⁴ Because of its relatively small size, we rank Boston as less efficient than Anheuser-Busch, and because of its rapid growth rate, we rank Boston as more efficient than Miller and Coors.¹⁵ This provides two additional trios of firms to be used to calculate RPD: Anheuser-Busch, Boston, and Miller (A-BB-M) and Anheuser-Busch, Boston, and Coors (A-BB-C). Recall that an increase in RPD implies an increase in competition. Mean estimates of RPD for four sets of firms are plotted in Figure 3, where the values were normalized to equal 100 in 1991 (the first year that Boston data are available). Consistent with the findings of Iwasaki *et al.* (2008), the results show that the beer industry became more competitive during the beer wars that lasted through the mid-1980s, and the degree of competition remained relatively constant during the 1990s. Although RPD fluctuated in the early 2000s, its value reached historically high levels by the mid-2000s. This suggests that competition did not diminish substantially from the late 1990s through 2006.

¹¹ This definition makes it easier to interpret the effect of the war on market power in the optimal pricing regression.

¹² Income data were obtained from the Bureau of Economic Analysis at www.bea.gov. Population data were obtained from the U.S. Bureau of the Census at www.census.gov.

¹³ We do not make a comparison of Anheuser-Busch, Miller, and Coors because the relative efficiency of Miller and Coors is frequently too close to call.

¹⁴ Like a major macro brewer, Boston produces traditional lager beer and markets its Samuel Adams brands nationally. However, it also produces European ales like a micro brewer.

¹⁵ From 1991 to 2006, Miller's market share of domestic beer production fell by 10.2 percent, Coors' market share rose by 22.7 percent, and Boston's market share grew by 700 percent.

Table 3
Descriptive Statistics of Firm and Industry Data, U.S. Brewing Industry, 1977–2008

<i>Variable Name</i>	<i>Definition</i>	<i>Min</i>	<i>Mean (Std. Dev.)</i>	<i>Max</i>
<i>Firm Variables</i>				
Q	Firm output (measured in 10 million of barrels)	0.053	2.66 (2.83)	10.3
TR	Total revenue (thousands of 1982 dollars)	24,595	1,561,874 (1,679,509)	5,798,582
P	Price (total revenue divided by output; 1982 dollars per barrel)	25.86	55.891 (9.20)	74.092
MC	Marginal cost (total cost divided by output; 1982 dollars per barrel)	26.318	51.165 (8.574)	68.237
π^v	Variable profit (total revenue minus total variable cost; thousands of 1982 dollars)	1,396	483,732 (647,211)	2,598,093
D_N	National Firm Dummy Variable (1 for national producer and 0 otherwise)	0	0.431 (0.497)	1
<i>Industry Variables</i>				
HHI	Hirfindahl-Hirschman Index	11.93	23.314 (7.563)	43.291
CR4	Four-Firm Concentration Ratio	17.05	60.207 (28.02)	94.39
WAR	Efficient number of firms divided by the total number of firms (N^*/N)	0.224	0.325 (0.055)	0.418
<i>Demand Variables</i>				
DEM	Demographic variable—Proportion of the U.S. population age 18–44	0.372	0.414 (0.016)	0.433
INC	Per-capita real disposable income (1982 dollars)	10,299	11,940 (1,553)	16,210

Summary statistics are for the minimum (Min), mean, maximum (Max), and standard deviation (Std. Dev.).

Next, we use regression analysis to estimate the optimal price equation (Equation 1). Data limitations require that we use average cost as a proxy for marginal cost. This is a reasonable assumption for the national producers because they are large and able to reach MES. To control for cost and other possible differences between national and regional brewers, we include a dummy variable, D_N , which equals 1 for national producers and 0 otherwise.

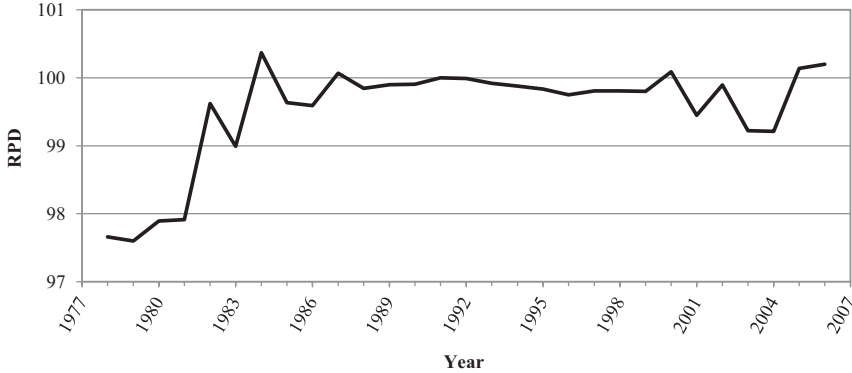
Given our uncertainty concerning whether market power remained constant over our sample period, we consider several specifications. As a starting point, we consider the simple model where market power is constant. This model is given by

$$p_i = MC_i + \beta_0 D_N + \lambda q_i, \quad (5)$$

where β_0 and λ are parameters to be estimated. Notice that the parameter on MC_i equals 1. In this specification, firms have market power when $\lambda > 0$.

Figure 3

Mean Relative Profit Difference (RPD) *Note: This plots the mean RPD for the following triads of firms: Anheuser Busch, Miller, and Genesee; Anheuser Busch, Coors, and Genesee; Anheuser Busch, Boston Beer, and Miller; Anheuser Busch, Boston Beer, and Coors*



This model is unlikely to be valid in brewing, however, given previous evidence that there has been a war of attrition in brewing. One hypothesis is that market power changes over time and is a function of WAR: $\lambda = \beta_1 + \beta_2 \text{WAR}$. In this case, the model becomes

$$p_i = MC_i + \beta_0 D_N + \beta_1 q_i + \beta_2 \text{WAR} \cdot q_i. \tag{6}$$

As we have defined WAR, a reduction in the intensity of the war implies that $\partial p_i / \partial \text{WAR} = \beta_2 q_i > 0$. That is, market power increases with the WAR variable.

Sutton (1991) and Tremblay and Tremblay (2005) argue that three periods or regimes in brewing relate to market power. In the first period, 1977–1986, the war was so intense that market power was zero.¹⁶ Market power then rose progressively into the second period (1987–1996) and the third period (1997–2008). If this is true, the following model is appropriate.

$$p_i = MC_i + \beta_0 D_N + \beta_3 q_{87-96} + \beta_4 q_{97-08}. \tag{7}$$

In this specification, $q_{87-96} \equiv D_{87-96} \cdot q_i$, $q_{97-08} \equiv D_{97-08} \cdot q_i$, $D_{87-96} = 1$ from 1987 through 1996 (0 otherwise), and $D_{97-08} = 1$ from 1997 through 2008 (0 otherwise). If market power rose from one period to another, then $\beta_4 > \beta_3 > 0$.

¹⁶This implies that λ was 0 (i.e., β_1 and β_2 equaled 0) before 1987.

Table 4
Parameter Estimates and Standard Errors of the Optimal Price Equation

Variable	M1	M2	M3	M4	M5	M6	M7	M8
MC	1.030 ^a (0.009)	1.029 ^a (0.010)	1.036 ^a (0.009)	1.037 ^a (0.009)	1.067 ^a (0.007)	1.049 ^a (0.008)	1.069 ^a (0.008)	1.062 ^a (0.009)
<i>q</i>	1.198 ^a (0.140)	0.575 ^a (0.175)	-0.067 (0.147)	-0.014 (0.151)	-	-	-	-
<i>q</i> ·War	-	-	3.287 ^a (0.152)	3.629 ^a (0.198)	-	-	-	-
<i>q</i> ₈₇₋₉₆	-	-	-	-	0.447 (0.337)	0.098 (0.321)	-0.639 ^c (0.379)	-0.635 ^c (0.368)
<i>q</i> ₉₇₋₀₈	-	-	-	-	1.024 ^a (0.112)	0.475 ^a (0.175)	-0.347 ^b (0.143)	-0.482 ^a (0.160)
<i>q</i> ₈₇₋₉₆ ·War	-	-	-	-	-	-	2.586 ^a (0.227)	2.215 ^a (0.291)
<i>q</i> ₉₇₋₀₈ ·War	-	-	-	-	-	-	3.815 ^a (0.220)	3.569 ^a (0.234)
D _N	-	3.809 ^a (0.559)	-	-1.130 ^b (0.522)	-	3.789 ^a (0.584)	-	1.545 ^b (0.608)
\bar{R}^2	0.995	0.996	0.998	0.998	0.995	0.996	0.998	0.998
Wald χ^2	94,749 ^a	54,108 ^a	91,077 ^a	110,320 ^a	58,514 ^a	46,619 ^a	56,958 ^a	54,865 ^a

Standard errors are in parentheses. The sample size is 174.

^aSignificant at 1 percent.

^bSignificant at 5 percent.

^cSignificant at 10 percent.

In the final specification, we modify Equation (7) to control for the effect of the war on market power during these later regimes. In this case,

$$\begin{aligned}
 p_i = & MC_i + \beta_0 D_N + \beta_3 q_{87-96} + \beta_4 q_{97-08} \\
 & + \beta_5 WAR \cdot q_{87-96} + \beta_6 WAR \cdot q_{97-08}.
 \end{aligned}
 \tag{8}$$

This model allows us to determine how market power changes over time and is affected by the WAR variable. If market power rises over time, then $\beta_4 > \beta_3 > 0$ and $\beta_6 > \beta_5 > 0$.

Each specification is estimated, with and without D_N, using an instrumental variables estimation technique. As discussed above, the instruments are per-capita disposable income and the proportion of the population age 18 to 44. Given our use of pooled data, we use a clustering method that allows the standard error of the regression to vary by clusters (i.e., firms). Following Cameron, Gelbach, & Miller (2008), we obtained standard errors using bootstrapping with repeated resampling and replacement within each cluster for 1,000 trials. The specifications that were estimated are labeled Models 1 through 8 (M1–M8) in Table 4. In each model, the Wald χ^2 statistic is sufficiently high, implying that the parameters of the model are jointly significant. The MC parameter is close to 1, and in most specifications, the national dummy variable is positive and significant, which is

Table 5
Lerner Index Estimates

Period	Model			
	M5	M6	M7	M8
1987–1996	0.0696	0.0761	0.0700	0.0726
1997–2008	0.0771	0.0812	0.0795	0.0811

consistent with the fact that most national brands sell for higher prices than do regional brands.

Regarding the issue of market power, we are particularly interested in two hypotheses. The first is the hypothesis that a decrease in WAR (i.e., an increase in the intensity of the war) reduces market power. This hypothesis is confirmed in models M3 and M4, as the parameter on the interaction variable between output and WAR is positive and significant.

Second, we are interested in determining whether market power increased progressively from 1987–1996 to 1996–2008. In the absence of the WAR variable, Models M5 and M6 are consistent with this hypothesis. In both models, the parameter estimate on q_{97-08} is greater than the parameter estimate on q_{87-96} , although the difference between parameters is insignificant. We obtain a similar result when we include the WAR variable in Models M7 and M8. The parameter estimates on q_{97-08} exceeds that of q_{87-96} , and parameter estimates on $q_{97-08} \cdot \text{War}$ exceed that of $q_{87-96} \cdot \text{War}$. Furthermore, we fail to reject the joint hypothesis that the parameters differ between q_{97-08} and q_{87-96} and differ between $q_{97-08} \cdot \text{War}$ and $q_{87-96} \cdot \text{War}$ (at the 99 percent significance level for each model).

To further investigate how market power has changed over time, we estimate the Lerner index for the periods 1987–1996 and 1997–2008 from Models M5 through M8 (see Table 5). Consistent with Tremblay and Tremblay (2005), the results show that the Lerner index is relatively low. The results also show that there has been a small increase in the Lerner index from the 1987–1996 period to the 1997–2008 period. The increase is never significantly different from zero, however, with p -values equaling 46 percent for M5, 64 percent for M6, 36 percent for M7, and 39 percent for M8. In total, the results suggest that even though the war of attrition came to a close, there is no evidence of a substantial or significant increase in market power in the U.S. brewing industry.

IV. Concluding Remarks

Industry concentration has risen dramatically in the post–World War II era in the macro segment of the U.S. brewing industry. Previous studies show that profits and market power remained low during the 1970s and 1980s because firms were forced

to compete in a war of attrition. Today, macro beer production is dominated by just two companies, Anheuser-Busch and Miller-Coors. This raises concerns that their market power may rise. The purpose of this paper is to estimate market power and determine whether it rose from the late 1990s through 2008.

Two methods are used to estimate the degree of competition in brewing. The first is the traditional new empirical industrial organization technique, which we modify to allow market power to vary over time. The second is a technique developed by Boone (2008), which uses data on variable profits to determine whether competition decreased over time. The results confirm that the war was intense through the 1990s. Regression results using the new empirical industrial organization approach indicate that although market power rose somewhat in the 1997–2008 period, it still remains low. This suggests that the degree of competition in brewing remains high even though there are only a few remaining major beer producers.

References

- Baumol, W.J., Panzar, J.C. and Willig, R. (1982). *Contestable Markets and the Theory of Industry Structure*. New York: Harcourt Brace Jovanovich.
- Bresnahan, T.F. (1989). Empirical studies with market power. In: Schmalensee, R. and Willig, R.D. (eds), *Handbook of Industrial Organization*. Vol 2. New York: North-Holland. 1011–1057.
- Boone, J. (2008). A new way to measure competition. *Economic Journal*, 118, 1245–1261.
- Beer Industry Update*. various years. Suffern, NY: Beer Marketer's Insights.
- Bulow, J. and Klemperer, P. (1999). The generalized war of attrition. *American Economic Review*, 89, 439–468.
- Cameron, C., Gelbach, J. and Miller, D.L. (2008). Bootstrap-based improvements for inference with clustered errors. *Review of Economics and Statistics*, 90(3), 414–427.
- Corts, K.S. (1999). Conduct parameters and measurement of market power. *Journal of Econometrics*, 88(2), 227–250.
- Färe, R., Grosskopf, S. and Lovell, C.A. Knox. (1985). *The Measurement of Efficiency of Production*. New York: Springer.
- Färe, R., Grosskopf, S. and Lovell, C.A. Knox. (2008). *Production Frontiers*. Cambridge: Cambridge University Press.
- Färe, R., Grosskopf, S., Seldon, B.J. and Tremblay, V.J. (2004). Advertising efficiency and the choice of media mix: A case of beer. *International Journal of Industrial Organization*, 22(4), 503–522.
- Fisher, F.M. (1987) On the misuse of accounting rates of return to infer monopoly profits. *Rand Journal of Economics*, 18, 384–396.
- Fisher, F.M. and McGowan, J.J. (1983). On the misuse of accounting rates of return to infer monopoly profits. *American Economic Review*, 73, 82–97.
- Genesove, D. and Mullin, W.P. (1998). Testing static oligopoly models: Conduct and cost in the sugar industry, 1890–1914. *Rand Journal of Economics*, 29(2), 355–377.
- Iwasaki, N., Seldon, B.J. and Tremblay, V.J. (2008). Brewing wars of attrition for profit and concentration. *Review of Industrial Organization*, 33, 263–279.
- Lerner, A.P. (1934). The concept of monopoly and the measurement of monopoly power. *Review of Economic Studies*, 1 (June), 157–175.

- Newsweek*. The battle of the beers, September 4, 1978, 60–70.
- Perloff, J.M., Karp, L.S. and Golan, A. (2007). *Estimating Market Power and Strategies*. New York: Cambridge University Press.
- Slade, M. (1995). Empirical games: The oligopoly case. *Canadian Journal of Economics*, 28, 368–402.
- Statistical Abstract of the United States* (2010). U.S. Bureau of the Census, Washington D.C.
- Steinberg, C. (1980). *TV Facts*. New York: Random House.
- Sutton, J. (1991). *Sunk Costs and Market Structures*. Cambridge: MIT Press.
- Tremblay, C.H. and Tremblay, V.J. (2011a). The Cournot-Bertrand model and the degree of product differentiation. *Economics Letters*, 111(3), 233–235.
- Tremblay, C.H. and Tremblay, V.J. (2011b). Recent economic developments in the import and craft segments of the U.S. brewing industry. In: Swinnen, J. (ed.), *The Economics of Beer*. New York: Oxford University Press. 141–160.
- Tremblay, C.H. and Tremblay, V.J. (2012). *New Perspectives on Industrial Organization: Contributions From Behavioral Economics and Game Theory*. New York: Springer.
- Tremblay, C., Horton Tremblay, M.J. and Tremblay, V.J. (2011). A general Cournot-Bertrand model with homogeneous goods. *Theoretical Economics Letters*, 1(2), 38–40.
- Tremblay, V.J. and Tremblay, C.H. (2005). *The U.S. Brewing Industry: Data and Economic Analysis*. Cambridge: MIT Press.
- Tremblay, V.J. Iwasaki, N. and Tremblay, C.H. (2005). The dynamics of industry concentration for U.S. micro and macro brewers. *Review of Industrial Organization*, 26(3), 307–324.