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An analysis of market power in the U.S. brewing industry:

A Simultaneous Equation Approach

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Introduction

The U.S brewing industry plays an important role in the U.S. economy. The industry had $88 billion in direct sales in 2010 and employed 1.8 million direct, indirect and induced workers in 1,678 breweries across the United States (U.S. Brewers Association, 2011). Beer is one of the top five beverages consumed in the U.S (Tremblay and Tremblay 2005). There are two major players in this industry- AB-Inbev and MillerCoors. AB- Inbev reported annual worldwide sales of $36 billion in 2010 with the US market representing 90 percent of total sales and MilllerCoors reported $3.2 billion in worldwide sales in 2009 with the US market representing 75% of their annual sales. (WSJ and Reuters 2011).

Despite the recent rapid growth of domestic specialty beer and imported beer over the past 30 years these two products still only account for roughly 15 percent of the beer consumed in the U.S. (Tremblay and Tremblay, 2005). On the other hand, those beers produced by the mass producing segment of the market account for 75 percent of beer sales in the U.S. (Tremblay and Tremblay, 2005). These products include domestic super premium, premium, and light beer products. Light beer is the most commonly purchased style of beer in the U.S accounting for 48.7 percent of total sales in 2009 (Crecca, 2009). The most well-known light beer products in this segment are Bud Light, Miller Lite, and Coors Light.

The U.S. brewing industry has seen significant increases in concentration over the past half century (US Census Bureau-various years). Concentration as an issue is a vastly explored topic in industrial organization studies due to its relationship with market power, or the ability of a firm to raise the price of a good higher than a competitive market price. In the U.S. brewing industry the increasing concentration and potential for market power are relevant public policy concerns. In addition, such issues are also of interest to economists, the media, general public and the industry itself. Such interest in market power is relevant due to its impact on optimizing total social welfare in a market. The number of macro-breweries has decreased from 350 breweries in 1950 to less than 20 today (Tremblay, Iwasaki, and Tremblay, 2005). Some of the major players in the industry, such as

Anheuser-Busch-InBev and MillerCoors, are the results of horizontal mergers between leading firms[1].

The increase in concentration in the industry can be dated back to the repeal of prohibition in 1933 when many pre-prohibition firms exited the market. For example, in 1915 there were 1,300 firms while in 1935 there were 750 firms. Although medium size breweries had a significant place in the market in the pre-prohibition era, there exit from the market allowed large scale firms such as Anheuser-Busch and Pabst to grow at rates of 173 and 87 percent respectively from 1934 to 1940. The small size firm departure from the industry was due to new legislation that forbade alcohol manufacturers from owning bars or saloons, requiring them instead to sell their beer to wholesalers that in turn would distribute their beverages to retailers (Stack 2003). Following World War II the total number of breweries operating fell dramatically. This signaled the growing importance of the large national breweries. Some of these larger firms included: Anheuser-Busch, Pabst, Schlitz, Coors, and Miller. From the mid-1940s to 1980 the five largest breweries saw their share of the national market grow from 19 to 75 percent (Adams 1995). In the 1980s the number of firms in the industry rebounded and started to increase. Stack (2003) argues this increase is almost entirely attributed to the dramatic rise of microbreweries which are firms producing 5,000-100,000 barrels annually compared to nearly 100 million barrels by Anheuser-Busch in 2000 (Beverage Industry 2003). However, although the number of firms has increased the overall industry remained very concentrated, with a three firm concentration ratio in 2000 of 81 percent (Stack 2003). As mentioned, recent developments of continuing consolidation in the industry were the merger of the Miller and Coors and Anheuser-Busch and InBev in the past decade.

There is an on-going debate over the impact of rise in concentration in the brewing industry as well as its competitiveness. For example, Keithahn (1978) argued that changes were due to technological change, while Greer (1971) saw the increase in concentration resulting from advertising. Further, some argue that the changes in concentration are a result of both factors, such as Elzinga (1973) and Sutton (1991) have argued. Gallet and Euzet (2002) found that competition in the industry was higher when demand was low and future industry profits were expected to be low. Advertising is a major strategic component of the brewing industry and firms use advertising to create barriers to entry. Gallet and Euzet found that advertising had a positive impact on market

[1] Anheuser-Busch and InBev merged in 2007 and Miller and Coos merged in 2008. Anheuser-Busch was the largest U.S firm and Miller and Coors were the second and third largest firms in the U.S pre-merger measured in sales.

power confirming earlier arguments by Commanor (1974) and Mueller and Harnm (1974). In a related study, Tremblay and Tremblay (1995) looked at the effect of advertising on social welfare in the U.S brewing industry and found that the market level of beer advertising is excessive from society's point of view and argue for advertising restrictions based on this excessiveness. High concentration tends to yield high market power (Pipoblabanan 2008). However, previous empirical studies show conflicting evidence regarding competitiveness of the U.S. brewing industry. Using market level data, Denney et al. (2002) found that market power was low in the U.S. brewing industry. Tremblay and Tremblay (2005) used firm level data from 1950-2001 for Anheuser-Busch to estimate market power in the industry. Their rationale was that since AB was the dominant firm in the industry, therefore, an estimation of its market power would be indicative of the industry's degree of market power. Tremblay and Tremblay's results show that AB had exerted market power since the late 1980's. The authors provided evidence of rising market power and diminishing competition in the industry. Furthermore, they found that the degree of market power increases as concentration increases.

Such on-going concerns and debate over the issue of U.S. brewing industry's rise in concentration and potential market power are relevant public policy concerns. In addition, such issues are also of interest to economists, the media, general public and the industry itself. Therefore, the purpose of this paper is to use empirical models to test the relationship between concentration and market power in the U.S. brewing industry using a contemporary simultaneous Structure-Conduct-Performance (SCP) approach.

Relationship between Concentration and Market Power

Firms that operate in an industry where demand is relatively inelastic and where firms have relatively large market shares will also be firms with substantial degree of market power as measured by the Lerner index or the firm's price marginal cost distortion (Pepall et. al. 2002). This is based off of oligopoly theory and firm profit maximization. Using the Cournot model, one can show a direct link between market concentration and performance. This can be shown by maximizing profit, (π), for a firm (firm i). Assuming q_i is the amount produced by firm i, P is the price of the good which is a function of total industry supply Q ($\sum_{i=1}^{n} q_i$), and C is the cost for firm i, then the objective function for firm i is given by:

$$\pi_i = P(Q)q_i - C(q_i)\,. \qquad (1)$$

Profit maximization for firm *i* yields:

$$\frac{\partial \pi_i}{\partial q_i} = \frac{\partial P}{\partial Q} q_i + P - \frac{\partial C(q_i)}{\partial q_i} \quad (2)$$

$$\frac{Q}{P}\frac{P}{Q}\left[\frac{\partial P}{\partial Q} q_i + P - \frac{\partial C(q_i)}{\partial q_i}\right] = 0 \quad (3)$$

$$P\left[1 + \frac{S_i}{\varepsilon_d}\right] = MC \quad (4)$$

$$\frac{P - MC}{P} = \frac{S_i}{\varepsilon_d} \ . \quad (5)$$

The left hand side of Eq. (5) shows the price-cost margin or markup (PCM) and on the right hand side S_i ($S_i = \frac{q_i}{Q}$) is the share of the market that firm *i* has and ε_d is the inverse elasticity of demand. Multiplying each side of Eq. (5) by S_i and aggregating for *N* firms in the industry where H is the HHI index.

$$\sum_{i=1}^{N} S_i \left[\frac{P - MC}{P}\right] = \frac{\sum_{i=1}^{N} S_i^2}{\varepsilon_d} \quad (6)$$

$$\frac{P - MC}{P} = \frac{H}{\varepsilon_d} \ . \quad (7)$$

Eq. (7) formally shows that if the elasticity of demand is relatively inelastic and the HHI is high there will be high levels of market power as measured by the PCM. As discussed thus far, the level of concentration in the U.S. brewing industry has been rising steadily over the past 30 years. Additionally, many have determined that the elasticity of demand in the brewing industry is relatively inelastic with a mean value in studies from 1972 to 2003 amounting to -0.49 (Tremblay and Tremblay, 2005). Now that the theoretical relationship between concentration and market power is understood, we can see why there are concerns that arise in terms of market power in the U.S. brewing industry. We will now investigate the empirical methods used in determining whether that relationship is present in an industry.

A Modified Structure Conduct Performance (SCP) Approach

Significant advancement in SCP literature took place with the advent of simultaneous equation modeling, replacing the often maligned single equation modeling used by Bain. This was because Bain's view that strategic choices (conduct) do not have an important influence on industry structure was deemed to be incomplete (Porter, 1979). It was argued by Strickland and Weiss (1976) that there are feedback effects of firm conduct (strategy) on market structure. Therefore, using a single equation model with the relationship between concentration and market power would be bias (Strickland and Weiss, 1976). The simultaneous approach has since been adopted in the literature to take into account the multiplicity of causality between the different variables in the SCP framework; such as the effect of conduct (advertising) on concentration or concentration on advertising. In addition, a simultaneous model with a lagged structure is argued to be superior to the simultaneous model alone due to the fact that variables may affect one another over time and not only contemporaneously. Therefore, a simultaneous equation method introduced by Strickland and Weiss (1976) and Martin (1979) and further refined by Kambhampati (1996) and Steigert et al. (2009) is used in the analysis of the U.S. brewing industry in this paper.

The framework for the structure, conduct and performance equations used in this paper can be represented by the model below, where S_t represents structure, C_t represents conduct and P_t represents profitability. Also, *t* represents the current period and *t-1* represents a lagged period to allow for structural adjustment.

$$
\begin{aligned}
S_t &= f(C_{t-1}, P_{t-1}), \qquad (8)\\
C_t &= f(S_t, P_{t-1}) \text{ , and}\\
P_t &= f(S_t, C_t)
\end{aligned}
$$

A few hypotheses are proposed using equation (8): (i) lagged profitability is expected to impact structure because successful firms have more resources to invest and grow; (ii) based on Dorfman and Steiner (1954), we expect that lagged profitability will have a positive effect on advertising; (iii) we also expect concentration to be positively related with advertising based on Cable (1972). Advertising, as a conduct parameter, is likely to have a positive impact on profitability, as advertising is known to create barrier to entry; and (iv) finally and most important of all, we expect that there will be a positive relationship between concentration and profitability.

Equation (8) is transformed into a system of empirical equations using modified versions of both Kambhampati (1996) and Steigert et al. (2009). In this system of equations, *HHI* represents the Herfindahl Hirschman index, *ADV* represents advertising to sales, *KO* is capital equipment, *PROFIT* is profitability measured by the PCM, *MES* is minimum efficient scale, and *GROWTH* is the growth rate measured as a percentage change in sales. The subscript *t-1* indicates a lagged variable. After adding an error term to all the models, the system of equations is as follows:

$$HHI_t = \alpha_0 + \alpha_1 ADV_{t-1} + \alpha_2 PROFIT_{t-1} + \alpha_3 MES_{t-1} + \epsilon_t \quad (9)$$

$$ADV_t = \beta_0 + \beta_1 GROWTH_t + \beta_2 PROFIT_{t-1} + \beta_3 HHI_t + \mu_t \quad (10)$$

$$PROFIT_t = \gamma_0 + \gamma_1 HHI_t + \gamma_2 ADV_t + \gamma_3 MES_t + \theta_t \quad (11)$$

Data

The necessary brewing industry data was collected for the period of 1980-2009. All prices used in the analysis are in 1984 dollars and some variables in the analysis needed to be interpolated. In addition, advertising, minimum efficient scale (MES), and HHI index data needed to be interpolated for the years various due to data limitations. The price of beer is measured in 31 gallon barrels and was deflated using the beer price index. Variable descriptions, their sources, and the descriptive statistics are found in tables 1 and 2.

Table 1: SCP Model Variables and Descriptions

Variable	Description	Source
HHI_t	Herfindahl-Hirschman Index	*Annual Survey of Manufactures (1980-2009). Tremblay and Tremblay (2005)*
ADV_t	Yearly advertising expenditures as a percentage of value of shipments.	*Annual Survey of Manufacturers(1980-2009)*
$PROFIT_t$	(Value of Shipments – Total Cost) / value of shipments	*Annual Survey of Manufacturers and NBER (1980-2009)*
$GROWTH_t$	Change in quantity produced year-over-year in thousands of 31-gal barrels	*Brewers Almanac(2011)*
MES_t	Minimum efficient scale	*Tremblay (2005)*

Table 2: Descriptive Statistics

Variable	Mean	Std.	Minimum	Maximum
HHI_t	2918.9	659.882	1533	4200
ADV_t	0.0523	0.008	0.0388	0.066
$PROFIT_t$	0.390	0.100	0.173	0.516
$GROWTH_t$	0.005	0.011	-0.022	0.025
MES_t	19.163	2.507	15	23.367

Estimation Procedures

Due to the endogeneity problem that is present in the SCP system of equations (9)-(11), using an OLS estimation of each equation independently would result in biased estimates because it violates the assumption of no correlation of the dependent variables and the error term. We utilize a two stage least square (2SLS) approach to remove simultaneous equation bias. For the first stage of the 2SLS method, and following Steigert el al. (2009), we use the exogenous variables of: lagged advertising (*ADV*), growth (*GROWTH*), lagged capital intensity (*KO*), and lagged profitability (*PROFIT*) as instruments for estimating the endogenous variables of *PROFIT, ADV,* and *HHI*. The second stage consists of regressing all the estimated endogenous variables of *ADV, PROFIT,* and *HHI* to estimate the three structural equations of equations (9)-(11). For theoretical details on the 2SLS approach see Wooldridge (2003).

Empirical Results

Regression results are presented in table 3. Some interesting results are evident from the estimation. First, in the concentration model (HHI_t) all signs are significant and have the expected signs. As hypothesized, advertising has led to higher levels of concentration in the U.S. brewing industry. Tremblay and Tremblay (2005) who argue that, "advertising in the U.S brewing industry has been seen as a barrier to entry due to the economies of scale achieved by macro brewers in national advertising campaigns," which, not surprisingly, increase concentration. Lagged profitability also has a positive and significant effect on concentration suggesting that higher profit levels in the prior period leads to higher levels of concentration in the next period. This relationship could be explained by firms investing in larger advertising campaigns as well as investing in more capital equipment with excess profits, thus creating barriers to entry in the industry. Finally, it was hypothesized that technology created a barrier to entry in the industry and this hypothesis is confirmed by a positive sign on lagged MES. This is because as MES increases it represents firms

needing to produce more output in order to operate cost efficiently. Therefore, larger operation capacity is needed and capital requirements increase for the industry, this in turn creates a barrier to entry in the industry.

Table 3: SCP Regression Results

Independent Variables	***Parameter***	***Conc.(HHI) Model***	***Advertising Model***	***Profitability Model***
Intercept		-1619.13 (-7.67)***	0.035 (4.80)***	0.101 (1.15)
MES	MES_t			0.010 (1.27)
Lagged MES	MES_{t-1}	167.58 (7.88)***		
HHI	HHI_t		0.000036 (5.81)***	$1.04x10^{-4}$ (3.11)***
Advertising	ADV_t			-3.57(-3.84)***
Lagged Advertising	ADV_{t-1}	10452.12 (4.00)***		
Growth	$GROWTH_t$		0.169 (1.95)**	
Lagged Profit	$PROFIT_{t-1}$	2092.18 (3.94)***	-0.22 (-5.81)***	

*** Indicates significance at 1% level; **Indicates significance at 5% level; *t-statistics* in parentheses.

The advertising equation has some interesting results as well. One, growth has the expected sign and is significant. This indicates that growth in the industry's output results in higher advertising expenditures. This can be explained by firms attempting to capture the increasing demand in the industry through higher advertising expenditures. Lagged profitability is of considerable interest. The negative sign suggests that as profitability increases in the previous period firms do not advertise more as a result. This goes against the Dorfman-Steiner (1954) condition which evokes a positive relationship between advertising and profitability for a profit maximizing monopolist (with no causality specified)[2]. However, as Resende (2007) argues, the positive sign evoked by the Dorfman-Steiner condition can be questioned as it refers to a monopoly setup, whereas in the case of the U.S. brewing industry it is more likely an oligopoly is present.

Finally, the sign on concentration is positive and significant indicating higher levels of concentration result in higher levels of advertising. As Gupta (1983) argues, the loss of demand suffered by an individual firm due to enhanced advertising by a rival increased with the degree of mutual dependence, therefore, two opposite arguments hypothesis regarding the relationship

[2] Following, $\frac{P_A A}{PQ} = \left(\frac{P-MC}{P}\right)\delta$, where $P_A A$ is total industry advertising, PQ is value of shipments, and δ is the elasticity of output demand with respect to advertising. This indicates that as advertising to sales increases with the Lerner index, $\left(\frac{P-MC}{P}\right)$ and the effectiveness of advertising (Iwasaki 2008).

between advertising and concentration are suggested. One, if mutual dependence *is not* recognized among firms and they take their decisions independently, the likelihood of a rivalry via advertising increases with concentration, which then suggest a positive relationship between advertising and concentration. On the other hand, if mutual dependence *is* recognized then joint decision making among firms is possible and collusion among firms to avoid mutually cancelling advertising increases with concentration suggesting a negative relationship between concentration and advertising. Our results suggest the first argument made by Gupta (1983), that mutual dependence was not recognized among firms and a positive relationship between concentration and market power resulted.

The last equation is the profitability model and is of considerable interest as it estimates a relationship between concentration and profitability. The positive and significant sign on the concentration variable indicates that higher concentration results in higher profitability levels. This fails to reject our hypothesis that higher levels of concentration have led to higher levels of concentration in the brewing industry. This finding follows that of Tremblay and Iwasaki (2008) who found a similar relationship in the U.S. brewing industry. The negative and significant relationship of advertising on profitability is unexpected. However, since the relationship between lagged profitability and advertising is negative, along with the fact that causality in the Dorfman-Steiner condition can run both ways, a negative relationship between advertising and profitability is expected in this system of equations. Lastly, the positive relationship between MES and profitability is positive and significant. This suggests that a barrier to entry is created when firms invest in more capital in order to achieve efficient production through larger production facilities.

It was hypothesized earlier that the two major factors led to increasing concentration in the U.S. brewing industry; advertising and technological change. Both of these factors were argued to create barriers to entry in the industry. One, firms advertising on a national market scale is able to achieve economies of scale in advertising. However, the cost required to advertise on such a large scope creates a barrier to entry for smaller firms wishing to advertise nationally. Similarly, the technological change that the brewing industry experienced required large firm sizes in order to achieve economies of scale in production. This technological condition in the U.S. brewing industry was also hypothesized to create a barrier to entry in the industry.

The SCP model was also used to fulfill another goal of this paper: evaluate market power in the U.S brewing industry using an SCP approach. In an earlier section, the theoretical linkage between

concentration and market power was established, and the parameter γ_1 in Eq. (11) was hypothesized to be positive. Results in Table 3 established here that higher levels of concentration have led to higher levels of profitability in the U.S. brewing industry as measured by the PCM. Therefore, the results from the SCP estimates here imply that higher levels of concentration have led to higher levels of market power in the U.S. brewing industry.

Conclusion and Implications

The goal of this paper was to utilize empirical models to: determine the factors leading to higher concentration in the U.S. brewing industry and analyze market power in the U.S. brewing industry using an SCP approach. The period of analysis was from 1980-2009. Using the SCP model, it was shown that both technology and advertising led to higher levels of concentration in the industry. In addition, the SCP model estimated that higher levels of concentration in the industry have led to higher levels of profitability measured by the Lerner index.

The policy use of this analysis must be taken with a grain of salt. While we have shown that higher levels of concentration result in higher levels of profitability in the brewing industry in the SCP analysis, in a parallel NEIO analysis (not presented here) the collusive market power actions hypothesized were not substantiated. Therefore, in terms of the policy analyst and antitrust litigator, it would be improper to simply assume higher concentration is an unfavorable condition in the U.S. brewing industry.

In future analysis it would be advantageous to separate the analysis of the industry between craft breweries and macro breweries. However, this seperability in analysis is faced with strong data limitations as it necessitates aggregation of individual firms accounting data. Nevertheless, separate sectorial analysis of the industry would be useful for policymakers because it would not simply aggregate macrobrewers actions with craft or microbrewers actions.

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