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Three Essays on Craft Beer and Craft Breweries

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Chapter 1 empirically estimates the effects of vanity and quality on the demand for craft beer. While large "macro" breweries have historically dominated the US beer industry, the industry has seen a significant rise in smaller "craft" breweries. Two possible sources of consumer preferences leading to the growth of craft breweries' beer have been forwarded. The first, quality, suggests that craft beers are simply better. The second, what I term "vanity", suggests that the non-macro image and branding increase consumer utility. The goal of this paper is to disentangle empirically these two sources of growth. Data on beer sales, prices, and beer brand characteristics from six U.S. cities is combined with brewery ownership data and a quality measure of beer derived from a popular beer rating site. One cannot measure consumer preference for craft beer directly. A negative coefficient on craft branding shows up in past analyses because, by definition, craft beer has a substantially smaller market share than macro beer. To capture craft beer's vanity effect, I exploit the fact that within the dataset some macro breweries produce craft beers. This allows me to compare beers with similar market shares. Splitting up craft beer into true craft and macro craft, I find consumers prefer the former to the latter, showing a vanity effect of true craft beer. Overall, both quality and vanity have been driving craft beer growth, but vanity has a larger impact than quality.

Chapter 2 empirically estimates the effect of on premise beer sales on the number and production of microbreweries. Many states in the US use a three-tier system for beer distribution. Under a three-tier system, breweries must use distributors to get their products to consumers. Recently, macro breweries have begun trying to vertically integrate with some of their distributors. This paper looks at the competitive effects of vertical integration on craft breweries. To model the three-tier system, a Bertrand competition model with product differentiation and heterogenous firms is used. This paper finds when a macro brewery vertical integrates, fewer craft breweries enter the market. Also, the vertically integrating macro brewery forecloses on craft breweries when there are only two distributors in a market. Lastly, vertical integration decreases consumer welfare when there is low product differentiation.

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Chapter 3 builds a theoretical model to look at the competitive effects of vertical integration on craft breweries. In the beer industry, states control their beer regulations. On premise beer sales allow craft breweries to operate an onsite tap room at their brewery. Allowing on premise beer sales gives microbreweries the opportunity to increase their profits and build their brand in a highly concentrated market. Since 1989, 33 states have passed laws to allow on premise beer sales. This paper looks at how on premise beer sales affects the number and production of microbreweries, a type of craft brewery. A difference-in-differences approach is used to measure the effect on premise beer sales has on microbreweries. Allowing on premise beer sales increases the number and production of microbreweries. Passing an on premise beer sales law leads to an immediate increase in the number of microbreweries and an eventual increase in microbrewery production. States who have not passed on premise beer sales will see an average increase of 4 microbreweries and an average increase in production of microbrewed beer by 35% if a state passes an on premise beer sales law.

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Chapter 1

Quality or Vanity? A Look at Craft Beer

1.1 Introduction

The U.S. beer industry is in the midst of a structural shift. Traditionally large macro breweries like MillerCoors and ABInbev have dominated the beer market, but craft breweries such as Dogfish Head, Boston Beer Company, New Belgium, and Sierra Nevada are leading the way to a new era in the beer industry, the rise of the craft brewery. These craft breweries produce craft beers, which are highly differentiated from macro beers. Over the last decade, the market share of craft beer, by volume, has consistently grown from just 2.4% in 2001 to 12.3% in 2016 (Brewers Association, 2016). Industry experts expect this growth of market share to continue for the near future (Brewers Association, 2016).

What has been driving this growth of craft beer? There are several hypotheses for the increased growth of craft beer consumption. The first is the branding of these breweries' beers as craft. Tremblay and Tremblay (2005) argue that consumers may use craft beer as a way of showing off their social status. Orth, McDaniel, Shellhammer, and Lopetcharat (2004) make the case that the craft branding influences consumers to purchase craft beer. The Brewers Association, the trade group for craft breweries, has heavily pushed the craft labeling to help improve consumer's awareness of craft beer and help small craft breweries position themselves to succeed in a heavily concentrated market. The idea of consumers benefiting from the craft branding gives craft beer an aspect I term "vanity". A second hypothesis for the growth is the high quality beer craft breweries produce. Clemons, Gao, and Hitt (2006) find that ratings of beers, used as a measure

of quality, has helped increase the growth of sales for craft breweries. Ratings allow consumers to observe information about a beer before purchasing, giving them the opportunity to learn more about a beer's quality and make a well-informed purchase.

This paper measures the effect beer quality and the craft branding has on a consumer's decision to purchase craft beer, providing the first test of these competing hypotheses for the growth of craft beer. To tease apart these different motivations for consumers, this paper uses beer ratings from Beer Advocate, a beer rating website, as a measure of quality. Beer ratings can be viewed as a quality measure because they vertically differentiate beers for consumers. To capture craft beer's vanity effect, beers are broken up into categories by brewery type, which depends on a brewery's production volume, ownership, and production location. Categorizing and comparing breweries by type will capture vanity because it will reveal consumer preferences for different types of breweries. To test these two hypotheses the demand for beer is estimated with beer quality and brewery types.

A number of studies have estimated the demand for beer (Hausman, Leonard, & Zona, 1994; Pinkse & Slade, 2004; Rojas & Peterson, 2008; McCluskey, Mittelhammer, & Gonzalez, 2014). All but one of these papers estimates the demand for macro and imported beer, with only McCluskey, Mittelhammer, and Gonzalez (2014) examining craft beer. The authors find a small cross price elasticity between craft and macro beers, establishing that consumers who drink craft beer value craft beer more than macro beer. The data McCluskey, Mittelhammer, and Gonzalez use for their analysis only contains the city of Chicago and is from the early 1990's. Their data doesn't give a good representation of craft beer in the market today. Similar to the results in this paper for the craft branding coefficient, they find the branding has a negative impact on beer sales when compared to macro beer. A negative coefficient on craft branding shows up in these analyses because by definition craft beer is small and has a substantially smaller market share than macro beer.

This paper gets around the problem of comparing craft beer to macro beer to capture craft beer's vanity effect by exploiting the fact that some macro breweries produce craft beers. Macro breweries have either acquired a craft brewery and produce beer under the craft brewery's name or have created their own craft beer brands under a different brewery name.[1] Splitting these two types of breweries into true craft and macro craft allows me to estimate the vanity effect of craft beer when competing with comparable beers that have similar market shares. The results in this paper show true craft has a vanity effect over macro craft.

None of the previous beer demand estimation papers have quality of beers in their datasets. Also, this

[1] An example of a macro brewery producing craft beer brands is MillerCoors who has a company, Tenth and Blake Beer Company, which produces craft beers under multiple breweries.

analysis utilizes a novel data set that provides a good representation of craft beer in the US beer market today, giving this paper the ability to update the estimation of the demand for beer and test the hypotheses for the increased growth of craft beer.

1.2 Background

Beer is primarily split up into three categories: macro, craft, and imported beer. These beers not only differ in their product characteristics, but also in their production process. Breweries that produce macro beers produce more than 6 million barrels (186 million gallons) a year, where breweries that produce craft beers produce fewer than 2 million barrels (62 million gallons) a year. There is a gap of over 4 million barrels (124 million gallons) between these categories because no craft brewery produces between 2 and 6 million barrels a year.[2] For this paper, a craft brewery will be defined as being less than 30% owned by a non-craft brewery and producing less than 6 million barrels a year.[3] This definition is not as strict as the Brewers Association's definition of a craft brewery.[4] In the dataset there are some beers that are marketed as craft beer, but macro breweries produce them.[5] Because of this, craft beers are split up into true craft, beers produced by craft breweries and macro craft, beers produce by macro breweries. Splitting up craft beer this way captures the vanity effect of craft beer. The last category, imports, are beers produced outside of the U.S. and is not distinguished by brewery size.

Not only do macro and craft breweries differ in production volume, but also in the ingredients used to produce their beers. Four main ingredients make up beer: water, barley (or other cereal grains), hops, and yeast. All these ingredients create the flavor characteristics of beer. When comparing macro and craft beer flavor characteristics, these beers can be broken into two broad styles lager and ale because of the type of yeast that ferments these beers. Most macro beers fall into the lager style, while most craft beers fall into the ale style. Lager yeast generally produces a very clean and crisp beer without imparting any distinctive flavor characteristics. Ale yeast gives beer higher levels of flavor than lager yeast, resulting in fruity or spicy

[2]There are two craft breweries that are the exception; Boston Beer Company (Sam Adams) and Yuengling. They each produce just over 2 million barrels of beer a year.

[3]As a robustness check both Sam Adams and Yuengling are excluded from the craft breweries. The omission of them from craft doesn't affect the sign or significance of the estimation results.

[4]*Small*: Annual production of 6 million barrels of beer or less (approximately 3 percent of U.S. annual sales). Beer production is attributed to the rules of alternating proprietorships.
Independent: Less than 25 percent of the craft brewery is owned or controlled (or equivalent economic interest) by an alcoholic beverage industry member that is not itself a craft brewer.
Traditional: A brewer that has a majority of its total beverage alcohol volume in beers whose flavor derives from traditional or innovative brewing ingredients and their fermentation. Flavored malt beverages (FMBs) are not considered beers.
`https://www.brewersassociation.org/statistics/craft-brewer-defined/`

[5]A list of the macro craft beers is in the Table 1.5.

flavors. Macro and craft beers also differ in the barley and hop ingredients used in the brewing process. Macro breweries use adjuncts, such as rice and corn, that gives little to no flavor to beer. Craft breweries, on the other hand, almost always use malted barley, which gives craft beers a wide spectrum of flavors. Also, craft breweries add more hops to their beers than macro breweries giving craft beers a hoppier profile. The ingredients used in craft beers give them a more diverse flavor profile.

Within the lager and ale categories there are additional styles. These styles are differentiated by characteristics such as flavor, aroma, alcohol content, and color.[6] A brand of beer brewed by a brewery is a specific style of beer. In the data set each observation is a beer product, which is made up of a specific brand, container type, container size, and packaging size. The container type can be one of two types; aluminum cans or glass bottles. Containers vary in size from 8 ounces to 33.8 ounces for cans and 7 ounces to 40 ounces for bottles. Packaging size is the number of containers in a given products packaging, which varies from a single beer up to 30 beers. In this analysis the style of light beer is not included because almost all craft breweries do not produce a light beer, Sam Adams and Yuengling being the only ones. Because nearly no craft breweries produce light beer, it is highly unlikely light beer drinkers would substitute light beer for craft beer or vice versa for craft beer drinkers.

The beer ratings used, as the measure for quality, come from the beer rating website BeerAdvocate. These ratings are on a five-point scale, with 0 being the lowest and 5 being the highest. Ratings may be biased towards craft and/or imported beers because many users who rate beers are beer enthusiasts. Beer enthusiasts may rate macro beers lower than the average beer drinking because of their beliefs. This could create a problem for beer ratings because they will no longer be an unbiased measure of beer quality. If this were a problem, the coefficient estimate on quality would be biased downwards because macro beer has such a large market share. The estimation results show that beer ratings have a positive and significant affect on consumer utility, indicating beer ratings possible bias is not a problem.

The beer industry before Prohibition[7] looked similar to the landscape of the beer industry today, an abundance of small breweries. Before Prohibition there were over 1,300 breweries operating in the US, but after there were just over 700. As time passed a shift towards consolidation began occurring in the beer industry. The consolidation took off during the 60's and 70's, significantly changing the US beer industry landscape. This resulted in a highly concentrated industry (Tremblay & Tremblay, 1988). By 1978, there were 89 breweries remaining, the fewest the US has ever seen. The increased concentration in the

[6]See Beer Judge Certification Program `http://www.bjcp.org/docs/2015_Guidelines_Beer.pdf` for a more in-depth explanation of beer styles or Brewers Association beer style guidelines `https://www.brewersassociation.org/wp-content/uploads/2015/03/2015-brewers-association-beer-style-guidelines.pdf`.

[7]Prohibition was enacted by Amendment 18, which was ratified in 1919 and repealed by Amendment 21 in 1933.

beer industry came from breweries exploitation of scale economies, changes in marketing methods, and the introduction of new products (Elzinga & Swisher, 2005). It was believed given the increasing concentration of the beer industry, only a handful of breweries would be operating today (Tremblay & Tremblay, 1988). During this time of heavily increasing concentration, Anchor Brewing Company in San Francisco, the first craft brewery, opened their doors in 1965. This marks the beginning of the craft brewery movement in the US. The popularity of craft beer increased when the US passed a law in 1978 allowing citizens to homebrew beer. In the late 1990's and early 2000's the trend of persistent growth reversed when a large number of craft breweries closed their doors. The large decrease of breweries was due to the low quality beers some craft breweries were producing and distribution bottlenecks (Elsinga, Tremblay & Tremblay, 2015). Tremblay and Tremblay (2005) argued the craft brewery boom appeared to be over at around 1,400 craft breweries. In 2016, the number of craft breweries has grown to over 5,000 with more than 1,000 in the process of opening (Brewers Association, 2016).

1.3 Data

Sales and retail price data for beer products used in this analysis comes from Nielsen scanner data, which includes six cities across the US; Boston, Chicago, Hartford - New Haven, New York, San Francisco, and Seattle. Nielsen collected the market data weekly from November 2009 to October 2012. The data is aggregated up to monthly data by combining weeks into months. Weeks that overlap two months are included in the month where the week had the most days. The average price of a beer product for each month is calculated by weighting each weeks price by the units sold. Sales of beer products with the same beer brand are aggregated together and measured in 12 ounce units. This keeps the sales units uniform across beer brands. The price for each 12 ounce unit of a beer brand is weighted by the units sold of each brand's product type. Product characteristics included in the Nielsen data are package size and the brewery who brews the beer brand. Breweries are broken up into macro, craft, and import breweries. Craft and import breweries are split up into two sub types. True craft and macro craft for craft breweries, and North American imports and World imports for import breweries. Other product characteristics in the data set are alcohol by volume (ABV), consumer ratings of beers, and beer styles for each beer brand, which are pulled from BeerAdvocate. Beer styles are grouped together using the Beer Judges Certification Guidelines. Variable summary statistics are in Table 1.1 and variable descriptions are in Table 1.2.

The demographic data source is the 2009 to 2012 Current Population Survey for each of the cities included in the dataset. The demographics used in the estimation are income and age. Demographics from

each market are generated using a random sample of individuals to capture demographic characteristics of consumers for the model. Consumer demographics vary across each market, assuming different consumers are making the decisions. Even though consumer's characteristics vary across markets, within a market a consumers characteristics remain the same for all the products in a given year. The unobservable consumer characteristics are drawn from a standard normal distribution with each market having ns simulated consumers.[8]

Following other beer demand estimations Pinkse and Slade (2004), Rojas and Peterson (2008), and McCluskey, Mittelhammer, and Gonzalez (2014) average package size, abv, and beer styles are used as control variables in this analysis. These characteristics are used because consumers may want to purchase a large amount of beer for a party, want a higher alcohol beer, or prefer a specific beer style. Therefore, these characteristics may influence a consumer's choice of beer instead of beer quality or the craft branding.

Macro beer constitutes 59% of sales in the data, import beer 28%, and craft beer 13%, closely resembling market shares in the beer market today. Between 2010 and 2012 craft beer's market shares were from 5% to 6.5%. In the data, craft beer has a larger market share by volume because light beers are not included in this analysis. Macro beer has the lowest average price per 12 ounces at \$0.75, while import beer has the second lowest at \$1.19, and craft beer has the highest at \$1.24. Macro beers come in with the lowest price because they are able to utilize scale economies unlike craft and import breweries. Tremblay, Iwasaki, & Trembaly (2005) estimates the minimum efficient scale of production is more than 23 million barrels a year, which no craft brewery comes close to. Another reason for the price disparity is macro breweries use of adjuncts such as rice and corn to cut down on costs. Although, raw materials are a small fraction of the total cost in producing beer. The higher price of imports comes from increased costs due to import taxes and transportation costs. Craft beer has the highest price due to the use of premium ingredients and the small scale of production, which doesn't allow craft breweries to utilize economies of scale like macro breweries.

Craft beer has an average rating of 3.53, while macro beer has an average rating of 2.57 and import beer 3.2. This is not surprising given craft breweries pride themselves in using high quality ingredients, while macro breweries use lower cost ingredients. Macro breweries only produce 11 different styles, with the American Adjunct Lager style making up 91% of the beers sales for macro beers. Import breweries produce 27 styles, which is a few more than macro breweries. Craft breweries produce 46 styles, producing 37 different styles than macro breweries. Because craft breweries produce more styles than macro breweries, craft breweries can fill the niche gaps, leading to more growth of craft beer. (Tremblay & Tremblay, 2005;

[8]This assumes the unobservable characteristics are generated from a standard normal distribution in the population and the number of consumers drawn is 50.

Carroll & Swaminathan 2000).

1.3.1 Instruments

A well-known problem when estimating demand are prices will be correlated with the error term, requiring the use of instruments for prices. The correlation between prices and the error term occurs because the error term picks up both supply and demand shocks. Not instrumenting for price will lead to incorrect estimation of price and other demand factors. To deal with the endogeneity of prices, instrumental variables are used to control for supply side or demand side shocks. Instruments need to be correlated with prices and uncorrelated with the error term. A starting point to find instruments is to use variables from either the supply or demand sides that can control for supply side or demand side shocks.

A common instrument used in demand estimation comes from Hausman, Leonard, and Zona (1994) who uses prices of products in different markets as instruments. Using other markets prices as instruments is possible because products across markets will share the same cost structure, but will be uncorrelated with demand shocks in other markets. However, prices from other markets won't work in this analysis because many craft breweries are regional and their beers only show up in a single market. Therefore, this paper follows Nevo (2001) who uses brands as instruments.[9] The reason to use brands is similar to Hausman, Leonard, and Zona's intuition about prices in other markets; brands will be correlated with prices because of similar production costs, but uncorrelated with demand side shocks. Using brands assumes that breweries exogenously choose a beer brand's characteristics. These instruments will work if brands are in the characteristics space exogenously (Nevo, 2001). Brands as instrument will be invalidated if breweries are reacting to demand shocks when choosing a beer brands' characteristics.

1.4 Demand Estimation

A few different discrete choice models exist to estimate the demand for products with aggregated sales. Following Berry (1994), Berry, Levinsohn, and Pakes (1995) and Nevo (2000(a,b), 2001), the BLP model, falling in the random coefficient logit model class, is used in this analysis to estimate the demand for beer. The BLP model was chosen because it takes into consideration individual's valuation of product characteristics, which gives more realistic substitution patterns across products than the logit model. Papers that estimate

[9]To use prices from other cities as instruments the data set drops from 253 brands to 17 brands. When running the model with prices from other markets as instruments, the results do not change for quality, but the craft branding coefficient becomes positive and significant. The only problem with reducing brands down to the ones that are in all markets is it only keeps one craft beer brand, Sam Adams Lager. Using this instrumental variable approach reduces the dataset down to much and does not give a good representation of craft beer.

the demand for beer use the Almost Ideal Demand System (Hausman, Leonard, & Zona, 1994) and nested logit (Rojas & Peterson, 2008; McCluskey, Mittelhammer, & Gonzalez, 2014). These demand estimation methods will not work for this analysis because the models nest on brewery type or beer style. To get at craft beer's vanity effect, I need to compare true craft beers to macro craft beers and grouping beer brands by brewery type or beer style will not allow me to capture the vanity effect of craft beer.

Suppose a consumer has a choice between $j = 1, \ldots, J$ beer brands in a market. The consumer's indirect utility when consuming beer brand j is:

$$\begin{gathered} u_{ijt} = v_{ijt} + \epsilon_{ijt} = x'_{jt}\beta_i - p_{jt}\alpha_i + \xi_{jt} + \epsilon_{ijt} \\ i = 1, \ldots, I_t, \qquad j = 1, \ldots, J_t, \qquad t = 1, \ldots, T \end{gathered} \tag{1.1}$$

where t denotes an observed market and i is the ith consumer in market t. The vector x_{jt} consists of observed beer brand characteristics, which remain constant across markets, and p_{jt} is the price of beer brand j in market t. The term ξ_{jt} is the unobserved beer brand characteristics, which includes flavor (this can vary drastically within a style of beer), a direct measure of the hoppiness and maltiness, and the freshness of a beer. The error term is ϵ_{ijt} and (α_i, β_i) are the individual specific coefficients.

Given beer brand characteristics remain the same across all markets and consumers, the unobserved characteristics may change. Unobserved characteristics of a beer may change if a brewery changes the production process or if the beer is mishandled. Mishandlings can happen on the end of the brewery, distributor, or retailer. Some of these mishandlings are sending out an infected batch of beer, storing beer incorrectly, or selling out of date beer. Also, the longer a beer travels to get to consumers, the greater the chance of a beer's characteristics changing. As many in the brewing industry say, beer is best drunk fresh. There is no way an econometrician can observe these possible changes to a beer's characteristics or to disentangle which channel affected the beer.

The unobserved error term can be split into a brand specific error term and a market specific error term for each beer brand. The broken up error term is $\xi_{jt} = \xi_j + \triangle\xi_{jt}$, where ξ_j captures the brand specific mean unobservables, and $\triangle\xi_{jt}$ captures the market specific variation. The market specific error will capture brand quality differences across markets, but not within market variation. The brand specific unobservables are captured by brand specific dummy variables when estimating the mean utility for each beer brand, assuming the brand specific error does not vary.

In the BLP model the parameters vary across consumers allowing for each consumer to have different valuations of the observed beer brand characteristics. Estimation of the parameters is split up into two

parts. Mean coefficients, which remain the same for all consumers and individual coefficients, which capture individual's valuation for beer brand characteristics. The coefficients are broken up as

$$\begin{pmatrix} \alpha_i \\ \beta_i \end{pmatrix} = \begin{pmatrix} \bar{\alpha} \\ \bar{\beta} \end{pmatrix} + \Pi D_i + \Sigma v_i \tag{1.2}$$

where D_i are the observed individual characteristics, Π is a matrix of coefficients measuring how the observed beer brand characteristics vary with observed individual characteristics, v_i are the unobserved individual characteristics, and Σ is a matrix of how coefficients vary with the unobserved individual characteristics.

For easier estimation the indirect utility is broken up into a mean utility, where all consumers have the same mean utility in a given market and a deviation from the mean utility for each individual consumer. Combining equations (1) and (2)

$$\begin{aligned} u_{ijt} &= \delta_{jt}(x_{jt}, p_{jt}, \xi_j, \triangle\xi_{jt}; \theta_1) + \mu_{ijt}(x_{jt}, p_{jt}, v_i, D_i; \theta_2) + \epsilon_{ijt} \\ \delta_{jt} &= x'_{jt}\bar{\beta} - p_{jt}\bar{\alpha} + \xi_j + \triangle\xi_{jt}, \qquad \mu_{ijt} = [p_{jt}, x_{jt}]' \times (\Pi D_i + \Sigma v_i) \end{aligned} \tag{1.3}$$

where δ_{jt} captures the mean utility of each beer brand and $\mu_{ijt} + \epsilon_{ijt}$ captures the consumer's deviation from the mean utility. Consumers are able to purchase an outside good if they decide not to purchase any of the brands. The outside good's mean utility is normalized to zero.

In the BLP model consumers only purchase one beer brand, which gives them the highest utility. This model assumes a consumer purchases only one 12 ounce unit of a specific beer brand.[10] Given consumers only purchase one unit, a set of individual characteristics can be defined for purchasing a specific beer brand j in market t, defined as

$$A_{jt}(x_t, p_{.t}, \delta_{.t}; \theta_2) = \{D_i, v_i, \epsilon_{it} \mid u_{ijt} \geq u_{ilt} \ \forall l = 0, 1, \ldots, J\}$$

Given set A_{jt}, market shares can be estimated as

$$s_{jt}(x_t, p_{.t}, \delta_{.t}; \theta_2) = \int_{A_{jt}} dP(\epsilon)dP(v)dP(D) \tag{1.4}$$

where $P(\cdot)$ are the distributions for ϵ, v, D.

Equation (4) does not have a closed form solution to estimate market shares for each beer brand. This

[10]Consumers purchasing only one 12 ounce unit a month may seem unrealistic, but to get a good representation of craft beer in the data set, weekly data need to be aggregated up to monthly data. Also, putting the sales data into 12 ounce units make each beer brand comparable.

equation is estimated through simulation using the multinomial logit model assuming ϵ_{ijt} is type 1 extreme value and iid. The simulation, following Nevo (2001), is

$$s_{jt}(x_{.t}, p_{.t}, \delta_{.t}; \theta_2) = \frac{1}{ns} \sum_{i=1}^{ns} \frac{exp(\delta_{jt} + \sum_{k=1}^{K} x_{jt}^k(\sigma_k v_i^k + \pi_{k1} D_{i1} + \ldots + \pi_{kd} D_{kd}))}{1 + \sum_{m=1}^{J} exp(\delta_{mt} + \sum_{k=1}^{K} x_{mt}^k(\sigma_k v_i^k + \pi_{k1} D_{i1} + \ldots + \pi_{kd} D_{kd}))} \tag{1.5}$$

where σ and π are the unobserved and observed valuation of the brand characteristics, ns is the number of simulated consumers, and (v_i, D_i) are consumer's unobserved and observed individual characteristics.

Estimating demand follows Nevo (2001) who splits up estimation of parameters into two parts and Berry, Levinsohn, and Pakes (1995) contraction mapping and search algorithm. Setting up the data to estimate the two vectors of parameters θ_1 and θ_2, two matrices X_1 and X_2 are created. Matrix X_1 contains prices, average package size, and brand dummy variables. Matrix X_2 contains prices, average package size, ABV, ratings, brewery types, and style categories. These matrices and the θ's estimate δ and μ respectively. The way the matrices X_1 and X_2 are split up is important because if brand dummy variables and brewery dummy variables are in the same matrix, the estimation of θ_1 or θ_2 will be impossible because of the collinearity between the variables. Splitting up estimation in this way creates a problem in estimating the mean coefficients because δ is estimated with the matrix X_1, which does not contain all of the fixed brand characteristics. The way these variables are solved for is described below.

Estimation of the full model uses GMM estimation to solve for the vector θ_1 and searches over θ_2 to minimize the GMM objective function. The set of instruments used is given by the vector $Z = [z_1, \ldots, z_m]'$. The moment conditions used for estimation are $E[Z'\omega(\theta^*)] = 0$.

Once the θ's are solved for the mean utility coefficients need to be backed out because the solution for the vector θ_1 does not contain the mean coefficients. Following Nevo (2001) a minimum-distance procedure is used to recover the estimates of the coefficients. The minimum-distance procedure regresses the estimated brand effects on brand characteristics. Formally the estimation is

$$\hat{\beta} = (X' V_d^{-1} X)^{-1} X' V_d^{-1} \hat{d} \tag{1.6}$$

where X is a matrix of beer brand's fixed characteristics, $\hat{d}$ is a matrix of brand dummy coefficients from θ_1, and V_d is the covariance matrix for the brand dummy coefficients. Once equation (6) is solved, the $\hat{\beta}$ estimates are the mean utilities for the fixed beer brand's characteristics.

1.5 Results

To test the hypotheses for the increased growth of craft beer, the demand for beer is estimated. The dependent variable for the demand estimation is $ln(s_{jt}) - ln(s_{0t})$, where s_{jt} is a beer brands markets share in market t and s_{0t} is the outside goods market share. The variables of interest to test the hypotheses are beer quality, measured by beer ratings and brewery type to capture vanity. Other variables price, average package size, abv, and beer styles are used as control variables in this analysis. The estimation results can be found in Tables 1.3 and 1.4. This analysis finds higher quality beers increase a consumer's utility and true craft beer has a vanity effect over macro craft beer. Each of these results will be discussed separately.

First looking at quality of beer, the results show that a higher quality beer leads to an increase in a consumer's utility. The positive coefficient on beer ratings reinforces the argument by Clemons, Gao, & Hitt (2006) that higher quality beers increase sales for craft breweries. Also, beer quality being positive and significant shows that beer ratings are not biased as a measure of quality. If ratings were biased the quality coefficient would show up negative and/or insignificant because craft and import beers have higher ratings than macro beer, but lower market shares. In the data, craft beer has a nearly one point higher average than macro beer. This shows that the higher quality beers craft breweries produce are a driving factor for the growth of craft beer.

On the craft branding, the branding leads to a decrease in utility for consumers when comparing craft beer to macro beer. There are a few possible reasons for the negative coefficient of the craft branding variable. First, craft breweries by definition are small and produce less beer than macro breweries. As a result, craft brewery sales are lower than macro brewery sales, resulting in a negative coefficient for craft branding. Second, craft beer is a relatively new type of beer product in the beer market and consumers may be unaware of craft beer. Consumers who are unaware of craft beer will not purchase it, reducing craft beer's market share. Therefore, for these reasons, comparing craft beer and macro beer won't capture vanity for craft beer.

To get at the vanity effect of craft beer, craft beer is split up into two types; true craft and macro craft. This captures if there is a vanity effect because true craft and macro craft beers have similar market shares. Splitting up craft beer this way gets around the problem of comparing craft beer to macro beer, which differ substantially in market shares. When comparing true craft to macro craft, the results show consumers receive a higher utility from a true craft beer than a macro craft beer. Though, overall the craft branding coefficient is negative, true craft beer has a vanity effect over macro craft beer.

One might think the inclusion of Sam Adams and Yuengling may be driving the results of the vanity

effect for true craft beer. Running the demand estimation with Sam Adams and Yuengling excluded from true craft, the true craft coefficient remains positive and significant. This indicates that the largest craft breweries are not driving the results of consumers preferring true craft over macro craft. When taking out Sam Adams and Yuengling from the craft brewery type and creating a new brewery type variable for them, the new variable's coefficient is positive and significant. This result shows that these two craft breweries' beers have a vanity effect over macro beers. The vanity effect could be due to consumers being aware of these two craft breweries because they nationally advertise and are the two largest craft breweries in the US. The finding of a vanity effect for true craft beer supports and goes further than McCluskey, Mittelhammer, and Gonzalez (2014) who finds consumers who drink craft beer prefer craft beer to macro beer, but this analysis tests why consumers prefer craft beer.

Quality overall leads to higher consumer utility, while vanity increases consumer's utility only within the craft beer market segment. When comparing craft beer to macro beer, quality increases consumer's utility, while the craft branding decreases consumer's utility. This will always be the case because craft beer has a substantially lower market share than macro beer. Within the craft segment, true craft beer has a vanity effect over macro craft beer. When comparing quality and vanity within the craft segment, vanity has a larger impact on consumers than quality for a one unit change. This is the case when Sam Adams and Yuengling are included in true craft beer. When these two breweries are removed, the impact of quality and vanity are not statistically different in increasing consumer's utility. Overall, I would conclude that quality is the driving factor for the growth of craft beer over vanity because vanity only shows up within the craft beer segment, while quality is an important factor throughout the whole beer market.

1.6 Conclusion

This study empirically estimates two competing hypotheses for the increased growth of craft beer. The first is the high quality of craft beer has lead consumers to choose craft beer over other beer choices. The second is the craft branding gives craft beers a vanity effect, giving consumers a greater utility when consuming these types of beers. This analysis is the first paper to empirically estimate the competing hypotheses for the increasing demand for craft beer. fff

The findings show that both quality and vanity are driving craft beer consumption. Comparing the two effects, vanity has a larger impact than quality. The difference between the average ratings of true craft and macro craft beer is 0.39, giving an effect of 0.206 for the quality of true craft beer. The vanity effect without Sam Adams and Yuengling is 0.631, giving consumers a larger utility increase than the increase in quality

between true craft and macro craft. When including Sam Adams and Yuengling in true craft, the vanity effect is even larger.

The findings of this paper are important because macro breweries have been trying to fight and regain lost market share to craft breweries by introducing their own craft brands or purchasing craft breweries. Recently, macro breweries have gone the route of acquiring craft breweries such as Blue Point Brewing Company, Elysian Brewing Company, and Golden Road Brewing to enter the craft beer market segment. This analysis shows that macro breweries are better off acquiring craft breweries. When macro breweries do this, they need to keep producing the beer under the craft brewery's name, while hiding the fact that the craft brewery is owned by a macro brewery. If macro breweries are able to do this, they have a better chance of entering the craft market segment and take away market share from craft breweries.

There are a few limitations to the study looking at the determinants of craft beer growth. First, the data comes from super market sales. A lot of craft beer sales come from draught and specialty beer shops, leading to a possible under representation of craft beer sales in the data. This is partially circumvented by not including light beers in the data set giving craft beer a 13% market share, which is close to what is observed in the market today. Second, Sam Adams and Yuengling have a disproportionately higher market share in the data set than they do in the beer market today. Removing them from craft beer does not change the results. Third, the study contains only 6 cities, limiting the scope of beer consumers in the US.

A future direction of understanding the determinants of craft beer's growth would be to look at time trends of craft beer sales and the introduction of new craft breweries in the area. This would capture if the news of new craft breweries opening up increases consumer's awareness of craft beer, leading consumers to purchase craft beer.

Table 1.1: Summary Statistics

Brewery Type	Price	Volume Sales	Average Volume	Average Package Size	Ratings	ABV	Brands	Styles	Style Categories	Breweries
Craft	1.24	0.13	0.005	7.44	3.53	5.73	120	46	20	61
	(0.43)				(0.388)	(1.258)				
Macro	0.75	0.59	0.022	10.4	2.57	5.16	52	11	7	15
	(0.325)				(0.432)	(1.057)				
Imports	1.19	0.28	0.009	6.27	3.2	5.15	81	27	14	41
	(0.934)				(0.516)	(1.096)				
True Craft	1.26	0.11	0.005	7.32	3.59	5.79	100	42	20	53
	(0.451)				(0.363)	(1.31)				
Macro Craft	1.1	0.02	0.004	7.92	3.2	5.43	20	17	13	8
	(0.236)				(0.347)	(0.922)				
World	1.26	0.11	0.005	5.36	3.32	5.08	64	24	13	36
	(1.032)				(0.465)	(0.966)				
North America	1.14	0.17	0.016	8.25	2.76)	5.43	17	6	5	8
	(0.52)				(0.47)	(1.494)				
True Craft	1.29	0.05	0.003	7.19	3.59	5.79	94	40	20	51
No Sam or Yueng	(0.441)				(0.371)	(1.28)				

Standard deviations in parenthesis.

Table 1.2: Variable Descriptions

Variable	Description
price	Price of a 12 ounce unit of a beer brand
avpackage	Average package size for a given beer brand sold in a market
abv	Alcohol per volume of a beer brand
quality	Rating of a given beer brand
craft	A dummy variable for a craft beer, includes true craft and macro craft
craftsy	A dummy variable for a craft beer, includes true craft and macro craft but not including Sam Adams and Yuengling
samyueng	A dummy variable for a beer produced by Sam Adams and Yuengling
truecraft	A dummy variable for craft beers produced by true craft breweries
truecraftsy	A dummy variable for craft beers produced by true craft breweries not including Sam Adams and Yuengling
world	A dummy variable for beers produced outside of North America
northa	A dummy variable for beers produced within North America, but outside of the United States

Table 1.3: BLP Results with Sam Adams and Yuengling included in Craft

Variable	Mean Coefficient	Standard Deviation	log(Income)	Age
constant	-7.247***	0.83	-0.067	0.334
	(0.773)	(1.098)	(0.883)	(1.199)
price	-27.594***	4.366	-0.106	0.044
	(0.534)	(2.066)	(1.472)	(1.098)
package	0.062***	0.033	-0.31	0.197
	(0.01)	(1.072)	(1.806)	(1.707)
abv	-2.878***	1.246	0.16	0.307
	(0.075)	(1.039)	(0.91)	(3.016)
quality	0.574***	2.095	-0.173	0.242
	(0.172)	(1.795)	(1.241)	(2.224)
craft	-3.261***	4.012	0.369	0.096
	(0.24)	(1.475)	(1.111)	(0.869)
truecraft	1.125***	0.558	-0.399	0.057
	(0.226)	(0.915)	(1.309)	(1.016)
world	-0.445**	1.948	-0.042	0.254
	(0.176)	(2.761)	(1.139)	(2.008)
northa	2.752***	0.917	0.014	-0.044
	(0.18)	(1.695)	(1.248)	(1.143)
style categories	Yes			
chi-square	6037			
weighted r2	0.8518			
n	18396			

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 1.4: BLP Results with Sam Adams and Yuengling not included in Craft

Variable	Mean Coefficient	Standard Deviation	log(Income)	Age
constant	-6.107***	0.811	-0.067	0.33
	(0.75)	(1.078)	(2.621)	(1.231)
price	-26.031***	4.4	-0.107	0.047
	(0.501)	(1.545)	(1.14)	(1.088)
package	0.034***	0.033	-0.31	0.197
	(0.01)	(1.353)	(0.863)	(1.029)
abv	-2.816***	1.252	0.164	0.308
	(0.073)	(0.994)	(1.266)	(1.551)
quality	0.529***	2.099	-0.171	0.242
	(0.166)	(2.515)	(1.71)	(2.473)
craftsy	-3.298***	4.018	0.355	0.096
	(0.231)	(1.027)	(0.858)	(2.135)
truecraftsy	0.631***	0.549	-0.399	0.058
	(0.224)	(0.991)	(1.26)	(0.85)
SamYueng	8.218***	0.634	-0.529	-0.131
	(0.342)	(1.735)	(1.056)	(0.916)
world	-0.332*	1.944	-0.042	0.254
	(0.172)	(1.476)	(1.236)	(1.929)
northa	2.858***	0.915	0.014	-0.045
	(0.174)	(0.944)	(1.163)	(1.032)
style categories	Yes			
chi-square	5940			
weighted r2	0.8403			
n	18396			

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 1.5: Macro Craft Beers

Be_High_Description	Be_Low_Description	Brand
MILLER COORS LLC	BLITZ WEINHARD BREWING CO.	Henry Weinhard's Woodland Pass IPA
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Sunset Wheat
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Canoe Paddler
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Oktoberfest
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Assorted
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Honey Weiss
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Berry Weiss
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Red
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Classic Amber
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Summer Shandy
MILLER COORS LLC	JACOB LEINENKUGEL BREWING CO	Leinenkugel's Creamy Dark
NORTH AMERICAN BREWERIES INC	DUNDEE BREWING CO	Dundee Original Honey Brown Lager
NORTH AMERICAN BREWERIES INC	DUNDEE BREWING CO	Dog Bite High Gravity Lager
NORTH AMERICAN BREWERIES INC	MAC TARNAHAN S BREWING CO.	MacTarnahan's Full Bloom Craft Lager
NORTH AMERICAN BREWERIES INC	MAC TARNAHAN S BREWING CO.	MacTarnahan's Winter Humbug'r Ale
NORTH AMERICAN BREWERIES INC	MAGIC HAT BREWING COMPANY	Blind Faith
NORTH AMERICAN BREWERIES INC	MAGIC HAT BREWING COMPANY	Heart of Darkness
NORTH AMERICAN BREWERIES INC	NORTH AMERICAN BREWERIES INC	Buffalo Bill's Pumpkin Ale
NORTH AMERICAN BREWERIES INC	PYRAMID BREWERIES INC.	Curve Ball Blonde Ale
NORTH AMERICAN BREWERIES INC	PYRAMID BREWERIES INC.	Snow Cap

Chapter 2

I'll Have a Pint. How On Premise Beer Sales Affect Microbreweries

2.1 Introduction

At the end of 2016, the US had 5,243 craft breweries, up from 1,509 in 2000 (Brewers Association, 2016). However, the increase in craft breweries varies widely by state due in part to differences in state laws[1]. The regulations that have been studied are the allowance of brewpubs, beer franchise laws, mandated exclusive territories, beer excise tax rates, and allowing self-distribution (Elzinga, Tremblay & Tremblay, 2015; Burgdorf, 2016; Malone & Lusk, 2016).

Elzinga, Tremblay, and Tremblay (2015) find states that allow brewpubs have a higher number of craft breweries and craft beer production. Also, they find that higher beer excise taxes reduces the number and production of craft breweries. Burgdorf (2016) find states that have franchise laws reduces craft brewery production[2]. He also finds beer excise taxes reduce the number and production of craft breweries. Exclusive territories, though, have no effect on craft breweries (Burgdorf, 2016). Malone and Lusk (2016) find that states that allow self-distribution have more microbreweries. Unlike the previous studies, they find beer

[1] Previous studies have looked at how beer regulations affect macro breweries. The most extensively studied beer regulation is exclusive territories, which only allows a single distributor in a specific territory to distribute a breweries' beer. Breweries use exclusive territories to align incentives and gain competitive advantages. Also, exclusive territories protects distributors from other distributors free riding on their investments. Jorand and Jaffee (1987) and Sass and Surman (1993) find exclusive territories increase the price of beer while increasing beer quality at the same time, leading to ambiguous welfare effects. Rojas (2012) finds exclusive territories in Arkansas, whose legislation mandated exclusive territories in 1991, increases consumer welfare.

[2] Franchise laws lock in craft breweries with their distributors for a length of certain period of time. If a brewery wants to terminate a contract with a distributor, they need to give the distributor a remedy period of 30 to 90 days to fix any problems and good cause that the distributor broke an agreement or agreements in the contract.

excise taxes have no impact on the number of microbreweries.

One regulation that has not been studied is on premise beer sales. On premise beer sales allow craft breweries to operate a taproom and sell their beer to consumers at their brewery. On premise beer sales is a newer regulation than the previously studied regulations. The first state to allow on premise beer sales was California in 1977. Since 1989, 33 states have passed laws to allow on premise beer sales and 6 states still do not allow them. This paper looks at how on premise beer sales affects the number and production of microbreweries.

In the US, breweries are defined by their size and are broken up into 4 categories: macro, regional, micro, and brewpub. Macro breweries produce more than six million barrels (or 186 million gallons) of beer a year, regional breweries produce between 15,000 barrels to six million barrels of beer a year, microbreweries produce fewer than 15,000 barrels of beer a year, and brewpubs are restaurants that produce and sell more than 25 percent of their own beer for consumption on their premises (Brewers Association, 2016). Nearly all states that allow on premise beer sales only allow regional and micro breweries to sell beer on their premises.

This paper focuses on how on premise beer sales affects microbreweries[3] because they are directly affected the most by on premise beer sales, as such sales have the potential to make up a larger percentage of sales. Conversely, regional brewery's sales would not drastically increase because selling beer out of a tap room would only be a small fraction of their overall sales. As for brewpubs, they are already allowed to sell their beer for on premise consumption so an on premise beer sales law would have no direct effect on them.

There are multiple reasons why on premise beer sales would increase the number and production of microbreweries. First, microbreweries operating a taproom receive the full markup when selling their beer. Craft breweries only receive a fraction of the markup when they use the three-tier system and have to use a distributor to get their beer to consumers. The ability for microbreweries to receive the full markup will entice more to enter and increase production because of the opportunity to make larger profits. Second, microbreweries are able to experiment with new beers without having to invest in packaging and labeling before knowing the demand. With the craft beer industry always pushing the frontier of new beers, craft breweries will be able to adjust to market demands faster and at a lower cost. Third, microbreweries that operate a taproom are selling the experience of going to a brewery. Consumers can go to learn about the brewing process and try beers that may not be available at retail. Murray and O'Neill (2011) find that people plan day trips and vacations around craft beer. Last, craft breweries are able to build their brand without having to compete in the retail space that is highly saturated. For all these reasons, microbreweries

[3]Regressions for the number and production of regional breweries and brewpubs are in Table 2.6.

will benefit from on premise beer sales.

This paper measure the effect on premise beer sales has on the number and production of microbreweries. To measure the effect of on premise beer sales on the number and production of microbreweries, a difference-in-differences approach is used. This paper finds on premise beer sales increases the number of breweries for the first few years and then increases the production of microbreweries in states that pass on premise beer sales laws. This paper also updates the results for Elzinga, Tremblay and Tremblay (2015), Burgdorf (2016), and Malone and Lusk (2016) to see the effects other beer regulations have on microbreweries.

2.2 Data

The data used for this analysis comes from Elzinga, Tremblay and Tremblay (2015), Burgdorf (2016) and data collected on states on premise beer sales laws. The data spans from 1989-2012 and allows for craft breweries to be broken up into microbreweries, regional breweries, and brewpubs. The data from Elzinga, Tremblay and Tremblay (2015) is firm level data that comes from *The New Brewer*, a publication by The Brewers Association. It includes type of brewery (micro, regional, brewpub), the state a brewery is located, and breweries production volume. The authors also collected data on real per-capita disposable income, population, median age, real federal plus state excise tax on craft beer per barrel, and whether states allow brewpubs. The data from Burgdorf (2016) is state beer regulations; self-distribution, franchise laws, and mandated exclusive territories. Data was collected on when states enacted on premise beer sales. From 1990 to 2012, 20 states passed on premise beer sales laws. Table 2.1 shows the variables descriptions, Table 2.2 shows the variables summary statistics, and Table 2.3 shows the dates on premise beer sales were enacted for each state.

Figure 2.1 shows the number of breweries by type from 1989 to 2012. From 2005 to 2012 the number of microbreweries began to grow rapidly while the growth of brewpubs and regional breweries stayed relatively stagnant. During this time period,12 states enacted on premise beer sales. Figure 2.2 shows the production volume of breweries by type. Unlike with growth of breweries by type, microbreweries and brewpubs produce around the same amount of beer until 2010, where microbreweries began producing more than brewpubs. The reason is states allow microbreweries to produce more than brewpubs in a year. This would indicate that on premise beer sales don't have an effect on production, but could indicate that there is a lagged effect of on premise beer sales on microbreweries production. On premise beer sales may have a lagged effect on microbreweries production because smaller microbreweries can enter the beer market and increase production overtime as they earn a profit and build their brand.

Figure 2.3 shows the average number of microbreweries by on premise beer sales from 1989 to 2012. States that allow on premise beer sales have more breweries than states that do not allow on premise beer sales. Figure 2.4 shows the average production, in 1,000 barrels, of microbreweries by on premise beer sales. Again, states that allows on premise beer sales produce more craft beer than states that do not allow them. This shows that on premise beer sales do impact microbreweries.

Figures 2.3 and 2.4 do not tell the whole story of how on premise beer sales affect the number and production of microbreweries. There are other possible factors that could lead to states that allow on premise beer sales to have more microbreweries and higher levels of microbrewery production. To identify the causal effect of on premise beer sales, other covariates need to be controlled for.

2.3 Methodology

A difference-in-differences approach is used to estimate the effect on premise beers sales has on the number and production of microbreweries. This setup is similar to Burgdorf (2016) who uses a difference-in-differences to estimate the effects of state regulations on craft breweries. Elzinga, Tremblay and Tremblay (2015) and Malone and Lusk (2016) use negative binomial models, but a negative binomial model will not work for this paper because I want to estimate the causal effect of on premise beer sales laws.

The regression specification for each dependent variable is:

$$Microbreweries_{st} = \mathbf{D_{st}}\beta + \mathbf{R_{st}}\theta + \mathbf{X_{st}}\gamma + \alpha_{\mathbf{s}} + \delta_{\mathbf{t}} + \varepsilon_{\mathbf{st}} \tag{2.1}$$

$$\log(1 + Microbreweries\ Production_{st}) = \mathbf{D_{st}}\beta + \mathbf{R_{st}}\theta + \mathbf{X_{st}}\gamma + \alpha_{\mathbf{s}} + \delta_{\mathbf{t}} + \varepsilon_{\mathbf{st}} \tag{2.2}$$

where $Microbreweries_{st}$ is the number of microbreweries in state s at time t, $Microbreweries\ Production_{st}$ is the production of microbreweries, measured in 1,000 of barrels. The dependent variable for the second regression is $\log(1 + Microbreweries\ Production_{st})$ because there are states that produce zero in some year and the production data is right skewed. $\mathbf{D_{st}}$ is a vector of whether or not a state allows on premise beer sales, $\mathbf{R_{st}}$ are state's other beer regulations and $\mathbf{X_{st}}$ are control variables, which include state characteristics; α_s and δ_t are state and year fixed effects. Using year and state fixed effects in the models controls for any differences that happen across the US over time and any differences between states. Because of the possibility of serial correlation within states over time, errors are clustered at the state level (Cameron & Miller, 2015).

State control variables used are median age, population in millions, and real per-capita disposable income.

The state regulations used as controls are federal and local beer excise tax rates per barrel of beer, allowance of brewpubs, self-distribution, beer franchise laws, and mandated exclusive territories. Another control variable added is the number of regional breweries in a state. The number of regional breweries is used as a control because having a regional brewery, or breweries, in a state gives an indication of consumers' awareness of craft beer. This will most likely increase the number of microbreweries because consumers may demand more diverse products that craft breweries produce if they know about craft beer (Tremblay & Tremblay, 2005). But regional breweries may have a negative impact on the production of microbreweries because there won't be as much room for microbreweries to sell their products if the craft beer market is saturated with larger craft breweries' products.

There is a possibility of the passage of on premise beer sales to be endogenous because microbreweries could have pushed for the law to be passed. A way to deal with the possibility of endogeneity is to use lagged variables for the passed beer laws (Elzinga, Tremblay & Tremblay, 2015). Using lagged variables for on premise beer sales laws will capture the persistence effect of on premise beer sales on the number and production of microbreweries. Also, the lags of the other regulations are used because of the possibility of those laws being endogenous as well. The lagged variables are whether or not a state had enacted a regulation in a specific year. The regression specification for each lagged regression is:

$$Microbreweries_{st} = \mathbf{D_{st-i}}\beta + \mathbf{R_{st-i}}\theta + \mathbf{X_{st}}\gamma + \alpha_{\mathbf{s}} + \delta_{\mathbf{t}} + \varepsilon_{\mathbf{st}} \tag{2.3}$$

$$\log(1 + Microbreweries\ Production_{st}) = \mathbf{D_{st-i}}\beta + \mathbf{R_{st-i}}\theta + \mathbf{X_{st}}\gamma + \alpha_{\mathbf{s}} + \delta_{\mathbf{t}} + \varepsilon_{\mathbf{st}} \tag{2.4}$$

$$\forall\ i = 1, 2, \ldots, 10$$

where $\mathbf{D_{st-i}}$ and $\mathbf{R_{st-i}}$ are the lagged regulations of whether or not a state had enacted a regulation i years previous to year t.

2.4 Results

The results for the effect of on premise beer sales has on the number of microbreweries are in Table 2.4. The coefficient for on premise beer sales is positive and statically significant, showing that passing an on premise beer sales law increases the number of microbreweries. On premise beer sales increases the number of microbreweries in a state by 3.8. The only other beer regulation that has an affect on the number of

microbreweries is self-distribution. If a state allows self-distribution, breweries do not have to self distribute. Unlike Burgdorf (2016), I find allowing self-distribution reduces the number of microbreweries, where he found not effect of self-distribution. This may be because I am only looking at microbreweries rather than all types of craft breweries. A possible explanation for the negative effect of self-distribution is the high saturation in the retail side of the beer industry. States may pass self distribution laws to entice microbreweries to enter the market, but if the retail is highly saturated, this leaves little room for microbreweries to enter the retail market.

As for the other regulations, none of them have a statically significant effect on the number of microbreweries. Two other covariates that increase the number of microbreweries are the number of regional breweries and population. For each regional brewery, a state will have nearly 2 more microbreweries. This may indicate that consumer awareness of craft beer increases the number of microbreweries.

The results for the effect of on premise beer sales has on the production of microbreweries are in Table 2.5. The coefficient for on premise beer sales is positive, but not statically significant. The other regulations in the regression also do not have a statistically significant effect on the production of microbreweries. The only covariates that are statically significant are the number of regional breweries, population, and income. This may be because these variables are the only ones that directly affect the demand for craft beer. Having an additional regional brewery decreases production of microbreweries by 10.8%. A population increase of one million increases production by 18.2%, and an increase of one thousand dollars per capita income reduces production by 10.2%.

The results for the effect of the lagged regulations on the number of breweries are in Table 2.6. Each column and it's number corresponds with the number of lagged years for each regulation. The coefficient for on premise beer sales is positive and statistically significant for the first 4 lagged years. The effect of on premise beer sales may only initially increase the number of microbreweries because of the opportunity to make a profit. But as more microbreweries enter the market it becomes saturated, reducing the potential profits of newer entrants. Another possibility for only seeing an effect for the first 4 years is there was a shakeout of craft breweries from 1998 to 2010 (Elzinga, Tremblay & Tremblay, 2015). During this shakeout the number of craft breweries declined from 1998 to 2000 and then remained relatively constant until 2010.

The results for the effect of the lagged regulations on the production of breweries are in Table 2.7. Each column and it's number corresponds with the number lagged of years for each regulation. The coefficient for on premise beer sales is positive and statistically significant for lagged years 5 through 8. The effect of on premise beer sales may increase the production of microbreweries a few years after the law has been passed

because allowing for on premise beer sales allows for smaller breweries to enter the market and earn a profit. Because of these small breweries marking a profit, they can later increase their production. Also, the first few years these breweries are able to build their brand and get a following of craft beer drinkers, allowing them to increase production. A reason why production does not stay statistically significant for lagged years 9 and 10 is only 6 states passed on premise beer sale laws when extending the lagged years out this far. Also when lagging this out this far, the time period gets into the first shake out of craft breweries that happened between the later 1990's and early 2000's (Elzinga, Tremblay & Tremblay, 2015).

2.5 Conclusion

This paper looks at the effect on premise beer sales have microbreweries. I find that after an on premise beer sales law is passed, the number of microbreweries increases for the first 4 years and then after 5 years the production of microbreweries increases.

The 6 remaining states that have not passed an on premise beer sales law will have an average increase of 4 microbreweries and have an average increase of microbrewery production by 35%. Microbreweries producing between 1,000 to 5,000 barrels a year employ on average 7 full time employees and if producing between 5,001 to 15,000 barrels employ on average 12 full time employees (Brewers Association, 2014). Unfortunately there is no data on how many part time employees microbreweries hire to help run their tap rooms.

A limitation of this paper is the data only goes up to 2012. The effect of on premise beer sales may be larger than this paper finds because between the years of 2013 to 2016, 10 states passed on premise beer sales laws. Also during this time period, the number of microbreweries went from 1,142 in 2012 to 3,132 in 2016, an almost 275% increase in microbreweries (Brewers Association, 2016). Also of the 23 states that passed on premise beer sales laws from 1989 to 2012, 10 have passed them since 2007. This may not give enough time for microbreweries to earn enough profits to expand or build their brands to see the full effect on premise beer sales has on microbreweries' production. Another limitation is the passing of on premise beer sales may be endogenous. Without an instrument for identifying on premise beer sales leads to the possibility of biased estimates of the effect on premise beer sales has on the number and production of microbreweries.

Table 2.1: Variable Definitions

Variable	Description
Number of Microbreweries	The number of microbreweries in a state
Microbrewery Production	Production of microbreweries in a state, given in 1,000s barrels
On Premise	= 1 if state allows on premise beer sales
	= 0 if state do not allow on premise beer sales
Brewpub	= 1 if state allows brewpubs
	= 0 if state do not allow brewpubs
Self Distribution	= 1 if state allows breweries to self-distribute
	= 0 if state do not allow breweries to self-distribute
Exclusive Territories	= 1 if state mandates exclusive territories
	= 0 if state does not mandate exclusive territories
Franchise	= 1 if state has a franchise law
	= 0 if state does not have a franchise law
Regional Breweries	Number of regional breweries
Income	Real per capita income in thousands of dollars
Population	Population in millions
Age	Median age
Tax	Real federal plus state excise tax on craft beer per barrel

Table 2.2: Summary Statistics

Variables	Mean	Std. Dev.	Min	Max
Number of Microbreweries	5.631	9.980	0	128
Microbrewery Production (1,000s barrels)	11.980	19.268	0	194.327
On Premise	0.435	0.496	0	1
Brewpub	0.935	0.247	0	0
Self Distribution	0.589	0.242	0	1
Exclusive Territories	0.588	0.492	0	1
Franchise	0.770	0.421	0	1
Regional Breweries	0.938	1.937	0	19
Income	14.074	2.562	8.817	28.111
Population	5.531	6.169	0.454	38.041
Age	35.533	2.518	26.2	43.5
Tax	11.203	6.781	3.753	57.629

Table 2.3: On Premise Beer Sales

State	Enacted	State	Enacted
California	1977	Washington	2008
Massachusetts	1982	Utah	2010
Colorado	1983	Illinois	2011
New Mexico	1985	Minnesota	2011
North Carolina	1985	Ohio	2011
Oregon	1985	Pennsylvania	2011
Arizona	1987	Wisconsin	2011
Florida	1987	Connecticut	2012
Idaho	1987	New Jersey	2012
Maine	1987	Kentucky	2013
Nebraska	1988	North Dakota	2013
Vermont	1988	Hawaii	2014
Iowa	1989	New Hampshire	2014
Louisiana	1989	New York	2014
South Dakota	1989	South Carolina	2014
Missouri	1990	District of Columbia	2015
Tennessee	1993	Georgia	2015
Virginia	1993	West Virginia	2015
Delaware	1994	Maryland	2016
Wyoming	1996	Alabama	No
Montana	1999	Kansas	No
Arkansas	2003	Mississippi	No
Indiana	2004	Nevada	No
Michigan	2005	Oklahoma	No
Alaska	2006	Rhode Island	No
Texas	2007		

Table 2.4: Number of Microbreweries

Variable	(1)
On Premise	3.807*
	(2.2299)
Brewpub	-0.411
	(1.1291)
Self Distribution	-2.466*
	(1.3769)
Exclusive Territories	-1.795
	(1.9499)
Franchise	-0.285
	(2.0764)
Regional Breweries	1.952***
	(0.6313)
Income	-0.656
	(0.5279)
Population	2.283**
	(1.0296)
Age	0.129
	(0.3315)
Tax	0.398
	(0.3747)
Constant	-10.503
	(19.2799)
Year & State FE	Yes
F	28.646
N	1224

$* \ p < 0.10, ** \ p < 0.05, *** \ p < 0.01$

Table 2.5: Production of Microbreweries

Variable	(1)
On Premise	0.161
	(0.1393)
Brewpub	0.043
	(0.1629)
Self Distribution	0.201
	(0.2099)
Exclusive Territories	0.258
	(0.4045)
Franchise	-0.390
	(0.4216)
Regional Breweries	-0.108***
	(0.0360)
Income	-0.102**
	(0.0493)
Population	0.182***
	(0.0598)
Age	-0.071
	(0.0551)
Tax	-0.020
	(0.0173)
Constant	3.645
	(2.1917)
Year & State FE	Yes
F	71.424
N	1224

$* \ p < 0.10, ** \ p < 0.05, *** \ p < 0.01$

Table 2.6: Other Craft Brewery Types

	Number of Regional Breweries	Production Regional Breweries	Number of Brewpubs	Production Brewpubs
On Premise	-0.007	0.519*	2.127	0.187
	(0.2515)	(0.3073)	(2.6835)	(0.1299)
Brewpub	-0.698***	-0.867**	-3.558**	-0.008
	(0.2581)	(0.3755)	(1.4803)	(0.1476)
Self Distribution	-0.561**	-0.338	-3.436**	-0.071
	(0.2420)	(0.4196)	(1.6626)	(0.1560)
Exclusive Territories	0.097	-0.083	3.984	0.051
	(1.0955)	(1.0324)	(3.2432)	(0.2719)
Franchise	0.320	-0.150	-3.509	-0.078
	(0.8042)	(0.9268)	(2.8503)	(0.2094)
Regional Breweries			3.410***	0.024
			(0.7230)	(0.0303)
Income	0.055	-0.108	-1.085	-0.103***
	(0.0937)	(0.1211)	(0.8193)	(0.0309)
Population	0.766*	0.224	3.871*	0.019
	(0.4546)	(0.2027)	(2.0651)	(0.0536)
Age	0.223	0.289*	-0.914	-0.055
	(0.1357)	(0.1693)	(0.5978)	(0.0395)
Tax	0.029	-0.040	0.316	0.031
	(0.0403)	(0.0596)	(0.3355)	(0.0228)
Constant	-11.449	-7.739	24.236	2.879*
	(6.8950)	(6.7680)	(32.6220)	(1.7084)
Year & State FE	Yes	Yes	Yes	Yes
F	6.591	23.041	27.330	44.870
N	1224	1224	1224	1224

$* \ p < 0.10, ** \ p < 0.05, *** \ p < 0.01$

Table 2.7: Number of Microbreweries: Lagged On Premise Beer Sales

Variable	(0)	(1)	(2)	(3)	(4)	(5)
On Premise	3.807*	4.479*	4.642*	4.825*	4.324**	2.836
	(2.2299)	(2.4828)	(2.7473)	(2.7709)	(2.0174)	(1.8007)
Year & State FE	Yes	Yes	Yes	Yes	Yes	
F	27.765	15.007	4.723	10.798	15.526	
N	1173	1122	1071	1020	969	
	(6)	(7)	(8)	(9)	(10)	
On Premise	2.897	2.763	1.960	1.680	1.186	
	(1.9587)	(2.0200)	(2.2434)	(2.0760)	(1.9124)	
Year & State FE	Yes	Yes	Yes	Yes	Yes	
F	18.737	16.767	20.002	19.646	8.428	
N	918	867	816	765	714	

$* \ p < 0.10, ** \ p < 0.05, *** \ p < 0.01$

Table 2.8: Production of Microbreweries: Lagged On Premise Beer Sales

Variable	(0)	(1)	(2)	(3)	(4)	(5)
On Premise	0.161	0.221	0.232	0.220	0.220	0.280*
	(0.1393)	(0.1577)	(0.1736)	(0.1635)	(0.1683)	(0.1608)
Year & State FE	Yes	Yes	Yes	Yes	Yes	
F	58.841	60.175	54.982	66.696	64.279	
N	1173	1122	1071	1020	969	
	(6)	(7)	(8)	(9)	(10)	
On Premise	0.443***	0.409**	0.347*	0.262	-0.050	
	(0.1650)	(0.1696)	(0.1926)	(0.1619)	(0.1277)	
Year & State FE	Yes	Yes	Yes	Yes	Yes	
F	43.939	40.633	40.985	37.340	35.968	
N	918	867	816	765	714	

$* \ p < 0.10, ** \ p < 0.05, *** \ p < 0.01$

Figure 2.1: Number of Breweries by Type

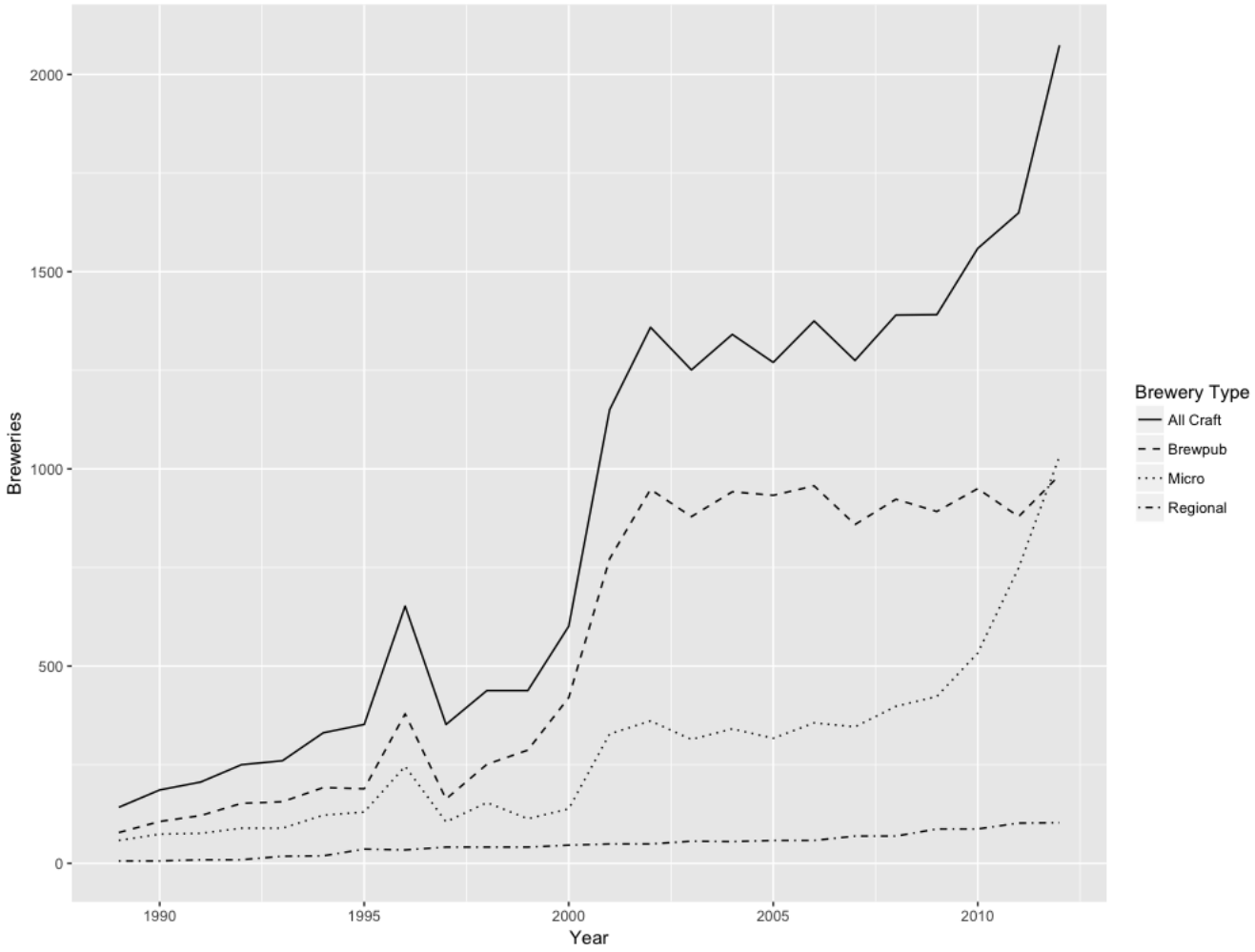


Figure 2.2: Production of Breweries by Type

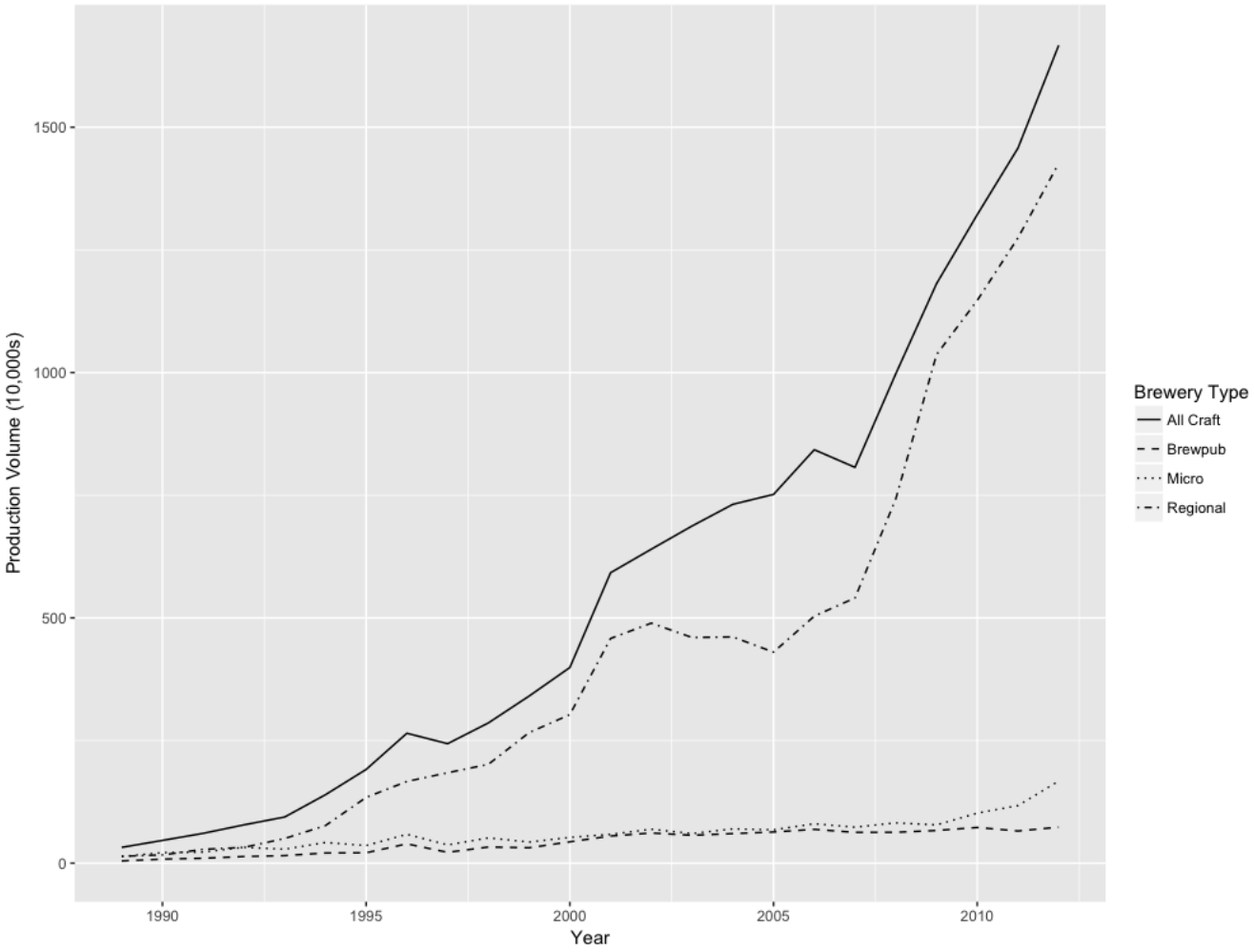


Figure 2.3: Average Number of Microbreweries by On Premise Sales

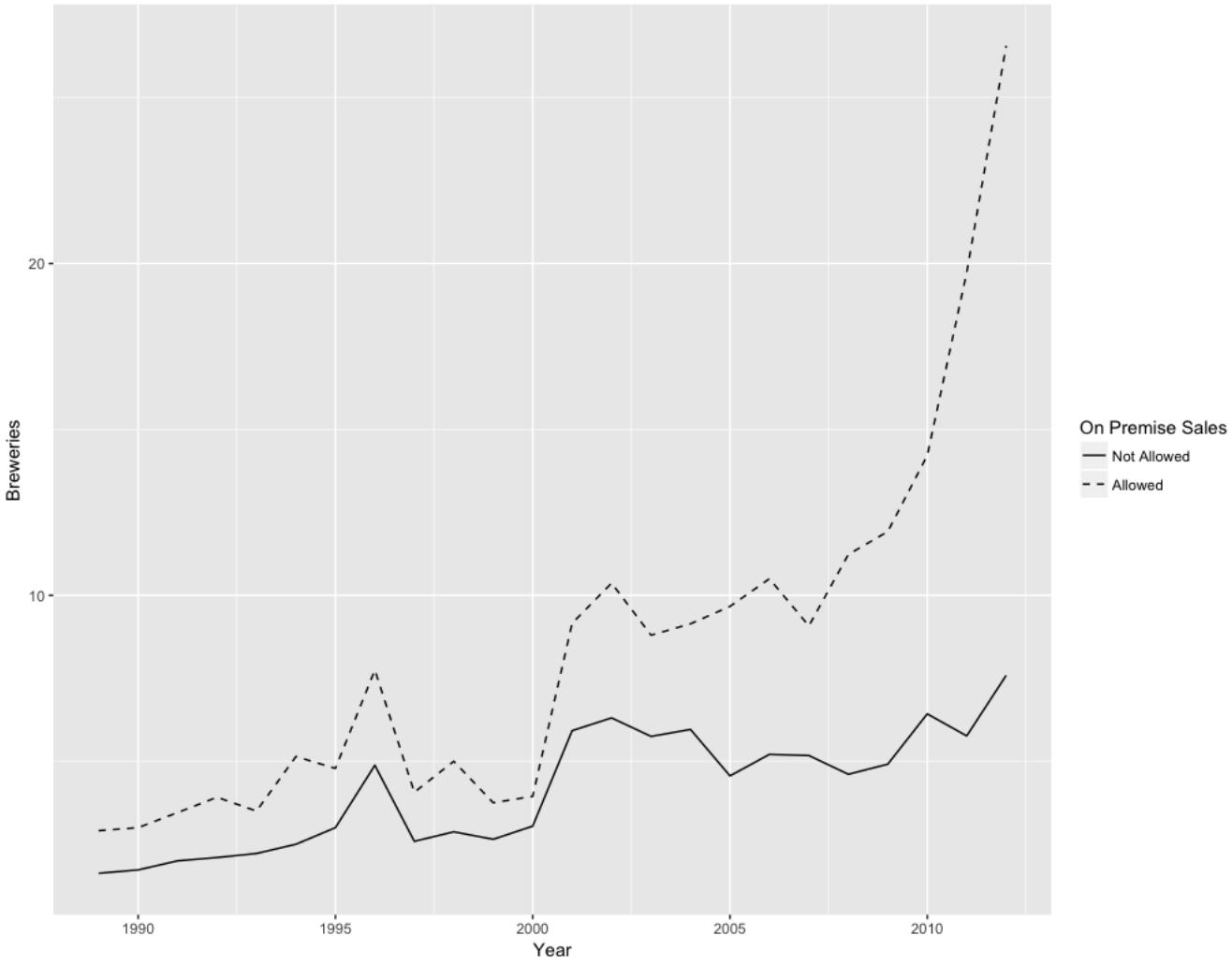
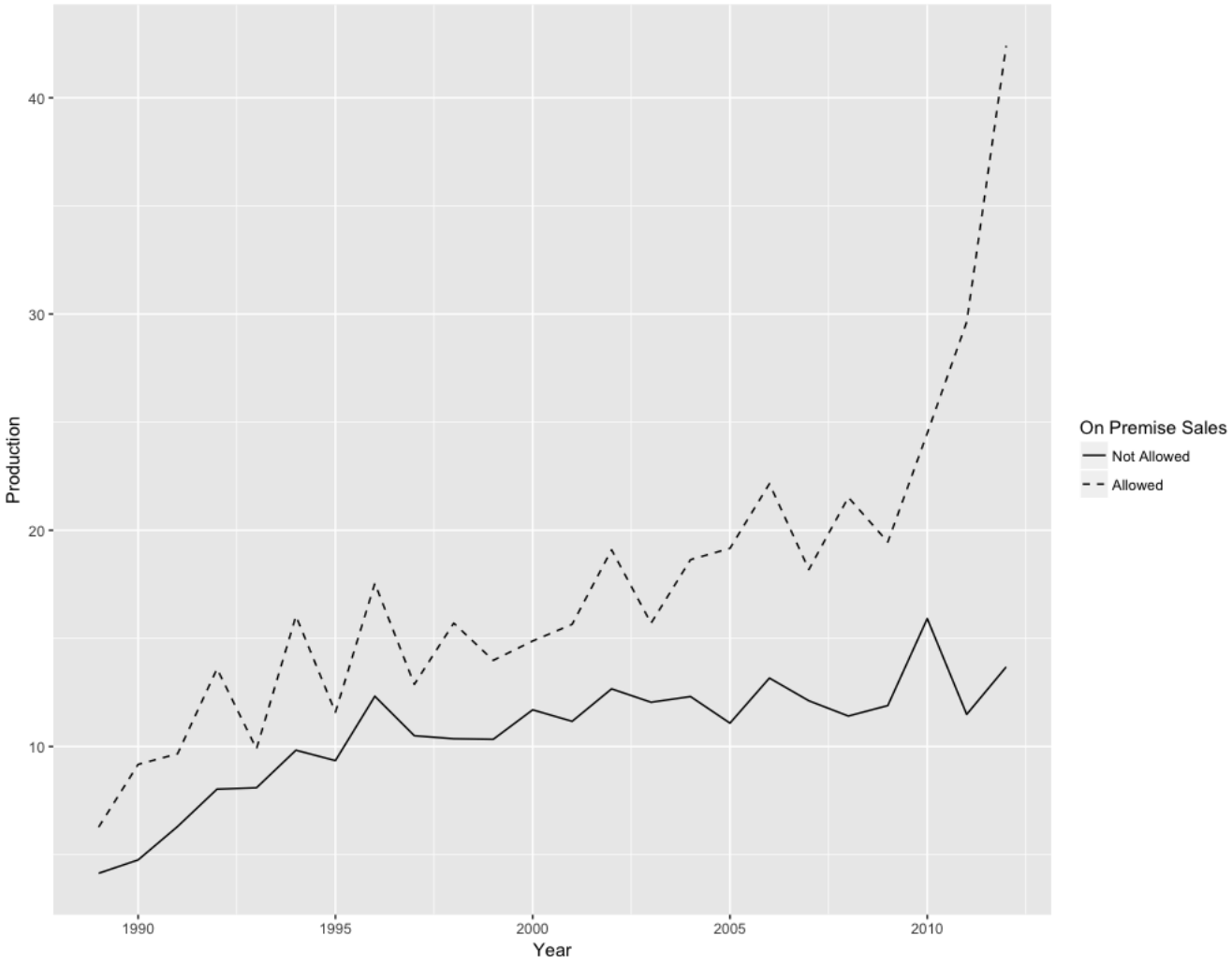


Figure 2.4: Average Production of Microbreweries by On Premise Sales



Chapter 3

The Competitive Effects of Vertical Integration on Craft Breweries: A Theoretical Look

3.1 Introduction

After the repeal of prohibition in 1933, the US gave states the power to regulate the production, distribution, and sale of beer. Many states implemented a three-tier system, which separates breweries, distributors, and retailers into separate tiers. The three-tier system allows a firm to operate in one of the three-tiers. Figure 3.1 depicts how the three-tier system operates. In recent years, AB InBev has come under fire by regulators and craft breweries for trying to vertically integrate with their distributors. This paper looks at the competitive effects on craft breweries if a macro brewery, such as Anheuser-Busch InBev (AB-InBev), vertically integrates with their distributor.

The vertical integration literature finds that firms who vertically integrate may foreclose on rivals, leading firms to exit the market (Salinger, 1988; Ordover, Saloner & Salop, 1990; Gaudet & Long, 1996). Market foreclosure is not a major concern in the beer industry even with macro breweries using vertical restraints. Macro breweries using vertical restraints has led to a slight reduction in the number of craft breweries in the beer market (Chen, 2014; Burgdorf, 2016). If macro breweries are allowed to vertically integrate, it could reduce the number of craft breweries in the market and lower consumer welfare if the vertically

integrating distributor forecloses on craft breweries. Proponents of the three-tier system believe it protects craft breweries from predatory practices by macro breweries, helping them stay competitive in the highly concentrated beer industry (Tamayo, 2009).

This paper finds that fewer craft breweries enter the market when a macro brewery vertically integrates with their distributor. Also, the vertically integrating macro brewery forecloses on craft breweries when there are only two distributors in the market. When the vertically integrating macro produces a craft beer, the brewery forecloses on craft breweries sooner, all else equal, than if they do not produce a craft beer. This is important because recently macro breweries have been purchasing craft breweries, adding to their beer portfolios. Last, consumers are hurt by vertical integration when there is low product differentiation.

3.2 Background

After prohibition, states put in place three-tier systems for several reasons. First, it eliminated the abusive marketing and sales practices by tied houses (Duffy, 1996). A tied house is a bar that has a contract to sell only one brewery's beer. Tied houses reduce the available retailers to breweries looking to expand, restricting their market expansion (Fogarty, 1985). Getting rid of tied houses prevents manufacturers and wholesalers from taking control of retailers, allowing for freer market expansion. Second, the three-tier system makes it easier for states to collect taxes efficiently. Last, it raises prices because of double marginalization, which encourages moderate beer consumption.

Many states do not allow breweries to own a distributor or self-distribute because of the three-tier system. Therefore, breweries use vertical restraints in beer distribution to align incentives and gain competitive advantages. One vertical restraint is exclusive territories, which reduces intrabrand competition within distribution territories (Jordan & Jaffee 1987; Rey & Stiglitz 1994). Also, exclusive territories protect investments between the brewer and distributor, not allowing other distributors to free ride on a distributor's investments (Sass & Surman 1993). Jorand and Jaffee (1987) and Sass and Surman (1993) find exclusive territories in the beer industry increase prices, but also increase the quality of beer, leading to ambiguous welfare effects. Rojas (2012) on the other hand, finds exclusive territories to increase consumer welfare, while having little impact on prices. Burgdor (2016) is the only author to look at how exclusive territories affects craft breweries, but he finds exclusive territories have no impact them.

Another vertical restraint, that looks similar to vertical integration, is exclusive dealings. Salop and Scheffman (1987) argue that exclusive dealings can raise a small rival's costs of distribution if there are scale economics. Raising rival's costs is the main argument that vertical mergers are anticompetitive. Sass (2005)

and Asker (2005) look at macro breweries' use of exclusive dealings and find that exclusive dealings do not lead to foreclosure on other macro breweries. Chen and Shieh (2016) finds InBev's market share increased 6% after merging with Anheuser-Busch and contracting exclusive dealings with Anheuser-Busch's distributors. They also find no significant change of InBev's product's prices. Chen (2014) looks at the effect of exclusive dealings on craft breweries and finds a small foreclosure effect on craft breweries in Northern California, but only in certain locations. Also, Chen finds a small welfare increase when exclusive dealings are not allowed.

All the findings in the US beer industry show little to no foreclosure because of exclusive territories and exclusive dealings — which can mimic vertical integration under certain conditions (Rey & Tirole, 1986b). Overall, these vertical restraints have little impact on craft breweries and the competitive nature of the US beer industry. So begs the question, what competitive effects would vertical integration have on craft breweries?

Firms vertically integrate to increase efficiency and eliminate the double marginalization of prices (Riordan, 2005). Both of these gains increase consumer welfare. On the other hand, vertical integration can also lead to foreclosure of non-integrating firms. The vertical integration literature focuses on market foreclosure by raising rival's costs as the main competitive effect (Salinger, 1988; Ordover, Saloner & Salop, 1990; Hart & Tirole, 1990; Gaudet & Long, 1996). The vertically integrated firm increases rival's costs by not participating with rivals in either the up or down stream markets, or by increasing the price of the intermediate input for competing down stream firms. Consumer welfare is negatively affected if the vertically integrated firm raises rival's costs high enough. If the intermediate good price increases, the final good price increases as well, leading to a decrease in consumer welfare (Salinger, 1988).

The previous models that have looked at vertical integration do not capture all the characteristics of the beer industry to look at how vertical integration would impact craft breweries. Some models of vertical integration model both the upstream and downstream markets as duopolies (Mcquire & Staelin, 1983; Hart & Tirole, 1990; Ordover, Saloner & Salop, 1990). Having duopolies in both markets make the models more tractable. For this paper, these models do not capture the effect when there are 3 down stream firms and 3 or more upstream firms. Other models assume products are homogenous (Salinger, 1988; Hart & Tirole, 1990; Gaudet & Long, 1996). In the beer industry products are not seen as homogenous, especially between macro beers and craft beers (Tremblay & Tremblay, 2005). Also, McCluskey, Mittelhammer, and Gonzalez (2014) find craft beer and macro beer have a low cross price elasticity. Because craft beer and macro beer are differentiated, product differentiation is an important feature to have in this paper's model. Last, a few models do not have heterogenous firms (Mcquire & Staelin, 1983; Salinger, 1988). In the beer industry,

breweries have different costs due to economies of scale and a high minimum efficient scale of production (Tremblay & Tremblay, 2005). Therefore, breweries will have different costs depending on wether they are a craft or macro brewery. All of these features are important to model the competitive effects of vertical integration on craft breweries.

3.3 Model

To look at the competitive effects of a macro brewery vertically integrating with their distributor, a Bertrand competition model is used. A Bertrand model follows how the beer industry operates, firms competing on prices. This model also captures the product differentiation that is evident in the beer industry. Compared to other models of product differentiation, this model allows for two market segments; allowing product differentiation to be larger across market segments than within. This captures consumers preferring a market segment, and consumers substituting to products in their preferred market segment. Also, firm heterogeneity is needed in the model because of the production cost differences between craft and macro breweries. This captures the size differences between craft and macro breweries.

The model consists of multiple firms, where there are always two macro breweries. Breweries supply either two or three down stream distributors with their final products. The distributors sell the final products to retailers. The model doesn't have the retail side of the three-tier system because this paper focuses on the competitive effects of a brewer and distributor vertically integrating. It is assumed that retailers are in a perfectly competitive market, making them price takers. This model set up is representative of the beer industry and beer distribution.

The model's costs are normalized, allowing for zero production costs for macro breweries producing macro beer. A restriction in this model is neither macro brewery can go with the same distributor because macro breweries use exclusive dealings and do not use the same distributors. Two different down stream market settings will be looked at; two or three distributors. The difference between these market settings is whether or not craft breweries have the opportunity to go with a distributor who does not distribute a macro breweries' beer.

To measure the competitive effects of vertical integration on craft breweries multiple market structures are used and analyzed. Below are three general market structures looked at:

Market Structures[1]

1. No vertical integration

[1]Figure 3.2 depicts the market structures.

2. Vertical integration with no foreclosure

3. Vertical integration with foreclosure

Also, there are two ownership structures for the craft and macro breweries. Below are the different product ownership structures:

Ownership Structures

1. Two macro breweries producing a macro beer each and multiple craft breweries each producing a craft beer.

2. The vertically integrating macro brewery producing a macro and craft beer, a macro brewery producing a macro beer, and multiple craft breweries each producing a craft beer.

All combinations of market and ownership structures will be looked at to determine the effects of vertical integration on craft breweries. Each combination of structures will be looked at when there are either two or three distributors. With two distributors, each distributor is distributing a macro breweries' beer. With three distributors, two distributers are distributing a macro breweries' beer and one distributor is only distributing craft breweries' beer.

To make the model tractable, a linear demand specification is used. There is a representative consumer, who's utility function is used to derive the demand for each good in the market. The representative consumer's utility function is:

$$U(\mathbf{q}) = \alpha \sum_{i=1}^{n} q_i - \frac{1}{2}\left[\beta \sum_{i=1}^{n} q_i^2 + \gamma \sum_{i=1}^{n} \sum_{j \in \psi_{-i}} q_i q_j + \delta \sum_{i=1}^{n} \sum_{k \in \psi_i} q_i q_k\right], \quad \alpha, \beta, \gamma, \delta > 0 \tag{3.1}$$

where ψ_i are products in product i's market segment, ψ_{-i} are products not in product i's market segment, n is the number of beer products, and $\mathbf{q} = \{q_1,\ q_2, \ldots,\ q_n\}$ are the quantities of each beer product. The representative consumer maximizes their utility:

$$\max_{q \in \mathbb{R}^n_+} U(Q) - \sum_{i=1}^{n} p_i q_i \tag{3.2}$$

which gives each products' inverse demand function:

$$p_i(\mathbf{q}) = \frac{\partial U}{\partial q_i} = \alpha - \beta q_i - \gamma \sum_{j \in \psi_{-i}} q_j - \delta \sum_{k \in \psi_i} q_k, \quad \forall i = 1, \ldots, n \tag{3.3}$$

The important parameters of the inverse demand functions are β, γ, and δ. These parameters define the product differentiation, which allows for market segmentation within the market. The parameters are defined below:

- Differentiated goods: $\gamma, \delta < \beta$
- Stronger substitution within market segment: $\gamma < \delta$
- Overall in the model: $\gamma < \delta < \beta$

The value δ/β gives the degree of product differentiation for products in the same market segment and γ/β gives the degree of product differentiation for products that are not in the same market segment. These range from zero to one, independent goods to perfect substitutes. γ/δ gives the level of product differentiation across the market segments, ranging from zero to one.

The inverse demand functions are inverted to define a system of demand functions:

$$q_i(\mathbf{p}) = \zeta_i - a_i p_i + b_i \sum_{j \in \psi_{-i}} p_j + c_i \sum_{k \in \psi_i} p_k, \quad \forall i = 1, \ldots, n \tag{3.4}$$

$$\begin{aligned}
\zeta_i &= \frac{\alpha(\beta - n_{-i}\gamma + (n_i - 1)d)}{(\beta^2 - n_i n_{-i}\gamma^2 + (n_i + n_{-i} - 2)\beta\delta + (n_i - 1)(n_{-i} - 1)\delta^2)} \\
a_i &= \frac{(\beta^2 - n_{-i}(n_i - 1)\gamma^2 + (n_{-i} + n_i - 3)\beta\delta + (n_{-i} - 1)(n_i - 2)\delta^2)}{(\beta - \delta)(\beta^2 - n_i n_{-i}\gamma^2 + (n_i + n_{-i} - 2)\beta\delta + (n_i - 1)(n_{-i} - 1)\delta^2)} \\
b_i &= \frac{\gamma}{(\beta^2 - n_i n_{-i}\gamma^2 + (n_i + n_{-i} - 2)\beta\delta + (n_i - 1)(n_{-i} - 1)\delta^2)} \\
c_i &= \frac{(-n_{-i}\gamma^2 + \beta\delta + (n_i - 1)\delta^2)}{(\beta - \delta)(\beta^2 - n_i n_{-i}\gamma^2 + (n_i + n_{-i} - 2)\beta\delta + (n_i - 1)(n_{-i} - 1)\delta^2)}
\end{aligned}$$

where n_i is the number of products in product i's market segment, n_{-i} is the number of products not in product i's market segment, and $\mathbf{p} = \{p_1,\ p_2, \ldots,\ p_n\}$ are the prices of each beer product.

To model distribution in the beer industry, there are two stages. First, breweries set wholesale prices, and then distributors set retail prices given wholesale prices. To solve for equilibrium wholesale prices and retail prices, backwards induction is use.

Each distributor maximizes profits:

$$\max_{p \in \mathbb{R}_+} \sum_{i \in \Phi} \Big[(p_i - w_i) q_i(\mathbf{p}) \Big] \tag{3.5}$$

where Φ are the products distributed by a distributor. Maximizing profits gives each distributor's best response function(s):

$$q_i(\mathbf{p}) + \sum_{l \in \Phi} (p_l - w_l) \frac{\partial q_l}{\partial p_i} = 0 \quad \forall i = 1, \ldots, n \tag{3.6}$$

This gives a system of equations of distributor's best response functions. Solving this system of equations gives equilibrium prices in terms of wholesale prices and the model's parameters.

Once equilibrium retail prices are solved for, each brewery maximizes profits given the equilibrium retail prices:

$$\max_{w \in \mathbb{R}_+} \sum_{i \in \phi} \Big[(w_i - c_i) q_i(\mathbf{p}) \Big] \tag{3.7}$$

where ϕ are the products owned by a brewery. Maximizing profits gives each brewery's best response function(s):

$$q_i(\mathbf{p}) + \sum_{l \in \phi} \left[(w_l - c_l) \sum_{m=i}^{n} \left(\frac{\partial q_l}{\partial p_m} \frac{\partial p_m}{\partial w_i} \right) \right] = 0 \quad \forall i = 1, \ldots, n \tag{3.8}$$

This gives a system of equations of brewery's best response functions. Solving this system of equations gives equilibrium wholesale prices in terms of the model's parameters.

Given the complexity of the demand functions, the market equilibrium is solved numerically. The below steps describes the algorithm to solve for the market equilibrium retail and wholesale prices.
Search Algorithm:

1. Start with initial wholesale prices
2. Solve for equilibrium retail prices[2] and quantities given initial wholesale prices
3. Update equilibrium wholesale prices given new retail prices
4. Repeat 1 through 3 until threshold met for search algorithm[3]

To see how many firms will exist in the market, this model adds one craft brewery into the market at a time. Each new entering craft brewery has an incrementally higher cost than the previous entering craft brewery. Every time time a craft brewery enters the market, all other breweries in the market adjust their demand functions to take into account the new entrant into the market. The craft brewery entering goes

[2]Equilibrium retail prices has a closed form solution.
[3]The search algorithm used is MINPACK, a solver for a system of linear and non-linear equations.

with the distributor where they receive the highest profit. Entry into the market ceases when a new craft brewery entrant into the market would earn a negative profit. Once the lowest cost craft brewery doesn't enter the market, no other craft brewery, who has a higher cost, wants to enter.

3.4 Results

To model the beer market, the cost of craft beer production, for both craft breweries and macro breweries, are high enough to allow for prices of macro beers to be lower and quantities for macro beers to be higher than for craft beers. This is representative of beer industry prices and quantities between craft and macro beers.

Proposition 1. *Fewer craft breweries enter the market under vertical integration.*

1. *If the vertically integrating macro brewery forecloses on craft breweries, there is a larger reduction in craft breweries entering.*

2. *If there are only two distributors and foreclosure occurs, the market has the fewest craft breweries.*

There are fewer craft breweries entering after vertical integration because of the elimination of double marginalization between the vertically integrating macro brewery and distributor. The elimination of double marginalization lowers prices, making it harder for higher cost craft breweries to enter the market. There is a larger reduction in craft brewery entry when the vertically integrating macro brewery forecloses on craft breweries. This reduction is largest when there are only two distributors in the market. Comparing Figures 3.3 and 3.4 show the difference between the number of craft breweries when there are three or two distributors with and without foreclosure. The vertically integrating macro brewery foreclosing on craft breweries gives the other distributor(s) more market power, reducing wholesale prices.

Proposition 2. *The vertically integrating macro brewery has an incentive to forecloses on craft breweries when there are two distributors and low product differentiation.*

1. *When product differentiation is high enough, the vertically integrating macro brewery doesn't foreclose on craft breweries.*

2. *If the vertically integrating macro brewery produces a craft beer, craft breweries have a high chance of being foreclosed on, all else equal.*

The vertically integrating macro brewery wants to foreclose on craft breweries when there are only two distributors because it gives the remaining distributor more market power, reducing wholesale prices. The reduction in wholesale prices reduces the profitability to craft breweries, reducing entry into the market. When product differentiation is high, there is no foreclosure. Unlike Ordover, Saloner, and Salop (1990), who find that with product differentiation[4] there is always foreclosure. In the far left box of each graph in Figure 3.5 shows when goods are independent. When goods are independent the vertically integrating macro brewery does not have an incentive to foreclose on craft breweries. As the across market product differentiation decreases, moving from the far left box to the boxes to the right, the probability of foreclosure increases, all else equal. This shift in foreclosure choice can be seen in Figure 3.5, with the cross over of the integration and foreclosure profit lines. The reason the vertically integrating macro brewery doesn't want to foreclose when there is high product differentiation is because the reduction in price isn't offset by an increase in quantity demanded. As product differentiation decreases, fewer craft breweries enter the market giving the distributor more market power. Also, if the vertically integrating macro brewery produces a craft beer, craft breweries are foreclosed on sooner, all else equal, than if the vertically integrating macro brewery only produces a macro beer. This is because the vertically integrating macro brewery is in both market segments giving them more market power than if they were just producing a macro beer.

Proposition 3. *Consumer welfare decreases under vertical integration when there is low product differentiation.*

1. *Consumer welfare decreases if craft breweries are foreclosed on.*

As product differentiation decreases, consumers have a higher probability of worse off because of vertical integration, all else equal. This can be seen in Figure 3.6. When the vertically integrating firm forecloses on craft breweries consumers are worse off because of the increase in prices of all beer products in the market and the reduction in product variety. The reduction in consumer welfare can be seen in Figure 3.7 when there is market foreclosure.

3.5 Conclusion

This paper looks at the competitive effects of a vertical integration of a macro brewery on craft breweries in the beer industry. When there are only two distributors and lower levels of product differentiation, consumer are worse off because the vertically integrating macro brewery forecloses on craft breweries. This

[4]The range of product differentiation ranges from zero to infinity

probability of foreclosure increases when the vertically integrating macro brewery produces a craft beer. With macro breweries increasing their purchase of craft breweries[5] consumers will be worse off if a macro brewery is allowed to vertically integrate.

A limitation of this paper is there is no closed form solution to the model and therefore market equilibriums need to be simulated. This does not allow for comparative statics to be done on equilibrium solutions to see the impacts of parameters changing. The product differentiation plays an important role in the competitive effects of vertical integration and therefore having two market segments sheds more light onto the competitive effects of vertical integration when there are two distinct market segments within an industry.

[5] A google docs of craft breweries purchased by macro breweries can be found here: `https://docs.google.com/spreadsheets/d/1PVMuFsFoccOVnFAk_K619wAUruLLEe7kPqpd_sjoxuI/`

Figure 3.1: Three-Tier System

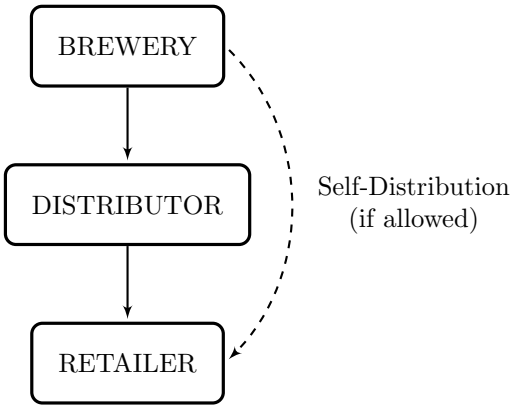
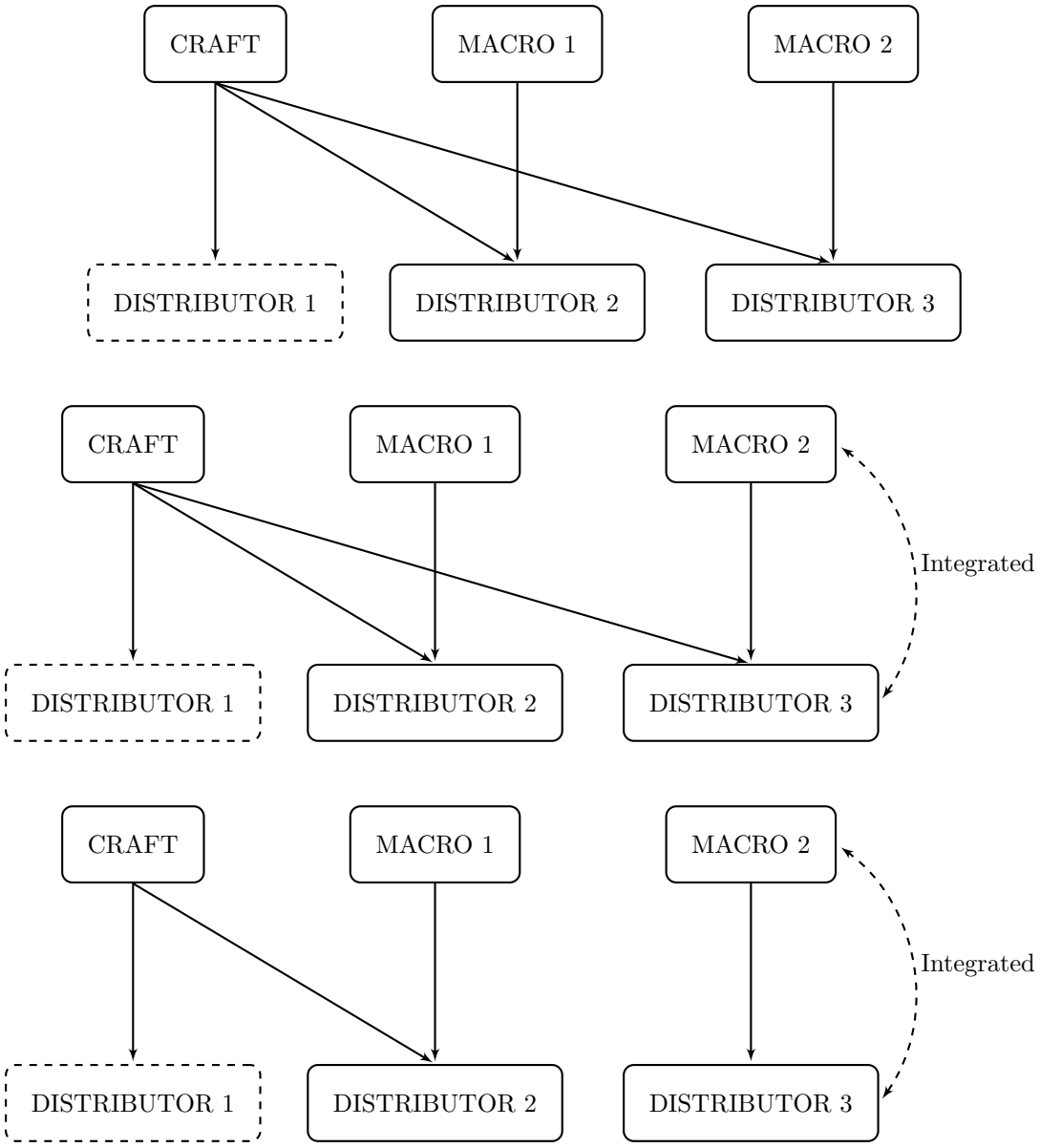


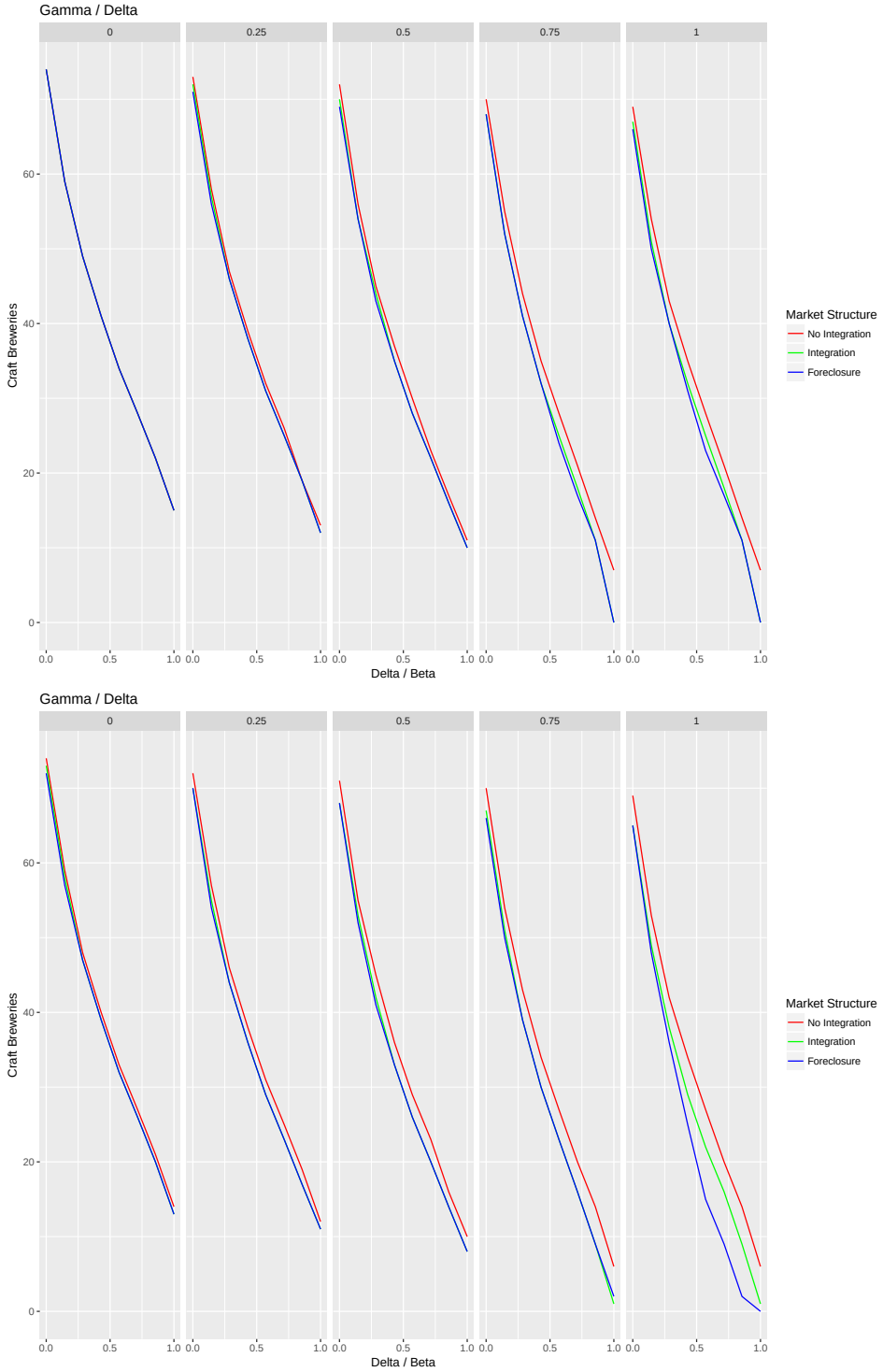
Figure 3.2: Market Structures



The market structures are split up into two categories:

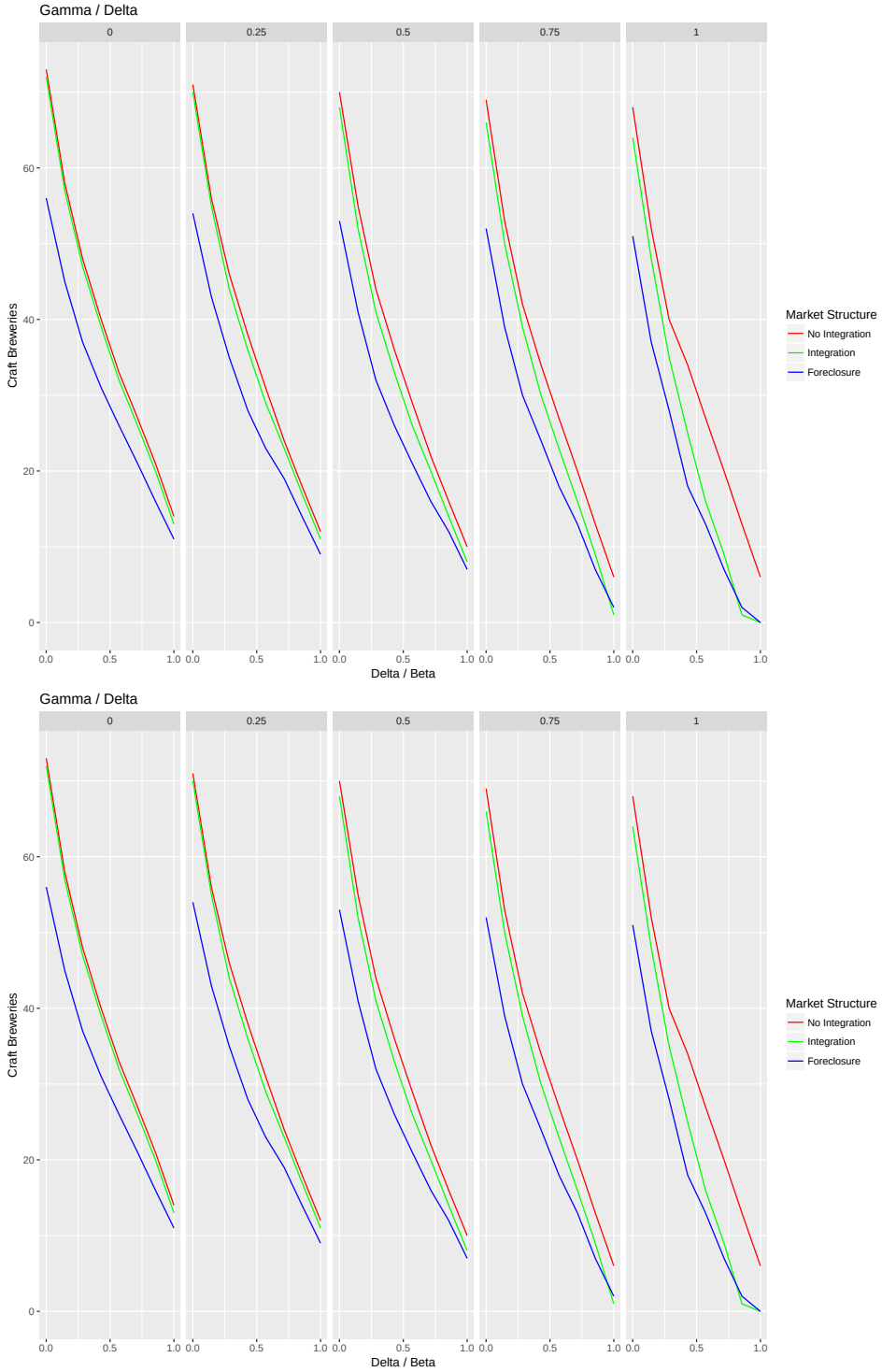
- Three distributors
- Two distributors, distributor 1 does not exist

Figure 3.3: Number of Craft Breweries with Three Distributors



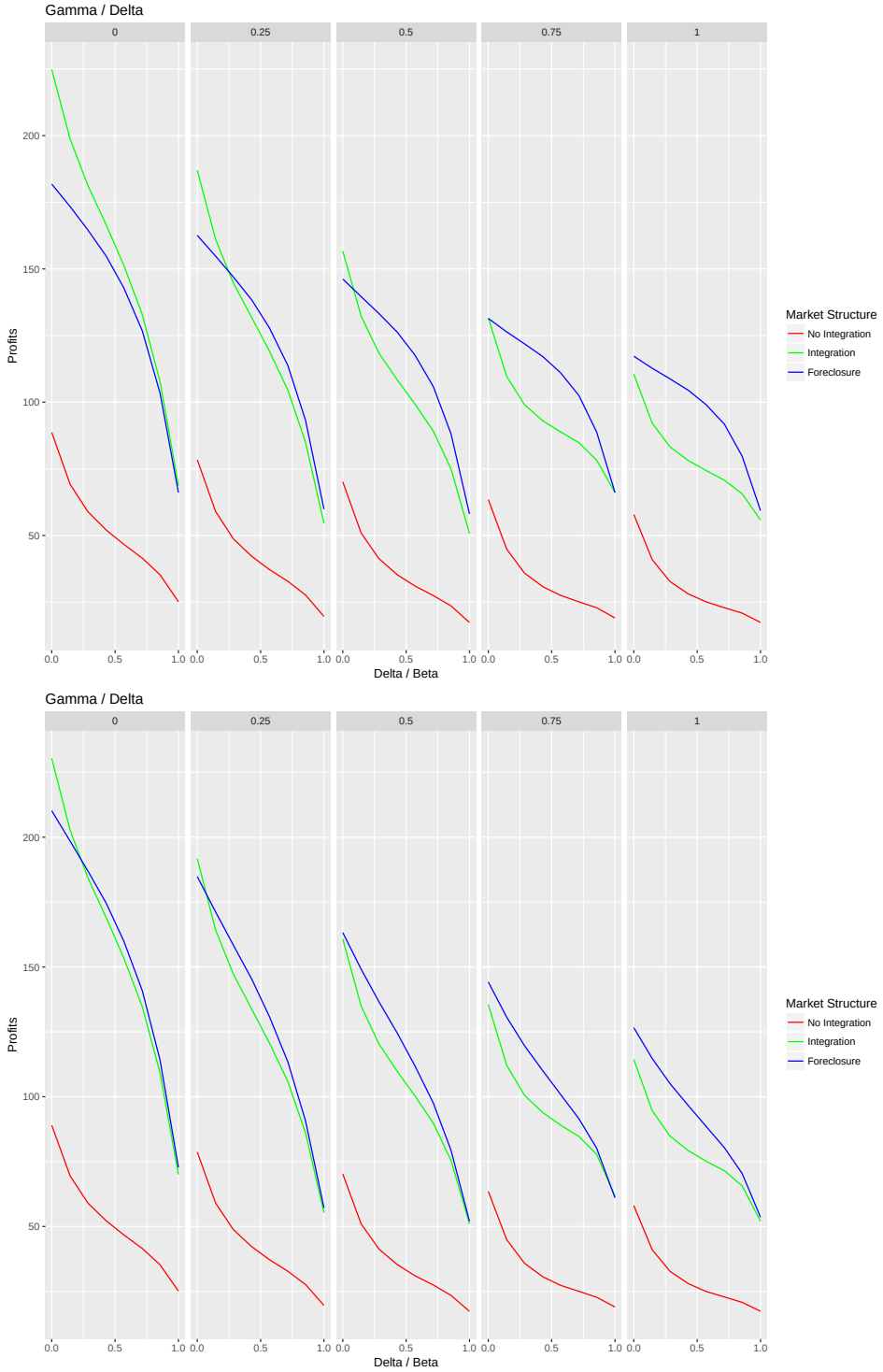
These graphs are showing the number of microbreweries given different levels of product differentiation. The top graph is two macro breweries producing a macro beer each and multiple craft breweries each producing a craft beer. The bottom graph is the vertically integrating macro brewery producing a macro and craft beer, a macro brewery producing a macro beer, and multiple craft breweries each producing a craft beer.

Figure 3.4: Number of Craft Breweries with Two Distributors



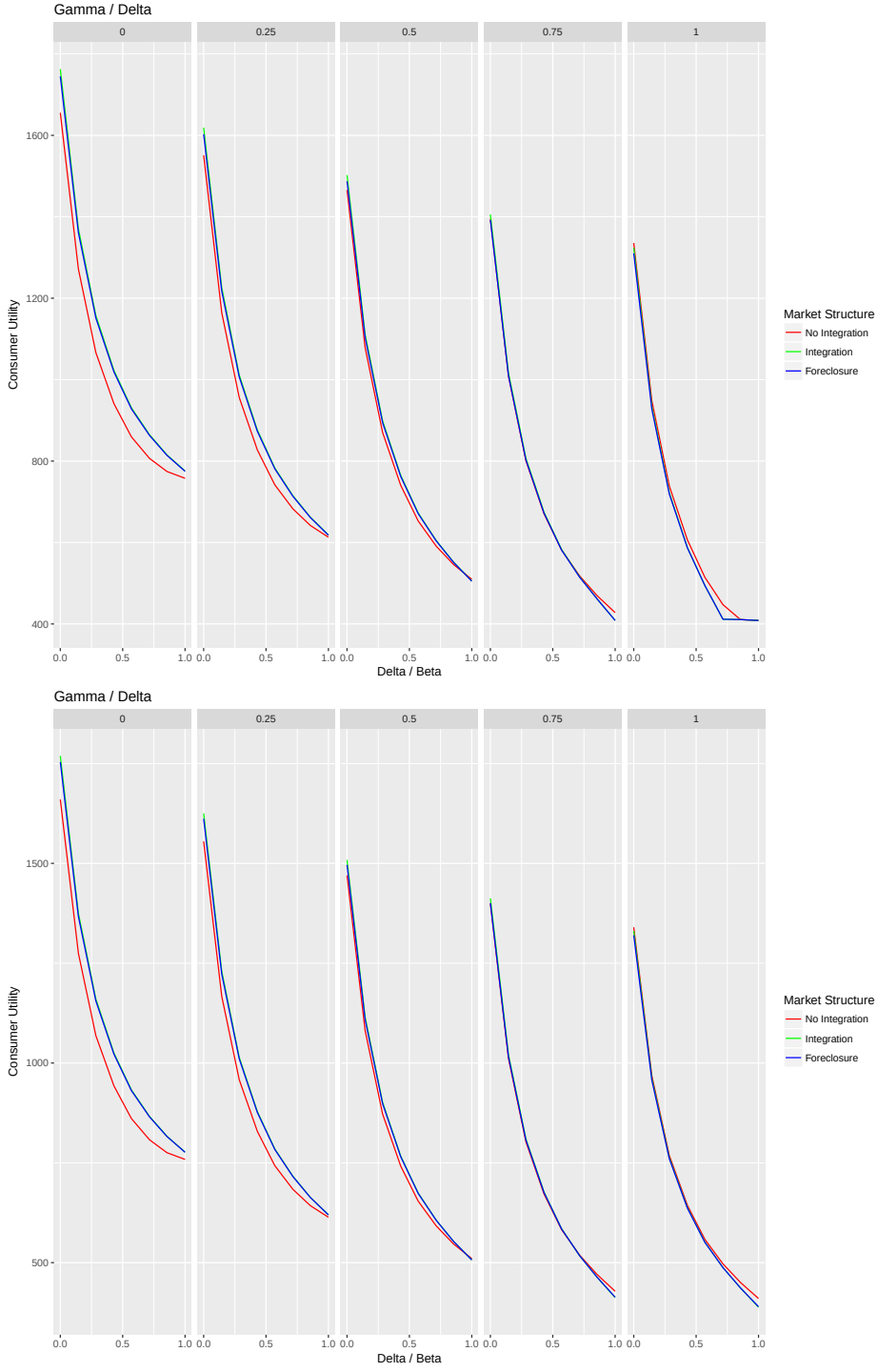
These graphs are showing the number of microbreweries given different levels of product differentiation. The top graph is two macro breweries producing a macro beer each and multiple craft breweries each producing a craft beer. The bottom graph is the vertically integrating macro brewery producing a macro and craft beer, a macro brewery producing a macro beer, and multiple craft breweries each producing a craft beer.

Figure 3.5: Vertically Integrating Macro Brewery's Profits with Two Distributors



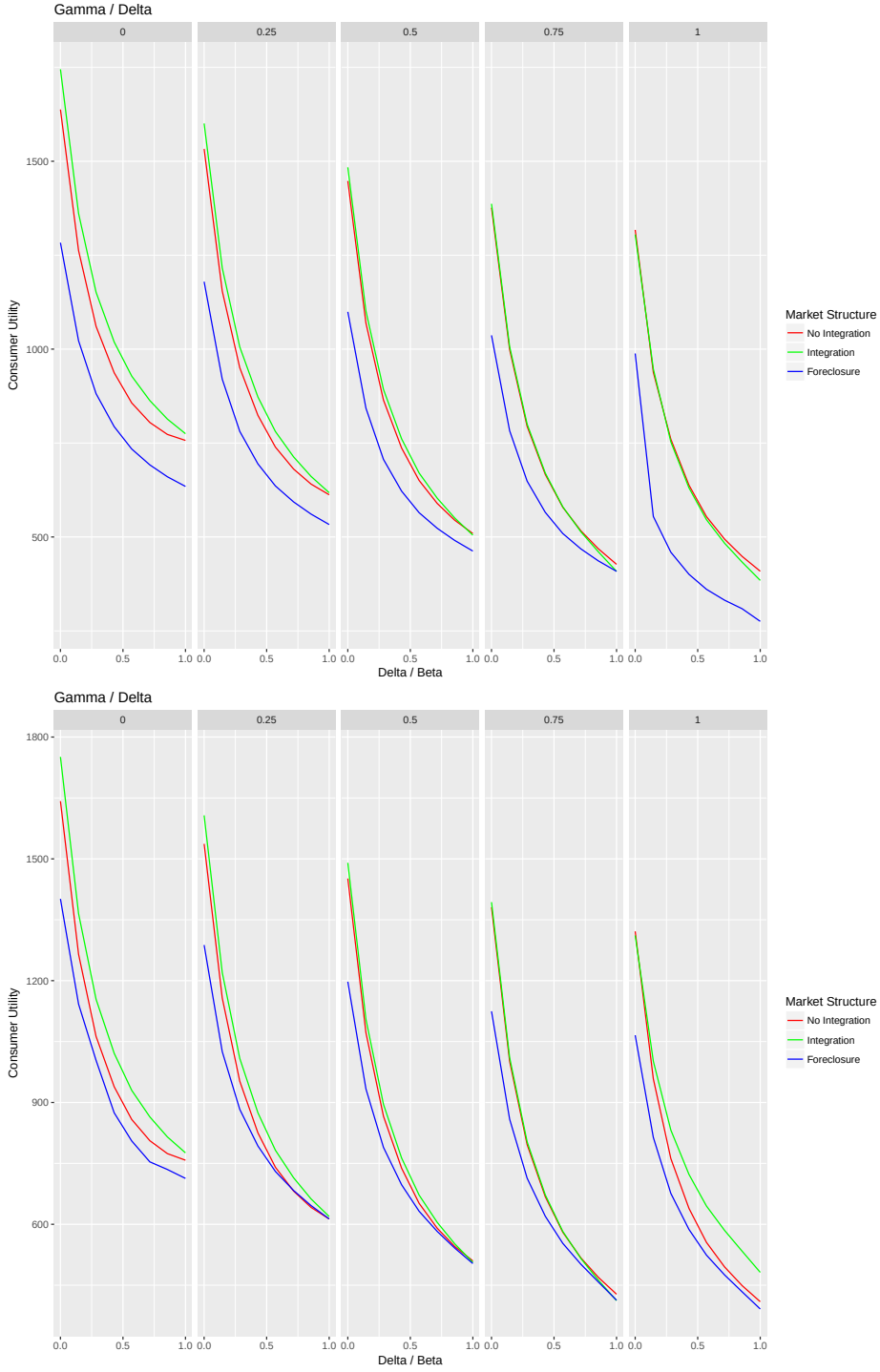
These graphs are showing the vertically integrating macro brewery's profits given different levels of product differentiation. The top graph is two macro breweries producing a macro beer each and multiple craft breweries each producing a craft beer. The bottom graph is the vertically integrating macro brewery producing a macro and craft beer, a macro brewery producing a macro beer, and multiple craft breweries each producing a craft beer.

Figure 3.6: Consumer Utility with Three Distributors



These graphs are showing the representative consumer's utility given different levels of product differentiation. The top graph is two macro breweries producing a macro beer each and multiple craft breweries each producing a craft beer. The bottom graph is the vertically integrating macro brewery producing a macro and craft beer, a macro brewery producing a macro beer, and multiple craft breweries each producing a craft beer. There is no major difference in the change in the representative consumer's utility if the vertically integrating macro brewery produces a craft beer.

Figure 3.7: Consumer Utility with Two Distributors



These graphs are showing the representative consumer's utility given different levels of product differentiation. The top graph is two macro breweries producing a macro beer each and multiple craft breweries each producing a craft beer. The bottom graph is the vertically integrating macro brewery producing a macro and craft beer, a macro brewery producing a macro beer, and multiple craft breweries each producing a craft beer. The reduction in the representative consumer's utility is less if the vertically integrating macro brewery produces a craft beer.

References