AN EMPIRICAL ANALYSIS OF THE IMPACT OF STATE EXCISE TAXES ON CRAFT BREWERIES IN THE UNITED STATES

by

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ABSTRACT

This thesis evaluates the effects of state excise taxes on the number of craft breweries and total craft beer production within a state between 1991 and 2012. It expands upon previous research on the brewing and beer industry by investigating the craft brewery market separately and empirically examining the relationship between state excise taxes and the supply side of this market. The estimating equations used to study this relationship include lagged dependent variables to account for entry and production stickiness between years. To consistently estimate the models, a Generalized Method of Moments (GMM) estimation method is employed to account for endogeneity in the lagged dependent variables. The results from this thesis indicate that there is a significant negative relationship between state excise taxes and both the number of craft breweries and total craft brewery production within a state. Additionally, elasticity estimates suggest that this relationship is inelastic, indicating that breweries are not extremely responsive to changes in the state excise tax. However, these estimates reflect short run elasticities because the estimating equations include both state and year fixed effects. While this thesis does not consider the fact that the number of craft breweries and total craft brewery production are likely jointly determined, it provides preliminary insight into the relationship between state excise taxes and craft breweries in the United States.

CHAPTER 1

INTRODUCTION

The brewing industry is a significant contributor to the U.S. economy. Recent estimates indicate that the brewing industry contributed between $99 billion (*Brewers,* 2013a) and $220 billion (*Beer*, 2013a) to the U.S. economy in 2012. Additionally, the total U.S. brewing industry employs more than one million people, with more than ten percent employed in the craft brewing industry (*Beer,* 2013a; *Brewers,* 2013c).[1] The U.S. brewing industry plays an important role in the overall output, sales, employment, and tax revenue at the local, state, and federal government levels. In addition, the sale of beer is considered an important economic indicator, evidenced by the fact that the Bureau of Labor Statistics includes expenditures on beer as part of the consumer price index calculation. The brewing industry is also a significant source of government tax revenue. In 2012, the U.S. government collected $3.7 million in federal tax revenue from beer, which accounted for 36.3 percent of federal taxes collected on all alcoholic beverages (*Beer,* 2013b).

The brewing industry has experienced significant changes since the beginning of the growth in craft breweries, which began in the 1980s. In 1980, there were forty-eight breweries operating in the United States – forty macrobreweries and eight craft breweries. Production was dominated by the four largest macrobreweries (Anheuser-Busch InBev, Coors, Miller, and Pabst Brewing Company), which accounted for more than eighty percent of all beer production in the country (*Beer,* 2013b; Tremblay and

[1] This includes employees involved in the brewing, wholesaling, and retailing processes.

Tremblay, 2005). Macrobreweries brew over six million barrels of beer per year and produce beers that are lighter in style and taste (*Brewers,* 2013d; Tremblay, 1985; Tremblay and Tremblay, 2011). By 2010 there were only 20 macrobreweries operating in the U.S. In contrast, craft breweries began to rapidly enter the market in the 1980s. Craft breweries are generally smaller breweries that produce a wider variety of beers by incorporating an assortment of different inputs. Between 1980 and 2012, more than two thousand breweries entered the market and 96.6 percent of them were craft breweries. In addition to an increase in the total number of craft breweries, total craft beer production also increased by16.8 million barrels between 1980 and 2012, amounting to a 773 percent increase in output.

This thesis seeks to understand factors that contributed to breweries' decisions to enter or stay in the market. One factor that has possibly influenced the recent changes in the U.S. brewing market is state excise taxes on beer production. This purpose of this study is to empirically estimate the impact of state excise taxes on the craft brewery market, which will provide some evidence on the responsiveness (e.g., elasticity) of craft breweries to increases in the marginal cost of production.[2] A lack of historical data about the craft brewery market has limited empirical analysis of this issue. Additionally, quantitative analysis of the effect of excise taxes on this market has been limited to its impacts on beer prices and consumption. This thesis seeks to bridge both of these gaps in the literature through a descriptive and empirical analysis of the impact of state excise

[2] It is also important to consider the effect of state excise taxes on the price of craft beer. However, price data are not readily available for the craft brewing market, and therefore our analysis is limited to the effect on quantity.

taxes on beer production on the number of craft breweries and total craft beer production within a state.

All breweries are subject to a number of both federal and state regulations relating to the brewing, transportation, and sale of beer. This thesis focuses on the effect of state excise taxes on beer. Using a basic supply and demand model, excise taxes increase the marginal cost of beer production, which is predicted to cause a decrease in the supply of beer. This thesis uses state-level brewery and production data for 1991 to 2012 from across the U.S., retrieved from the Brewers Association's Brewing Industry Production Survey (BIPS). The data retrieved from the BIPS is the most complete publically available record of state craft brewery and craft beer production. Excise tax information is retrieved from the Federation of Tax Administrators, the Alcohol and Tobacco Tax and Trade Bureau (TTB), and state alcohol control boards. These data are used in conjunction with state level socioeconomic and demographic characteristics retrieved from the U.S. Census Bureau.

Lagged dependent variables are included for both the number of craft breweries and total production within a state to account for entry and production stickiness between years. That is, the number of breweries within a state today is highly related to the number of breweries in the previous year because high fixed entry costs make entry into the craft brewery market relatively slow. Similarly, the total production of beer today is highly related to the total production in the previous year because there are high fixed costs associated with improving productive capabilities. However, the inclusion of these variables creates an endogeneity problem because the lagged dependent variables are correlated with the contemporaneous error term. Therefore, a Generalized Method of Moments (GMM) method is employed to consistently estimate this model.

The results of the GMM estimation indicate that excise taxes have a significant negative effect on both the number of craft breweries and total craft brewery production within states. Additionally, they suggest that there is an inelastic relationship between the tax rate and both the number of craft breweries and total craft brewery production, indicating that a one-percentage increase in the tax rate results in less than a one percent decrease in both the number of craft breweries and craft beer production. This suggests that state and federal governments might consider increasing excise taxes as a means of raising additional government revenue.

In contrast, public policy that prevents the industry from expanding, such as excise taxes, has potentially negative economic implications because the craft brewery industry has significant positive economic impacts at the state and federal levels. Therefore, public policy that prevents the industry from expanding, such as excise taxes, has potentially negative economic implications. Alternatively, policy that limits the growth of breweries and beer production might be desirable if the brewing industry causes social welfare losses (e.g., driving while under the influence, negative health impacts). The results of this thesis provide preliminary insight into the economics of the craft brewing market.

CHAPTER 2

BREWING INDUSTRY OVERVIEW

Beer has accounted for the largest share of total alcohol consumption in the United States since the 1960s. Table 2.1 provides a summary of the trends in total alcohol consumption in the United States since 1961. The share of beer in terms of total alcohol consumption increased by 2.9 percentage points between 1961 and 2010, with wine increasing by 6.1 percentage points and distilled spirits decreasing by 9.1 percentage points. In 2005, beer accounted for roughly 58 percent of total alcohol consumption and in 2010, it was half of all alcohol consumed. Additionally, the United States is among the top beer-drinking countries in the world. With the exception of Australia, most of the countries with higher per capita consumption of beer than the United States are in Northern and Eastern Europe (Colen and Swinnen, 2010).

Table 2.1: Summary of total alcohol consumption share by type, 1961-2010 (select years)

Year	Beer	Wine	Distilled Spirits
1961	47.1%	11.1%	41.8%
1970	45.3%	10.7%	44.0%
1980	50.0%	12.3%	37.7%
1990	54.9%	13.6%	31.5%
2000	56.3%	14.3%	29.4%
2010	50.0%	17.3%	32.7%

SOURCE: World Health Organization Global Health Observatory Data Repository

NOTES: The Global Health Observatory Data Repository reports annual per capita consumption of alcohol in liters by type of alcohol. The Repository only considers recorded adults, which are defined as individuals fifteen years of age or older. Percentage shares are computed by dividing the per capita consumption of each type by the total consumption in the given year.

2.1 Types of Breweries

The U.S. beer brewing industry is comprised of two primary types of breweries: craft breweries and macrobreweries.[3] The craft beer industry is divided into three types of breweries: brewpubs, microbreweries, and regional craft breweries. The Brewers Association defines these three brewery types in the following way (*Brewers,* 2013e). Brewpubs typically produce lower volumes of beer relative to all other types of breweries. They produce beer primarily for sale in the brewery's restaurant, bar, or taproom and sell at least twenty five percent of their beer directly at those locations (i.e., on-site). Microbreweries produce less than fifteen thousand barrels of beer per year and sell seventy-five percent or more of their beer outside of the brewery's taproom or restaurant (i.e. off-site).[4] Regional craft breweries produce between fifteen thousand and six million barrels annually and sell seventy-five percent or more of their beer off-site. However, there is no economic reason to separate micro and regional craft breweries because both types of breweries are in business primarily to sell beer (versus operating more like a restaurant like brewpubs) and the only difference between them is their level of production. Therefore, micro and regional craft breweries are combined for the purposes of this study.[5]

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[3] Note that U.S. consumers also drink beer produced by international breweries (imports). In 2012, imported beer accounted for 13 percent of total beer consumption (*Beer*, 2013). However, the focus of this thesis is the production by and number of domestic breweries and therefore imports are outside the scope of this study.
[4] The terms 'microbrewery,' 'specialty brewery,' and 'craft brewery' are used interchangeably both within and outside of the brewing industry. However, for the purposes of this study, 'microbrewery' refers to a specific type of brewery and 'craft brewery' represents the entire craft beer segment of the brewing market.
[5] The direction and significance of parameter estimates from separate regressions for micro and regional craft breweries were similar, providing further evidence that it is appropriate to combine the two.

Macrobrewries produce more than six million barrels of beer per year. Beer produced by macrobreweries is typically lighter in style and taste because it is often produced with fewer hops and contains adjuncts like rice and corn in the place of malted barley (Tremblay, 1985; Tremblay and Tremblay, 2011). Additionally, there is little variation in the quality and taste of beer produced by different macrobreweries (Ackoff and Emshoff, 1975; Allison and Uhl, 1964; Tremblay, 1985; Tremblay and Tremblay, 2005). Tremblay (1985) states that, "the light Pilsner beer produced by most U.S. beer producers is nearly homogeneous." Additionally, according Tremblay and Tremblay (2005), "although individual consumers have strong opinions about which brands are best, it is difficult to identify real quality differences among the different brands of the mass-producing brewers." Beer produced by macrobreweries is distributed nationally and macrobreweries differentiate their beer from beer produced by competitors primarily through the use of television advertising (Esteve-Pérez, 2010; George, 2009; Greer, 1971; Larivirea, Lareub, and Chalfant, 2000; Lee and Tremblay, 1992; Rojas and Peterson, 2008; Tremblay and Tremblay, 2005). Some of the most prominent macrobreweries in the United States today are Anheuser-Busch InBev, MillerCoors, and Pabst Brewing Company.

There is significantly more variety in style and input quality in the beer produced by craft breweries. For example, many craft beers are darker in color, have stronger flavors, and higher alcohol and calorie content (Adams, 2006; Poelmans and Swinnen, 2011a; Tremblay and Tremblay, 2005; Tremblay and Tremblay, 2011). Craft beer is generally distributed in smaller, regional geographic ranges (e.g., within the state of production). Craft breweries differentiate their products both among their own different beers and from their competitors through the use of different raw materials that create distinct beer flavors, styles, and colors (Adams, 2006; Tremblay and Tremblay, 2005). For example, some craft breweries add fruits, herbs, rye, and other spices to create a wide range of flavors (Adams, 2006).

Craft breweries rarely engage in traditional advertising measures. Instead, they commonly generate local branding and product awareness through establishing relationships with area restaurants and bars, local event sponsorships, merchandise giveaways, and participation in local and regional beer festivals (Rojas and Peterson, 2008; Tremblay and Tremblay, 2005).[6] Four of the largest craft breweries in the United States today are the Boston Beer Company (Massachusetts), Sierra Nevada Brewing Company (California), New Belgium Brewing Company (Colorado), and Deschutes Brewery (Oregon).

2.2 History of the Number of Breweries

The number of breweries operating in the United States has changed significantly over the past century. Before the 1910s, many breweries, some of which still exist today, began to merge and take advantage of economies of scale in production. For example, the original Pabst Brewing Company was founded in 1844, but did not expand production until combining with another brewing company in 1873 (Tremblay and Tremblay, 2005). These types of mergers and partnerships resulted in rapid growth in both brewery size

[6] Research indicates that firms (in this case, breweries) benefit from information spillovers arising from such advertising efforts (Mathewson and Winter, 1984).

and output in the late 1880s. By the late 1910s, the brewing industry was one of the leading manufacturing industries in the United States (Stack, 2000). Prohibition began in 1919 when the U.S. government passed the Eighteenth Amendment.[7] This banned the production, transportation, sale, and import of all alcoholic beverages, resulting in 1,568 firms exiting the brewing business (Tremblay and Tremblay, 2005).

Prohibition caused many breweries to permanently stop operations. However, some firms remained in business by producing goods whose production processes are similar to the brewing process. For example, Anheuser-Busch InBev, MillerCoors, and Pabst Brewing Company endured prohibition by producing near-beer, dairy products, and malt syrup. [8] Other breweries stayed in business by producing soft drinks such as ginger ale and ice cream (Stack, 2000; Tremblay and Tremblay, 2005). Prohibition persisted until Congress passed the Twenty-first Amendment in 1933, which repealed the Eighteenth Amendment.

[7] Prohibition is informally known as the Volstead Act, named after Andrew Volstead who drafted the bill.
[8] Near-beer refers to a beer-like beverage that has less than 0.5 percent alcohol by volume. It was illegal to label these beverages as beer, so they were sold as "cereal beverages." Most breweries that remained in business during prohibition brewed and marketed their own near-beer products. For example, Anheuser-Busch InBev sold Bevo, a non-alcoholic cereal beverage, during prohibition.

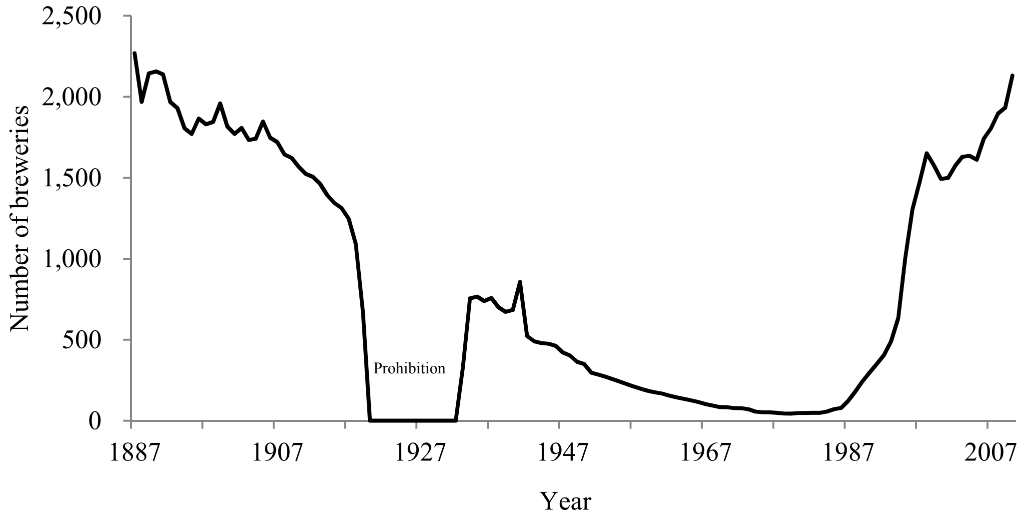

FIGURE 2.1: Total number of operating breweries in the United States, 1887-2010

SOURCE: Beer Institute 2013 Brewers Almanac

Figure 2.1 illustrates the history of the total number of breweries in the United States over the past 124 years. There was a surge in the number of breweries in 1934 after the repeal of prohibition. Firms that survived prohibition quickly shifted back to brewing beer. According to Carroll *et al.* (1993), roughly 75 percent of the breweries that opened between 1933 and 1934 were in operation before prohibition. After the post-prohibition surge, many breweries that re-entered the market were unable to survive because they could not compete with breweries that had improved their brewing processes by staying in business selling other products during prohibition (Tremblay and Tremblay, 2005). Figure 2.1 shows that the number of operating breweries began to decline in the late 1930s as breweries consolidated.

Contrary to predictions that the trend would not last (Horowitz and Horowitz, 1965), post-prohibition concentration persisted until the early 1980s. Between 1934 and 1979, the number of breweries fell from 756 to 44. Gisser (1999) finds that technological advancements in the brewing process were largely responsible for the concentration of breweries over this period. The market share of the leading breweries increased significantly between the repeal of prohibition and the late 1970s, with the top four breweries at the time (Anheuser-Busch InBev, Coors, Miller, and Pabst Brewing Company) controlling over eighty percent of the market (Iwasaki *et al.*, 2008; Poelmans and Swinnen, 2011b; Tremblay and Tremblay, 2005). This trend in concentration abruptly changed in the mid-1980s when the number of breweries began to rapidly increase. In 1980, there were 48 breweries operating in the United States, but only one decade later there were over six times as many breweries (298). Over the next twenty years, the number of operating breweries increased by over four hundred percent and by 2010 there were more than 2,000 operating breweries in the United States.

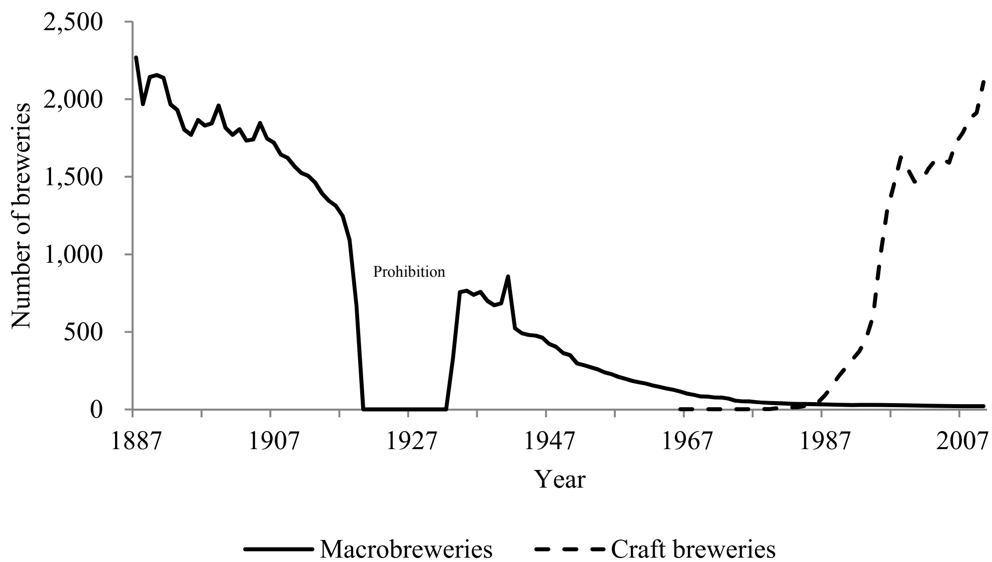

FIGURE 2.2: Total number of operating breweries in the United States by type, 1887-2010

SOURCE: Beer Institute 2013 Brewers Almanac

However, the growth in the number of brewing firms has varied between craft breweries and macrobreweries. Figure 2.2 illustrates trends in the number of breweries since 1887, with breweries separated by their respective type. After the repeal of prohibition, the number of macrobreweries reached a peak in 1941 at 857 breweries. However, macrobreweries began to subsequently consolidate through mergers and acquisitions and by 1980 there were only 40 macrobreweries in operation. According to Greer (2002), there were more than 600 horizontal mergers in the brewing industry between 1950 and 2000.The number of macrobreweries reached its low at twenty in 2006 and has remained relatively constant since. In contrast, there was a distinct difference in the type of breweries entering the market during the 1980s, with most entrants brewing predominantly craft style beers.

Figure 2.2 illustrates that craft breweries have been the primary driver of growth in the total number of firms in the industry since the 1980s. In 1980, there were only eight craft breweries in the United States, but by 1990, there were more than thirty-three times more craft breweries in operation. Over the next twenty years, there was a 685 percent increase in the number of craft breweries. Craft breweries accounted for 96.6 percent (2,013) of the total number of breweries that entered the market between 980 and 2012. By 2012, there were 2,111 craft breweries in operation, accounting for 99 percent of the total number breweries in the country.

While the literature does not specifically cite what encouraged and facilitated the growth in the craft brewery segment, several factors potentially influenced the change in the brewery market composition. For example, some research suggests that a change in consumer preferences toward more product variety was largely responsible for the significant growth in the craft brewery segment during this time (Carroll and Swaminathan, 2000; Poelmans and Swinnen, 2011a). This shift in preferences also coincides with the local food movement. This movement traces early development back to the 1960s but did not gain significant momentum in the early 1990s (Ikerd, 2008; *Whole,* 2011).[9] Changes in both the number of farms and total farm production since the 1980s are similar to those observed in the brewing industry. For example, there were almost three times as many farms in 2006 as there were in 1994, but total local food sales only accounted for roughly five percent of the total retail food market during this time (Ikerd, 2008).

2.3 History of Beer Production

Total beer production in the United States has also varied through history. Beer production was steadily increasing before prohibition, which was largely due to advancements in the brewing process and improvements to transportation technologies. For example, pasteurization, adopted in the 1870s, improved product consistency and reduced the incidence of spoilage (Carroll *et al.*, 1993; Gisser, 1999). Additionally, the innovation of refrigerated rail cars kept beer at constant temperature through transit (Gisser, 1999). The combination of these technologies allowed beer to be shipped farther without affecting product quality. Figure 2.3 illustrates the changes in total beer production in the United States over the past 124 years.

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[9] The terms “local,” “natural,” and “organic” are used interchangeably within the agricultural industry.

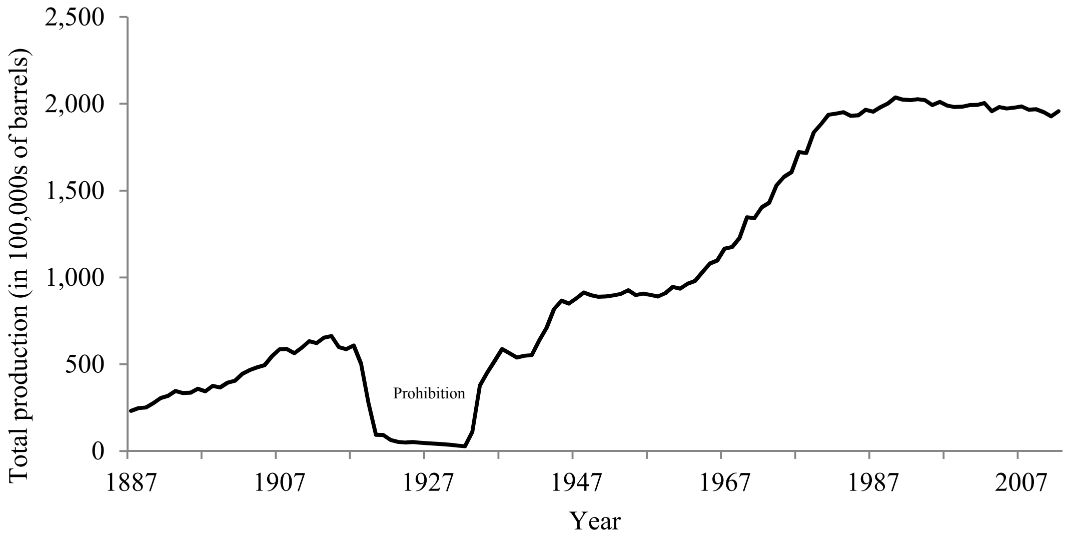

FIGURE 2.3: Total beer production in the United States, 1877-2010

SOURCE: Beer Institute 2013 Brewers Almanac

NOTES: While there was no legal production of alcoholic beverages during prohibition (1920-1933), the Beer Institute provides estimates of illegal production for these years.

In 1919, the year before prohibition, total beer production in the United States was almost twenty eight million barrels. In 1934, the year after prohibition was repealed, total beer production increased to almost thirty eight million barrels and continued to grow in the following five decades. Technological advancements positively contributed to breweries' production possibilities during this period, including the development of more automated brewing processes, more readily accessible refrigeration systems, and improved packaging technologies (Carroll *et al.*, 1993; Gisser, 1999; Tremblay and Tremblay, 2005; Xia and Buccolat, 2003). Beer production reached a plateau at just over two hundred million barrels in the late 1980s and has remained relatively constant ever since. Between 1980 and 2010, total beer production in the United States increased by 3.6 percent. U.S. breweries produced a total of 195.7 million barrels of beer in 2012. Figure

2.4 illustrates that, until recently, there has been an inverse relationship between the number of breweries and total production. However, there has been little research into the change in this relationship since the 1980s.

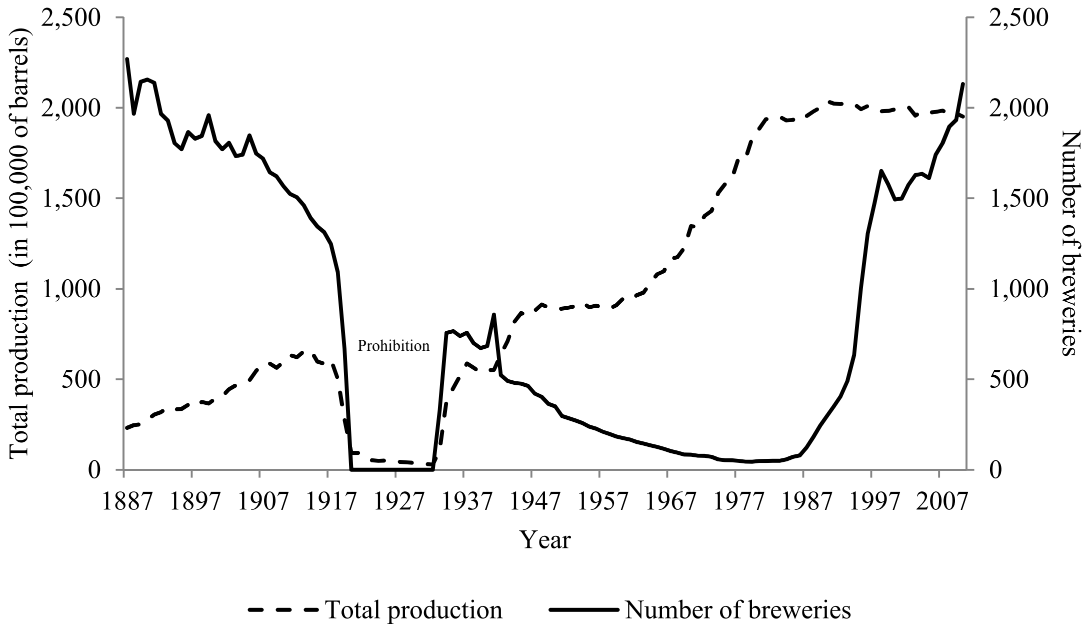

FIGURE 2.4: Number of breweries and total beer production in the United States, 1877-2010

SOURCE: Beer Institute 2013 Brewers Almanac

NOTE: This figure includes both craft and macrobreweries.

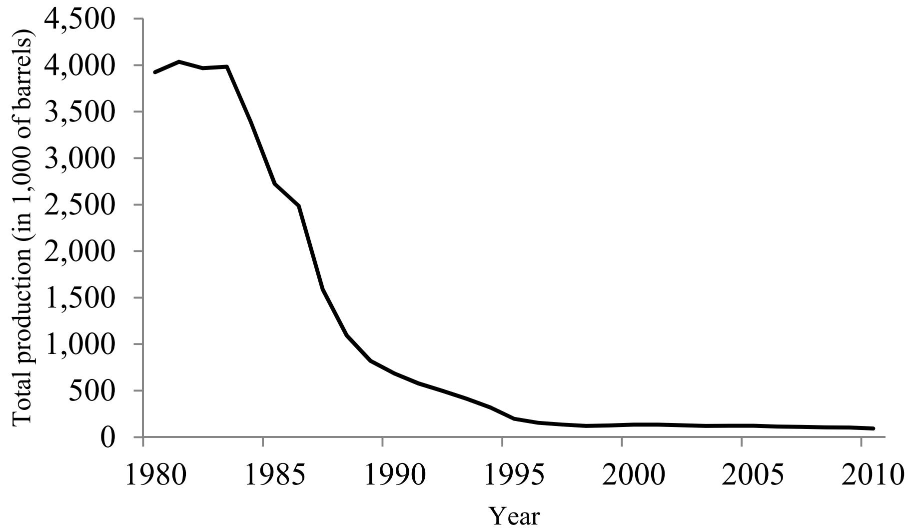

FIGURE 2.5: Average production per brewery, 1980-2010

SOURCE: Beer Institute 2013 Brewers Almanac

NOTE: This figure includes both craft and macrobreweries. Average production per brewery was calculated by dividing the total production by the total number of breweries in each year.

Figure 2.5 shows that the average production per brewery has significantly declined since the 1980s. In 1980, the average production per brewery was almost four million barrels of beer. This was during the time that the four largest breweries (Anheuser-Busch InBev, Coors, Miller, and Pabst Brewing Company) controlled over eighty percent of the market (Tremblay and Tremblay, 2005). However, by 1990, the average production per brewery was 683 thousand barrels per year and by 1995 average production per brewery decreased to198 thousand barrels per year. This means that there was a 71 percent decrease in the average production per brewery between 1990 and 1995 alone. The average production per brewery continued to decline between 1995 and 2010, but at a much slower pace. By 2010, the average production per brewery was 91.6 thousand barrels per year. Figures 2.4 and 2.5 demonstrate that, while the total number of breweries in the United States has increased significantly since the 1980s (see Figure 2.1) there have not been equal increases in production during that period. That is, while there are now more breweries operating in the United States, the average brewery is now smaller in terms of output. Additionally, the craft brewery share of total market output has increased since the 1980s. In 1980, craft beer production was negligible in terms of total beer production in the United States. However, by 2012, craft beer production was five percent of total production, increasing further to 7.8 percent in 2013 (*Beer,* 2013; *Brewers,* 2013c).

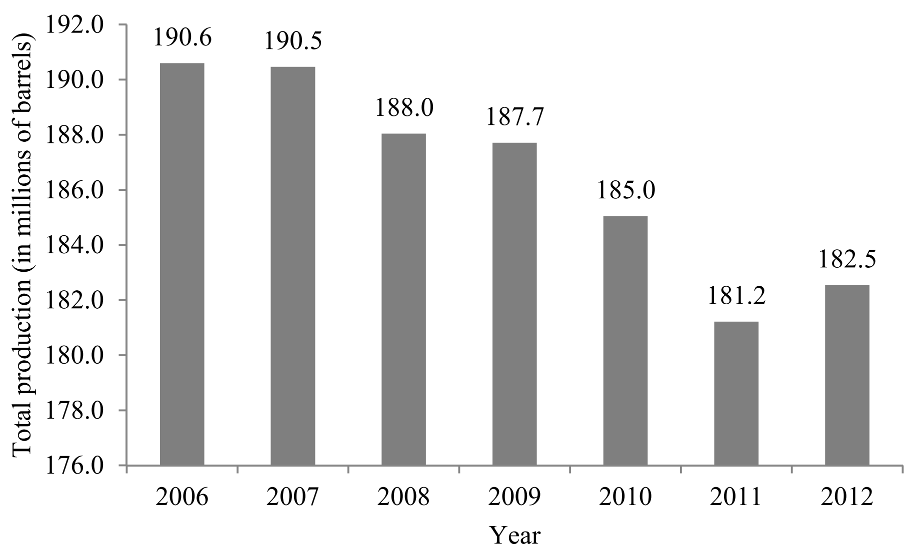

FIGURE 2.6: Macrobrewery production in the United States, 2006-2012

SOURCE: Brewers Association, Beer Institute 2013 Brewers Almanac

However, production patterns by brewery type have not been the same in recent years. Figure 2.6 illustrates the annual levels of macrobrewery brewery production between 1996 and 2012. During this time period, macrobrewery production decreased by four percent for a total of 8.1 million fewer barrels per year.

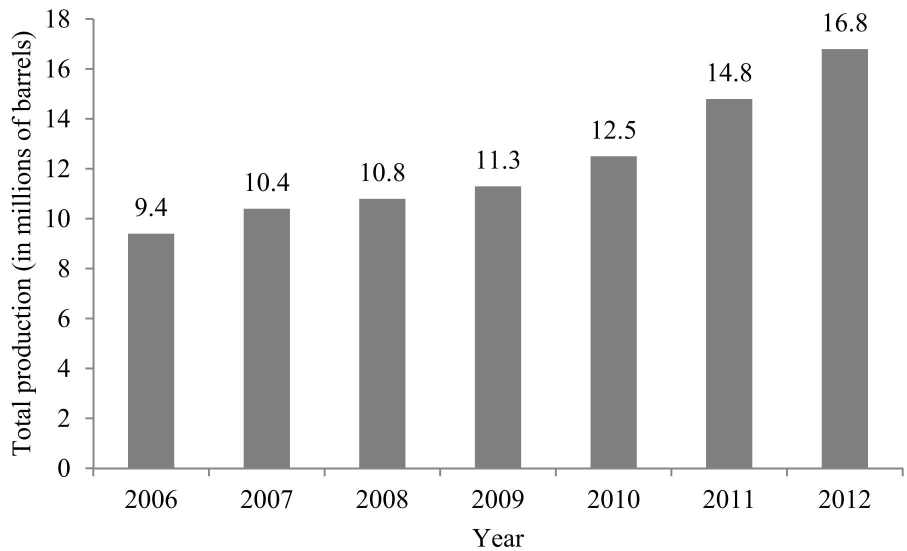

FIGURE 2.7: Craft brewery production in the United States, 2006-2012

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

In contrast, craft brewery production has steadily increased since 1996, as illustrated by Figure 2.7. Between 1996 and 2012, craft breweries increased production by 7.4 million barrels , amounting to a seventy nine percent increase. This increase partially offset the 8.4 million decrease in production by macrobreweries. Between 2011 and 2012, total beer production in the U.S. increased by one percent while craft breweries increased output by almost fourteen percent (*Beer*, 2013b). In 2006, domestic craft breweries produced over nine million barrels of beer, accounting for 4.8 percent of total beer production in the United States; by 2012, craft brewery output as a share of total production almost doubled, reaching 8.6 percent of total beer production (*Brewers,* 2013a; *Beer*, 2013a).

2.3 Craft Brewery Growth

Production information provided by the Brewers Association contain brewery-level production data for all of the craft breweries operating in the United States between 1991 and 2012. These data are aggregated to the state level by brewery type (see Section 6.1 for more information on this data). Figure 2.8 illustrates the number of craft breweries in the United States between 1991 and 2012. The total number of breweries increased from 92 to 2,045—a 2,122 percent increase. Declines in the number of breweries occurred only in 2003 and 2008, which coincided with economic recessions.[10]

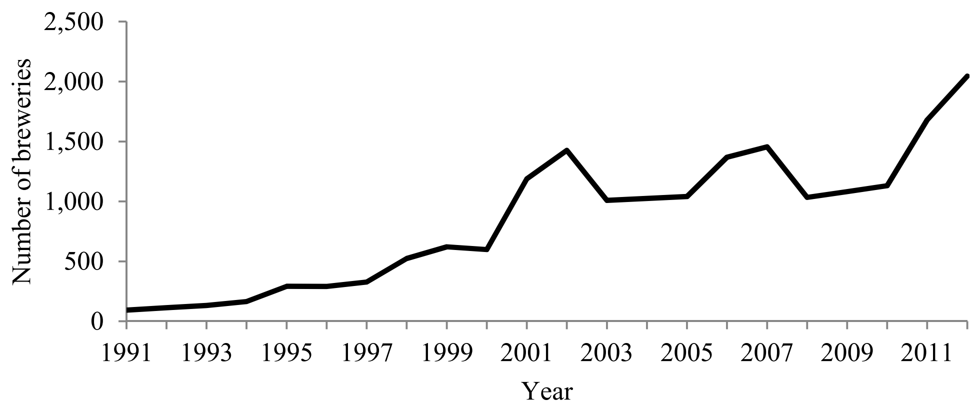

Figure 2.8: Total number of craft breweries in the United States, 1991-2012

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

NOTES: The BIPS production data lists annual production by brewery by state. The total number of breweries in each year is the sum of individual breweries with positive production values in each year.

Figure 2.9 shows changes in total craft brewery production since 1991. The total production by craft breweries increased by 773 percent, from 1.9 million barrels in 1991

[10] Freeman (2011) finds that beer is a pro-cyclical, normal good in his chapter "Cold Comfort in Hard Times: Do People Drink More Beer During Recessions?" That is, consumers drink less beer during recessionary periods.

to 16.8 million barrels in 2012. With the exception of a significant decline in total production in 2003 (28 percent), there is an overall positive trend in the total production between 1991 and 2012. While overall production does not decrease in 2008 as the total number of breweries does (see Figure 2.8), production slowed from a 10.4 percent increase in production between 2006 and 2007 to a 4 percent increase in production between 2007 and 2008.

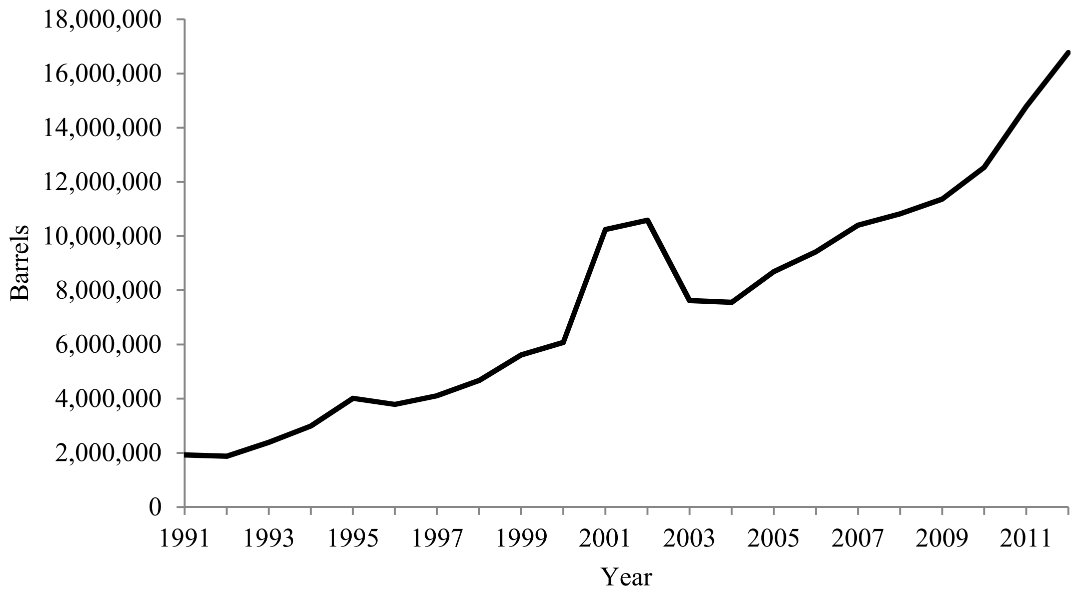

Figure 2.9: Total craft brewery production in the United States, 1991-2012

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

NOTES: The BIPS production data lists annual production by brewery by state. The production in each year is the sum of production values.

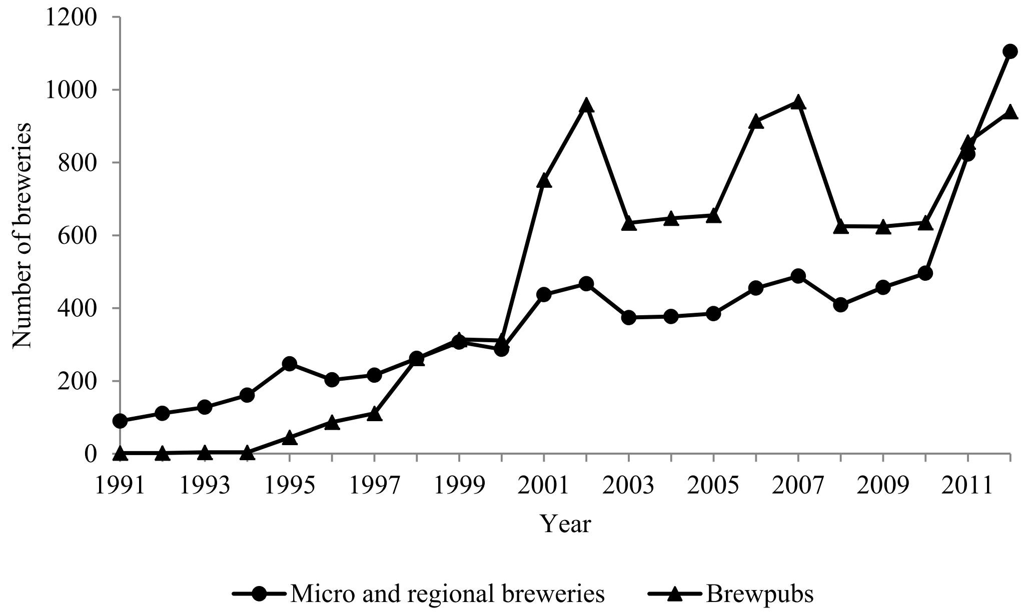

Figure 2.10: Total number of craft breweries in the United States by type, 1991-2012

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

NOTES: The BIPS production data lists annual production by brewery by state. The total number of breweries in each year is the sum of individual breweries with positive production values in each year sorted by type.

Figure 2.10 shows that there has been an increase in both types of craft breweries since the early 1990s. The number of both brewpubs and micro and regional breweries declined between 2002-2003 and 2007-2008, but the rate of brewpub decline was more pronounced in both instances. In 2003 there were 207 fewer micro and regional breweries than in 2002, amounting for a 19.9 percent decrease. In the same period, there were 325 fewer brewpubs, amounting to a 33.9 percent decrease. It is perhaps not surprising that brewpubs are more sensitive to periods of economic recessions because they are more subject to the economic position of consumers located nearby.[11] That is, the consumer base for brewpubs is concentrated within their immediate geographic vicinity because they primarily serve beer directly on their brewing site. In contrast, micro and regional craft breweries sell their beer to consumers across much wider geographic ranges, making them potentially less sensitive to the socioeconomic conditions within their close vicinity.

Table 2.2 provides more detail on the annual number of breweries by type along with their relative market shares. The table shows that, while there has been growth in both types of breweries between 1991 and 2012, brewpubs have significantly increased their market share in terms of the number of craft breweries relative to micro and regional breweries. In 1991, almost ninety-eight percent of all craft breweries were micro and regional breweries. However, the composition of craft breweries changed between 1991 and 2012 as brewpubs' share of the total number of craft breweries rapidly increased, reaching forty six percent in 2012. Brewpubs reached their peak market share at over sixty three percent in 2002.

[11] The national unemployment rate increased 26.36 percent between 2001 and 2003 and 25.86 percent between 2006 and 2008. In addition, U.S. median income decreased during these years.

Table 2.2: Total number of craft breweries by type, 1991-2012

	Micro and regional breweries		Brewpubs		
Year	Number of microbreweries	Market share of total number of firms	Number of brewpubs	Market share of total number of firms	Total
1991	90	97.8%	2	2.2%	92
1992	111	98.2%	2	1.8%	113
1993	128	97.0%	4	3.0%	132
1994	161	97.6%	4	2.4%	165
1995	247	84.6%	45	15.4%	292
1996	203	70.0%	87	30.0%	290
1997	216	66.1%	111	33.9%	327
1998	262	50.0%	262	50.0%	524
1999	307	49.4%	314	50.6%	621
2000	287	48.0%	311	52.0%	598
2001	437	36.8%	752	63.2%	1189
2002	467	32.7%	959	67.3%	1426
2003	374	37.1%	634	62.9%	1008
2004	377	36.8%	647	63.2%	1024
2005	385	37.0%	655	63.0%	1040
2006	455	33.2%	914	66.8%	1369
2007	488	33.5%	967	66.5%	1455
2008	409	39.6%	625	60.4%	1034
2009	457	42.3%	624	57.7%	1081
2010	496	43.9%	635	56.1%	1131
2011	823	49.0%	856	51.0%	1679
2012	1,105	54.0%	940	46.0%	2045

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

NOTES: Annual share figures by type computed by dividing the number of breweries in each type by the total number of breweries in the given year.

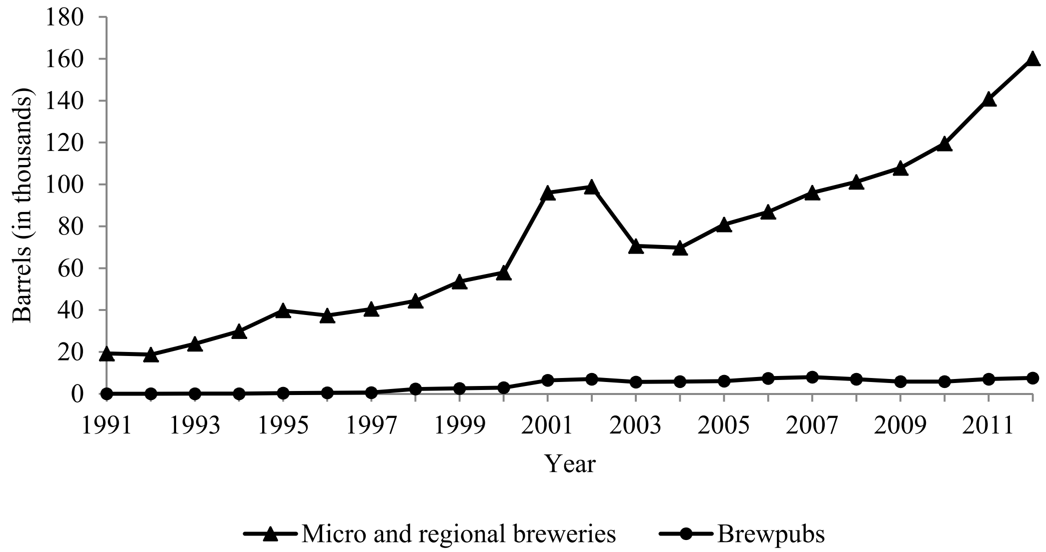

Figure 2.11: Total production by craft breweries in the United States by type, 1991-2012

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

NOTES: The BIPS production data lists annual production by brewery by state. The total production in each year is the sum of individual brewery production values in each year sorted by type.

Figure 2.11 shows the change in the total production by type of craft brewery since 1991. This shows that the majority of craft beer was produced by micro and regional breweries between 1991 and 2012. Additionally, this figure illustrates that micro and regional brewery production followed a relatively consistent upward trend, with the exception of a dramatic decrease between 2002 and 2003; production by micro and regional breweries fell by almost thirty percent between these two years. Table 2.3 provides more detail on the annual production levels by type along with their relative market shares. In 1993 at their lowest level of production, micro and regional breweries still produced 92.3 percent of the craft beer in the United States. This means that between

1991 and 2012, more than nine out of every ten craft beers consumed in the U.S. was produced by a micro or regional craft brewery.

Table 2.3: Total craft brewery production by type, 1991-2012

	Micro and regional breweries		Brewpubs		
Year	Production (barrels)	Market share of total production	Production (barrels)	Market share of total production	Total production (barrels)
1991	1,919,855	100.0%	417	0.0%	1,920,272
1992	1,870,448	100.0%	789	0.0%	1,871,237
1993	2,386,776	99.9%	1,421	0.1%	2,388,197
1994	2,985,722	99.9%	3,527	0.1%	2,989,249
1995	3,979,210	99.2%	30,789	0.8%	4,009,999
1996	3,741,878	98.8%	47,230	1.2%	3,789,108
1997	4,049,476	98.7%	55,003	1.3%	4,104,479
1998	4,437,967	95.1%	229,049	4.9%	4,667,016
1999	5,359,737	95.5%	254,439	4.5%	5,614,176
2000	5,787,799	95.2%	288,811	4.8%	6,076,610
2001	9,599,992	93.8%	639,545	6.2%	10,239,537
2002	9,886,914	93.4%	699,392	6.6%	10,586,306
2003	7,056,034	92.6%	562,791	7.4%	7,618,825
2004	6,971,427	92.3%	580,899	7.7%	7,552,326
2005	8,083,649	93.1%	602,793	6.9%	8,686,442
2006	8,686,975	92.2%	735,394	7.8%	9,422,369
2007	9,606,458	92.4%	793,680	7.6%	10,400,138
2008	10,121,754	93.6%	696,747	6.4%	10,818,501
2009	10,784,949	94.9%	579,238	5.1%	11,364,187
2010	11,953,539	95.4%	579,089	4.6%	12,532,628
2011	14,082,610	95.3%	698,180	4.7%	14,780,790
2012	16,017,648	95.5%	753,568	4.5%	16,771,216

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

NOTES: Annual share figures by type computed by dividing the production in each type by the total production in the given year.

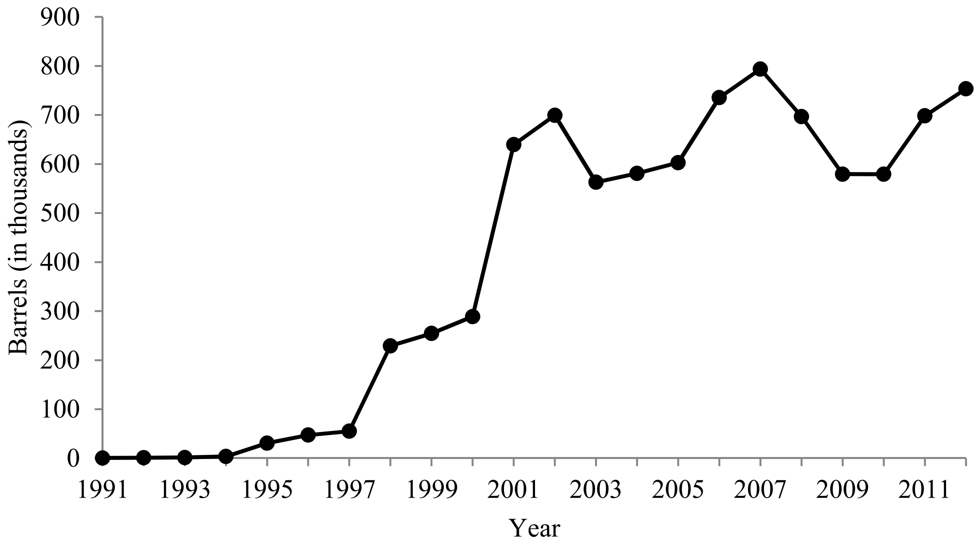

Figure 2.12: Total production by brewpubs in the United States, 1991-2012

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

NOTES: The BIPS production data lists annual production by brewery by state. The total production in each year is the sum of individual brewery production values in each year.

Even though micro and regional breweries consistently produced the majority of the craft beer in the United States between 1991 and 2012, Figure 2.12 shows that brewpubs also significantly increased production. In addition, Table 2.3 shows that brewpubs have gained market share over this period. In 1991, brewpub production was negligible in terms of the total craft beer production, but ten years later brewpubs were producing 6.2 percent of all craft beer. Brewpubs reached their peak production market share in 2004 at 7.7 percent.

Figures 2.13 and 2.14 illustrate changes in the number of brewpubs per capita and micro and regional breweries per capita, respectively, between 1991 and 2012. Figure 2.13 shows that brewpubs have been concentrating in western states (e.g., Washington, Oregon, Colorado) and states in the north east (e.g., Maine and Vermont). While the trends are similar for micro and regional breweries, these breweries also expanded into state in the Midwest (e.g., Nebraska and Kansas). Figures 2.15 and 2.16 illustrate changes in the total production per capita by brewpubs and micro and regional breweries, respectively. Figure 2.15 shows that in 1991 brewpub production per capita was relatively low across all states but increased in the western and north east states where was growth in the number of brewpubs. Figure 2.16 illustrates that increases in production per capita by micro and regional breweries occurred over wider geographic ranges, with high levels of production in states across the entire United States (e.g., Texas, Missouri, and New York). Figures 2.13 through 2.16 illustrate that there was little craft brewery presence in southern states (e.g., Alabama, Georgia, and Mississippi) between 1991 and 2012.

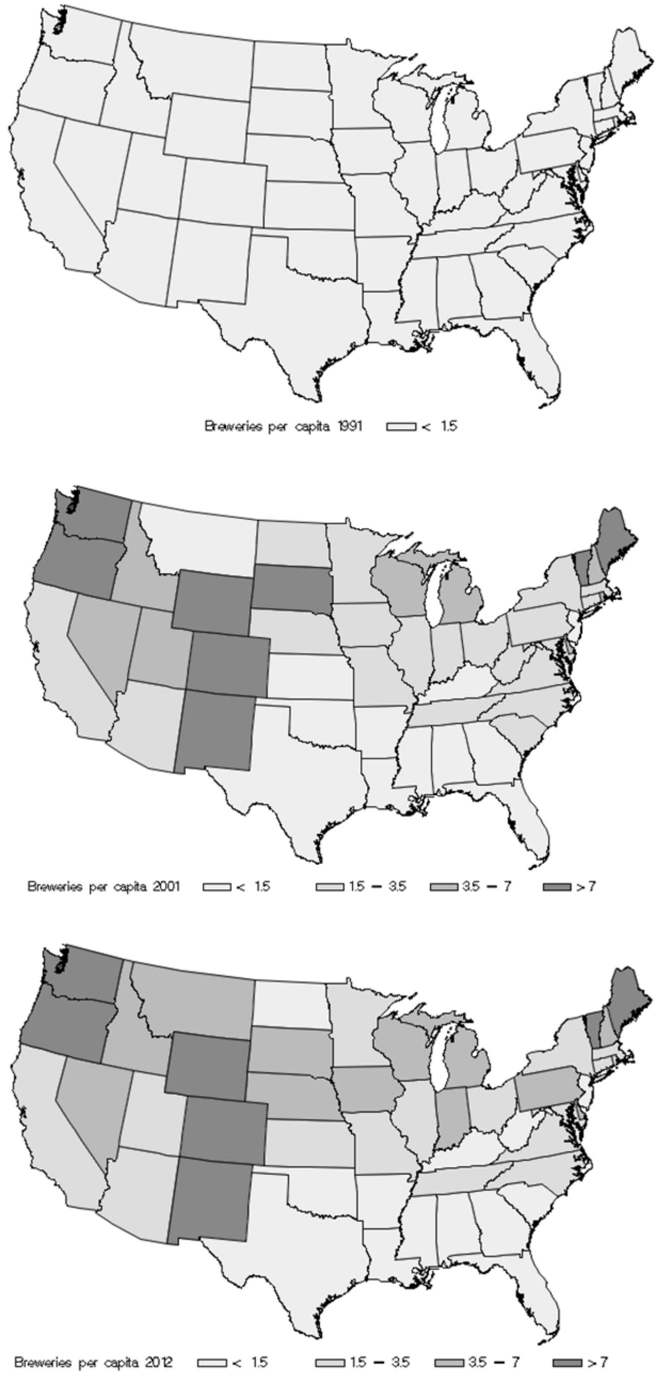

Figure 2.13: Brewpubs per capita, select years

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data

NOTES: Values are represented as the number of breweries per million people. The BIPS production data lists annual production by brewery by state. The total number of breweries in each year is the sum of individual breweries with positive production values in each year sorted by type.

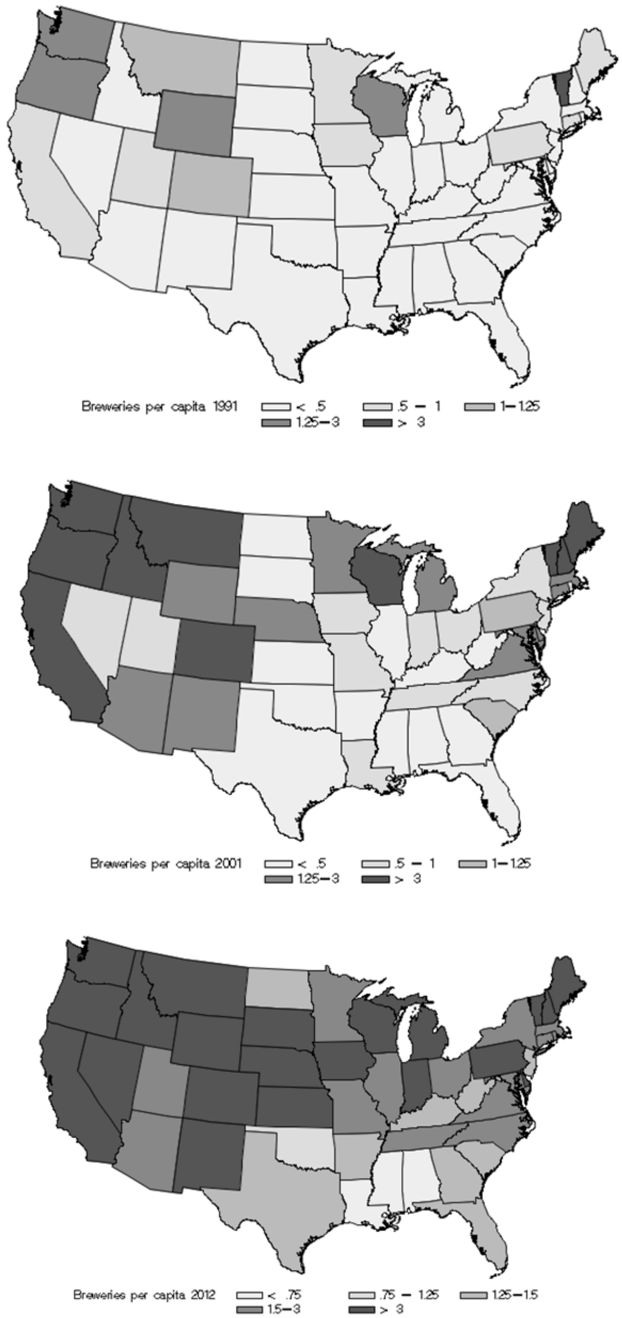

Figure 2.14: Micro and regional breweries per capita, select years

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data

NOTES: Values are represented as the number of breweries per million people. The BIPS production data lists annual production by brewery by state. The total number of breweries in each year is the sum of individual breweries with positive production values in each year sorted by type.

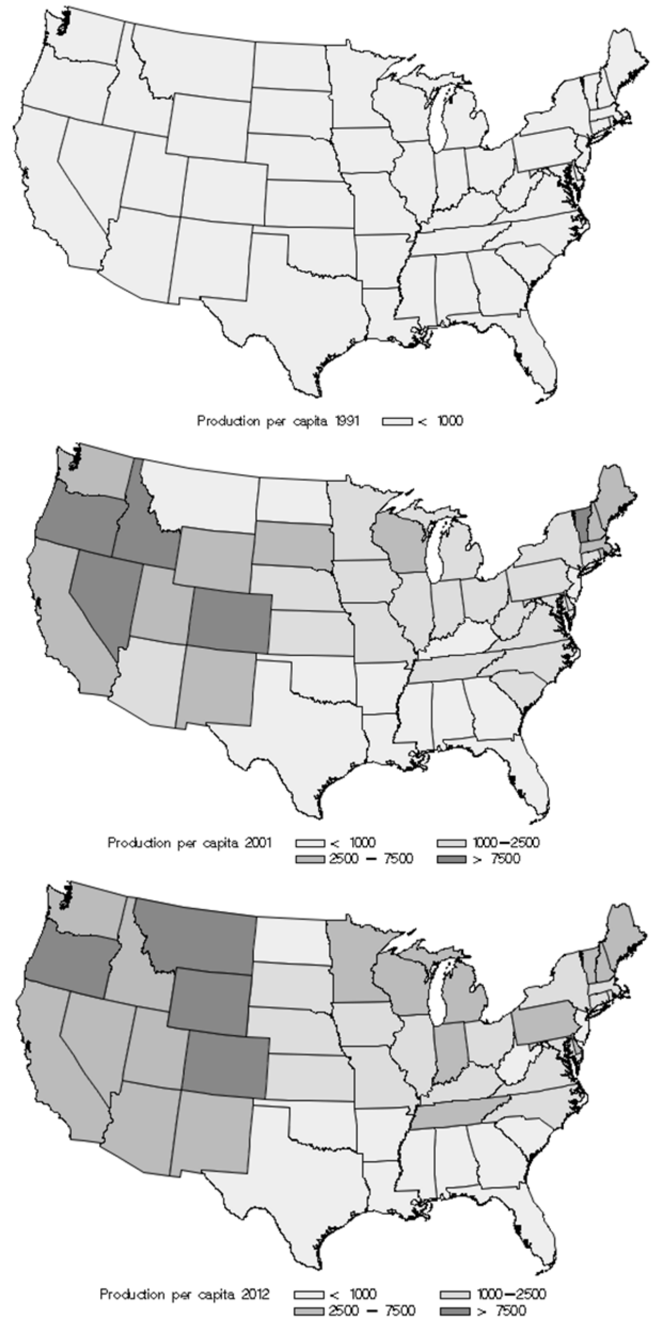

Figure 2.15: Brewpub production per capita, select years

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data

NOTES: Values are represented as the total production per million people. The total production in each year is the sum of individual brewery production values in each year.

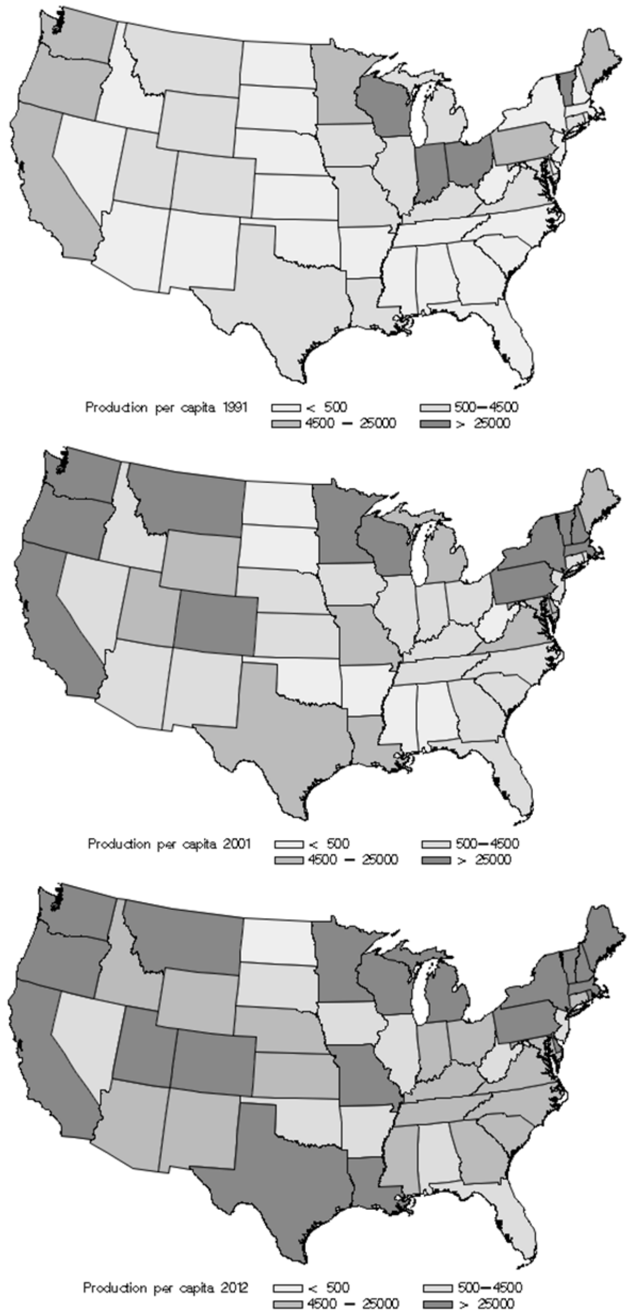

Figure 2.16: Micro and regional production per capita, select years

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data

NOTES: Values are represented as the total production per million people. The total production in each year is the sum of individual brewery production values in each year.

CHAPTER 3

INDUSTRY REGULATION

An excise tax is a per unit tax imposed on the production of a product (Keat and Young, 2009).[12] Both federal and state excise taxes are imposed on the production of beer in the United States.[13] These excise taxes levy costs on the production of beer in addition to the regular brewing costs, which include labor, material (e.g., hops, yeast, barley), shipping, and permit fees. This means that excise taxes on beer increase the marginal cost of beer production.

While excise taxes are paid to the government directly by breweries and are not explicitly collected from the consumer, a portion of the cost is realized by the breweries and another portion is passed on to consumers through higher prices. The incidence of the tax depends on the elasticity of the relative supply and demand curves for beer. Research finds that the demand for beer is inelastic (Hogarty and Elzinga, 1972; Larivirea, Larueb, and Chalfant, 2002; Lee and Tremblay, 1992; Niskanen, 1962; Pinkse and Slade, 2004; Wagenaar, Salois, and Komro, 2009), which suggests that consumers pay a larger portion of the excise tax relative to producers (breweries).[14]

However, Keat and Young (2009) also state that the short run supply curves for beer are relatively inelastic because breweries "cannot immediately remove resources

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[12] Excise taxes are sometimes also called "specific taxes." Excise taxes differ from sales taxes in that the latter are levied on the percent of a product's price (Keat and Young, 2009).

[13] Excise taxes on beer are often called "sin" taxes because they are imposed on goods that are "not considered desirable by today's standards" (Keat and Young, 2009). Sin taxes are also imposed on other alcoholic beverages (wine and distilled spirits) and tobacco products.

[14] Denny, Byunglak Lee, and Tremblay (2002) find that 20 percent of the cost is absorbed by breweries and 80 percent is passed on to consumers.

from this industry to another pursuit." This means that breweries will incur a higher incidence of the excise tax when the supply curve for beer is relatively inelastic. Ceteris paribus, an increase in the marginal cost of beer production is expected to cause a decrease in the supply of beer, thereby resulting in a decreased equilibrium quantity of beer and a higher equilibrium price. It is useful to understand the underlying agencies that impose and enforce excise taxes in the United States, which are outlined in Section 3.1.

3.1 Regulatory Organizations

The production and consumption of beer and other alcoholic beverages (wine and distilled spirits) in the United States is heavily regulated at the federal level by two organizations: The Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) and the Alcohol and Tobacco Tax and Trade Bureau (TTB). The ATF is the law enforcement agency that monitors and investigates illegal alcohol trafficking and operations while the TTB regulates and collects excise taxes on distilled spirits, wine, and beer. The ATF was the primary regulatory body for the alcoholic beverage industry prior to the Homeland Security Act of 2002, which transferred the law enforcement and criminal regulation of the industry from the U.S. Department of the Treasury to the U.S. Department of Justice and created the TTB to maintain excise tax control under the Department of the Treasury (*U.S.*, 2012; *United*, 2013).

Chapter 26 Section 5051(a)(1)(D) of the United States Code outlines the federal government's authority to tax beer production. In 2012, the United States government collected nearly $10.2 billion dollars in federal tax revenues from domestic and imported alcoholic beverage sales, a 2.8 percent increase from 2011. Of total federal excise tax collections on alcoholic beverages in 2012, $3.7 million (36.3 percent) was from beer (*Beer,* 2013b).[15] In addition to federal excise taxes, states regulate intrastate production, distribution, and consumption through state-level policies. States also impose excise taxes on the production of beer brewed within their borders.

3.2 Federal Excise Taxes

A federal excise tax on beer production was first imposed in the mid-1800s as part of the Revenue Act of 1862.[16] This excise tax was one of many imposed during this time to pay for costs related to the U.S. Civil War, which included taxes on income, distilled spirits, wine, and tobacco (*Internal,* 2014). After the end of the Civil War, public opposition persuaded Congress to cut the income tax rate, but taxes on alcoholic beverages and tobacco remained permanent in order for the government to continue generating tax revenue (*Internal,* 2014). The government has adjusted the tax rate several times after it was first imposed and excise taxes on beer production have become an "ongoing secure source of [government] finance" (Blocker, Fahey, and Tyrrell, 2003). Table 3.1 provides a summary of federal excise tax rates on beer production between 1862 and 2013.

[15] This includes both domestic and imported beer. The domestic share of 2012 federal excise tax collections accounted for 85.9 percent of the excise taxes collected on beer.
[16] The first excise tax on alcohol was actually in 1771, which was levied to pay for costs related to the U.S. Revolutionary War. However, this tax only applied to distilled spirits and not "fermented beverages" and therefore did not include beer (Ripy, 1999).

Table 3.1: History of federal excise tax rates

Year: From	Year: To	Tax rate per barrel ($)	Tax rate per gallon ($)	Reduced tax rate per barrel ($)	Reduced tax rate per gallon ($)
Sept. 1862	March 1863	1.0	0.032	0	0.000
March 1863	March 1864	0.6	0.019	0	0.000
April 1864	June 1898	1.0	0.032	0	0.000
June 1898	June 1901	2.0	0.065	0	0.000
July 1901	June 1902	1.6	0.052	0	0.000
June 1902	Oct. 1914	1.0	0.032	0	0.000
Oct. 1914	Oct. 1917	1.5	0.048	0	0.000
Oct. 1917	Feb. 1919	3.0	0.097	0	0.000
Feb. 1919	Jan. 1934	6.0	0.194	0	0.000
Jan. 1934	June 1940	5.0	0.161	0	0.000
July 1940	Oct. 1942	6.0	0.194	0	0.000
Nov. 1942	March 1944	7.0	0.226	0	0.000
April 1944	Oct. 1951	8.0	0.258	0	0.000
Nov. 1942	Dec. 1976	9.0	0.290	0	0.000
Jan. 1977	Dec. 1990	9.0	0.290	7	0.226
Jan. 1991	Present	18.0	0.581	7	0.226

SOURCE: The Alcohol and Tobacco Tax and Trade Bureau

NOTES: There are 31 gallons in each standard barrel of beer. The tax rates per gallon were computed by dividing the dollar value for the tax rate per barrel by 31 gallons. Both rates are presented because the government reports tax rates on a per gallon basis while the industry standard for reporting production and sales is in barrels. The reduced tax rate is the rate charged for the first 60,000 barrels of production to breweries that produce less than 2 million barrels annually.

In 1976, the government established a small brewer tax rate that, at the time, was $2 less per barrel than the regular rate. The small brewer tax rates was enacted in response to lobbying pressure from smaller breweries who wished to improve their competitive advantage in the beer market but were unable to do so with the existence of the large, dominant breweries of the time (e.g., Anheuser-Busch, Coors, Miller, and Pabst

Brewing Company). During the 1970s, these macrobreweries controlled most of the market in terms of supply, brand loyalty, and existing contracts and business relationships (Tremblay and Tremblay, 2005). For brewers who produced fewer than 2 million barrels annually, production was taxed at a reduced rate of $7 per barrel up to the first 60,000 barrels produced and $9 for every subsequent barrel.

The most recent reduced rate increase occurred in 1991 as a result of the Revenue and Reconciliation Act of 1990 in an effort to raise additional government revenue (Talley, 2009). Table 3.1 shows that in 1991, federal excise taxes on beer doubled from $9 per barrel to $18 for all production in excess of 60,000 barrels. For brewers who produce less than 2 million barrels annually, the reduced rate established in 1976 still applies. Tax rates on beer increased as part of a package of "luxury" taxes on items such as yachts, private planes, and jewelry (*The Joint,* 1990). Most of these luxury taxes have since been repealed, but the increased rate remains effective for beer.

While the small brewer exemption was enacted largely because of pressure from small breweries that existed in the 1970s, a lower tax rate has implications for both current breweries and prospective entrants. Specifically, since the tax rate on production less than 2 million barrels is lower than for production above that threshold, there may be an incentive for breweries to produce less to incur lower costs associated with excise taxes. It is plausible, therefore, that to keep up with demand, breweries will be smaller (i.e., produce less beer) but there will be more breweries. This hypothesis seems to reasonably describe the observed trends discussed in Chapter 2.

3.3 State Excise Taxes

State excise taxes on beer production are imposed in addition to federal excise taxes. Average state excise tax rate steadily increased between 1991 and 2012, as illustrated by Table 3.2. The average state excise tax rate increased by $0.039, or 15.4 percent, during this time. This implies that, on average, breweries have been facing higher marginal costs of production associated with state excise taxes.

Even though Table 3.2 shows that state excise taxes have been increasing over time, the state tax rates vary greatly between states. For example, Wyoming had the lowest excise tax rate in the nation in 2012 at $0.59 per barrel while Alabama charged $32.64 per barrel. This means that breweries in Alabama incurred excise tax costs that were fifty five times greater than similar sized breweries in Wyoming. Not surprisingly, in 2012, Alabama had significantly fewer breweries (1.89 per million per million people) and production (1.4 barrels per million people) compared to Wyoming (26 breweries per million people, 24.3 barrels of beer per million people).

Table 3.2: History of average nominal state excise tax rates

Year	Average nominal excise tax per gallon ($)	Min ($)	Max ($)	Average nominal excise tax per barrel ($)	Min ($)	Max ($)
1991	0.253	0.019	1.053	7.848	0.589	32.643
1992	0.253	0.019	1.053	7.848	0.589	32.643
1993	0.254	0.019	1.053	7.885	0.589	32.643
1994	0.259	0.019	1.053	8.025	0.589	32.643
1995	0.259	0.019	1.053	8.034	0.589	32.643
1996	0.259	0.019	1.053	8.034	0.589	32.643
1997	0.258	0.019	1.053	8.004	0.589	32.643
1998	0.258	0.019	1.053	8.010	0.589	32.643
1999	0.260	0.019	1.053	8.065	0.589	32.643
2000	0.260	0.019	1.053	8.065	0.589	32.643
2001	0.260	0.019	1.053	8.059	0.589	32.643
2002	0.274	0.019	1.070	8.504	0.589	33.170
2003	0.278	0.019	1.070	8.621	0.589	33.170
2004	0.278	0.019	1.070	8.621	0.589	33.170
2005	0.278	0.019	1.070	8.621	0.589	33.170
2006	0.278	0.019	1.070	8.621	0.589	33.170
2007	0.278	0.019	1.070	8.621	0.589	33.170
2008	0.278	0.019	1.070	8.621	0.589	33.170
2009	0.281	0.019	1.070	8.721	0.589	33.170
2010	0.291	0.019	1.070	9.025	0.589	33.170
2011	0.292	0.019	1.070	9.048	0.589	33.170
2012	0.292	0.019	1.070	9.046	0.589	33.170

SOURCE: Federation of Tax Administrators, the Alcohol and Tobacco Tax and Trade Bureau, and state alcoholic beverage control boards

NOTES: The average excise tax rate was computed by taking the average rate in all fifty states plus the District of Columbia in each given year. The tax rates per barrel were computed by multiplying the dollar value for the tax rate per barrel by 31 gallons.

Additionally, between 1991 and 2012, fourteen states implemented changes in their state beer excise tax rates while thirty-seven (including the District of Columbia) maintained the same nominal rates. Table 3.3 lists the states that enacted changes with their respective rates by year. Thirteen of the fourteen states that changed their state excise tax rates imposed higher tax rates, while New York was the only state to reduce its rate between 1991 and 2012. The excise tax rate in New York decreased in 1999, 2001, and 2003. However, it was later increased in 2009, but was still below its 1991 level. Most states only changed their excise tax rates once between during this time, but Illinois, New York, and Tennessee all changed their rates at least twice. The smallest increase occurred in Hawaii, when in 1998 the rate increased from $28.52 per barrel to $28.83, amounting to a one percent increase. In contrast, the largest increase occurred in Alaska, when in 2002 the rate increased from $10.85 per barrel to $33.17 per barrel, amounting to a 206 percent increase.

Table 3.3: State excise tax rates for states that changed rates between 1991 and 2012, select years

State	1991	1993	1994	1995	1997	1998	1999	2001	2002	2003	2009	2010	2011
Alaska	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	1.070	1.070	1.070	1.070	1.070
Connecticut	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.232
Hawaii	0.920	0.920	0.920	0.920	0.920	0.930	0.930	0.930	0.930	0.930	0.930	0.930	0.930
Illinois	0.070	0.070	0.070	0.070	0.070	0.070	0.185	0.185	0.185	0.185	0.231	0.231	0.231
Nebraska	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.310	0.310	0.310	0.310
Nevada	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.160	0.160	0.160	0.160
New Jersey	0.100	0.100	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120
New Mexico	0.180	0.180	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.410
New York	0.210	0.210	0.210	0.210	0.210	0.160	0.135	0.125	0.125	0.110	0.140	0.140	0.140
North Carolina	0.532	0.532	0.532	0.532	0.532	0.532	0.532	0.532	0.532	0.532	0.620	0.620	0.620
Ohio	0.140	0.140	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
Tennessee	0.110	0.110	0.110	0.126	0.126	0.126	0.126	0.126	0.138	0.138	0.138	0.138	0.138
Utah	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.413	0.413	0.413	0.413
Washington	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.760	0.760

SOURCE: Federation of Tax Administrators, the Alcohol and Tobacco Tax and Trade Bureau, and state alcoholic beverage control boards

NOTES: Excise tax rates are presented in dollars per gallon of beer produced. The excise tax rate is underlined for year(s) that excise tax changed within a state. Data for years where excise taxes did not change in any state is not presented. The rate in these years was the same as the nearest previous rate presented. For example, the excise tax rate in North Carolina in 2005 was 0.532 per gallon. The rate in 2012 was the same as 2011 for all states.

3.3 Other Regulation

States impose a variety of other laws that impact breweries' sales and costs. For example, some states prohibit the sale of beer in grocery stores, convenience stores, or on Sundays. Other states prohibit self-distribution, the ability of breweries to sell their product directly to retailers. In states where self-distribution is prohibited, breweries must work through licensed wholesalers and distributors to supply their beer to retailers. Self-distribution can reduce transaction costs associated with distributing through a wholesaler. This reduction in transaction costs might result in an increase in the supply of beer, thereby increasing production and reducing the price of beer. However, if breweries cannot distribute as effectively as wholesalers, their costs might actually increase, thereby increasing the marginal cost of production, decreasing production, and increasing price. A priori, we cannot determine the magnitude of each of these effects and so the economic impact on the equilibrium is unknown. While these laws vary across states, they have varied little within states over the past twenty years.

The brewing industry is also subject to laws relating to mergers, price discrimination, and exclusive dealing contracts. Anti-merger laws aim to break up large corporations, forbid collusion between firms, and eliminate business arrangements that result in market power. Breweries are also subject to section 2(a) of the Robinson-Patman Act of 1936, which prohibits adjusting prices to obtain monopoly power. Exclusive dealing contracts are prohibited under Section 3 of the Clayton Act of 1914 when the contract "may be to substantially lessen competition or tend to create a monopoly."

CHAPTER 4

LITERATURE REVIEW

While previous research on the beer and brewing markets is extensive, it nearly ubiquitously emphasizes on the determinants of demand, which includes demand estimation, the availability and effects of substitutes for beer, the impacts of advertising, and price and income elasticities. For example, Hogarty and Elzinga (1972), Larivirea, Larueb, and Chalfant (2000), Lee and Tremblay (1992), Niskanen (1962), Pinkse and Slade (2004), and Wagenaar, Salois, and Komro (2009) all estimate that the own-price elasticity of demand for beer is inelastic. Other studies estimate the income elasticity for beer (Fogarty, 2010; Hogarty and Elzinga, 1972; Johnson and Oksanen, 1977; Lee and Tremblay, 1992; Lynk, 1984; McGuiness, 1980; Niskanen, 1962; Penm, 1988; Tremblay, 1985). However, these studies do not estimate the elasticities separately for craft beer or consider supply side components of the market.

Additional literature considers industrial organization topics, such as market concentration and monopoly power. For example, Poelmans and Swinnen (2011b) find that firm concentration in the 1930s was largely driven by improvements in brewing technologies. Elzinga and Swisher (2005) comment on the factors driving brewery concentration in the 1980s, finding that scale economies, product innovation, packaging technology, marketing, and product differentiation all promoted an increase in concentration. Tremblay, Iwasaki, and Tremblay (2005) note that market concentration decreased considerably between 1980 and 2003 “due to entry and a diminishing variance in firm size." Donnar and Jakee (2004) find that macrobreweries are attempting to maintain their position as market leaders by acquiring craft breweries to gain revenue from the consumers who desire more craft-style beers.

Other studies consider the effects of alcoholic consumption because of its potential negative impact on social welfare (i.e., sociological, medical, and adverse behavioral effects). Economic analysis relating to these effects most often focuses on the impacts of advertising on beer consumption.[17] Lee and Tremblay (1992) and Gallat and List (1998) both reject the hypothesis that beer advertising has a positive causal effect on overall beer consumption. However, these authors do not address whether advertising results in brand switching between different brands or different alcoholic beverages. In a later study, George (2009) finds that television advertising is most effective for macrobreweries and that it leads to a decline in the market share of local breweries (e.g., craft breweries). This contrasts Greer (1971), who finds statistically significant evidence that advertising increases sales (and therefore consumption) for breweries of all sizes.[18]

In addition to research that evaluates the effect of advertising on overall consumption, other studies test whether advertising promotes beer consumption in youth. For example, Garfield, Chung, and Rathouz (2003) conduct one of the first of such studies and conclude that breweries target magazine advertisements at underage drinkers. However, their model relies more heavily on correlation estimates than establishing a causal relationship. In a subsequent study, Nelson (2006) attempts to evaluate the

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[17] Esteve-Pérez (2010) finds that the impacts of advertising within the United States beer market are smaller in magnitude than in other countries.

[18] However, this study occurred before the recent growth in the craft segment, so it is unclear whether this finding applies now with the existence of the craft brewery market.

existence of a causal relationship between beer advertising and youth consumption. The author specifically examines the impact of magazine advertising between 2001 and 2003 and finds that there is no statistically significant evidence that magazine advertisements target youth and, therefore, do not encourage underage beer consumption.

In contrast to the existing demand-side literature, discussion of the supply side of the brewing industry is less developed with the majority of research relating to the impact of technology and inputs. For example, Xia and Buccolat (2003) find that overall brewery growth over the past century is a result of higher packaging rates, longer shelf lives, and improved transportation technology. The authors also examine the elasticity of demand for factor inputs used in beer production (i.e., water, grains, yeast, hops) and find that the supply of beer is inelastic with respect to input and production costs, reporting estimates ranging between 0.224 and 0.258. However, the authors only consider physical production costs and do not include other important factors, such as excise taxes.

The majority of the existing literature considers the combination of all alcoholic beverages (beer, wine, and spirits), a combination of all types of beer (craft beer and macrobrews), and/or macrobreweries alone.[19] According to Tremblay and Tremblay (2005), "because of their production dominance, considerable discussion is devoted to the mass producers and their core products." Additionally, growth in the craft brewery market is relatively new (see Chapter 2 for more detail) and until recently, detailed craft brewery data have not been tracked separately from other brewery types, making empirical analysis of the craft brewery market difficult.

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[19] For example, Colen and Swinnen (2010) estimate demand functions for beer, but do not distinguish between different quality and taste differences across the various beer types included in their empirical analysis.

However, a few studies have attempted to provide preliminary insights and descriptive analysis of the recent growth in this market. In “A Brief Economic History of Beer,” Poelmans and Swinnen (2011a) find that the growth in craft breweries since the mid-1980s is largely a result of consumer preferences shifting towards more product variety. The brewery market responded by shifting toward a greater number of smaller firms because it is easier for smaller breweries to adjust their beer variety than their larger counterparts (i.e., macrobreweries) who must modify a large production operation to alter their beer. This is consistent with findings by Carroll and Swaminathan (2000) who note that the growth in the number of “specialty brewers” (i.e., craft breweries) is a result of shifts in consumer preferences.

The existing literature relating to the impacts of excise taxes on the brewery market is constrained to two primary topics: estimating how much of the tax is passed onto consumers through higher prices and evaluating how those higher prices impact beer consumption. The primary focus of both of these topics is to better understand how excise taxes impact social welfare. Research suggests that excise taxes are passed onto consumers through higher prices (Denny *et al.*, 2002; Kenkel, 2005; Ornstein, 1980; Young and Beilinska-Kwapisz, 2002). Denny *et al.* (2002) find that twenty percent of the cost is absorbed by breweries and eighty percent is passed on to consumers. Young and Beilinska-Kwapisz (2002) also find that excise taxes increase the prices faced by consumers, but they note that beer taxes poor predictor of alcohol prices because “prices rise by significantly more than the rise in excise taxes.”[20] Research suggests that the

[20] Keeler *et al.* (1996) finds similar evidence of final price increases exceeding excise tax increases in cigarette markets.

increase in price faced by consumers causes statistically significant reductions in beer consumption (Kenkel, 2005; Ornstein, 1980; Young and Beilinska-Kwapisz, 2002). In an extension, several studies evaluate the impact of the higher prices that consumers face as a result of excise taxes on risky behavior. For example, research finds that there is a strong inverse relationship between taxes on alcohol and motor vehicle fatalities (Cook, 1981; Chaloupka, Saffer, and Grossman, 1993; Ruhm, 1996; Wagenaar, Salois, and Komro, 2009; Young and Beilinska-Kwapisz, 2002, 2006; Young and Likens, 2000).

This thesis builds upon previous research in two primary ways. First, it considers the craft brewery market alone. To date, there is little existing research on this segment of the market because notable growth in the craft brewery segment did not begin until the mid-1980s and historically, information relating to this segment was combined with the rest of the market. Second, this thesis extends the existing focus on the effects of excise taxes on consumption to the supply side of the beer market (entry and production).

CHAPTER 5

EMPIRICAL METHODOLOGY

I empirically estimate how variation in state excise taxes on beer affects total craft beer production and the total number of craft breweries within a state. Equation (5.1) characterizes the empirical specification of the effect of the state excise tax rate (ET_{it}), the lagged number of breweries per capita in a state (LNB_{it}) unemployment rate (UR_{it}), median age (MA_{it}), median income (MI_{it}), the standard error of the median income ($SEMI_{it}$), and the average number of breweries per capita in bordering states (NBB_{it}) on the number of breweries per capita within a state (NB_{it}) for state *i* in year *t*, accounting for year (ψ_t) and state (δ_i) fixed effects. Equation (5.2) characterizes the empirical specification of the effect of the state excise tax rate, the lagged total production per capita in a state (LTP_{it}), unemployment rate, median age, median income, the standard error of the median income, and the average total production per capita in bordering states (TPB_{it}) on the level of total production per capita within a state (TP_{it}) for state *i* in year *t*, accounting for year and state fixed effects. Both equations are specified as log-log models by transforming all continuous independent and explanatory variables into the natural logarithm form.

$$NB_{it} = \beta_o + \beta_1 ET_{it} + \beta_2 LNB_{it} + \beta_3 UR_{it} + \beta_4 MA_{it} + \beta_5 MI_{it} + \beta_6 SEMI_{it} + \beta_7 NBB_{it} + \delta_i + \psi_t + \epsilon_{it} \quad (5.1)$$

$$TP_{it} = \beta_o + \beta_1 ET_{it} + \beta_2 LTP_{it} + \beta_3 UR_{it} + \beta_4 MA_{it} + \beta_5 MI_{it} + \beta_6 SEMI_{it} + \beta_7 TPB_{it} + \delta_i + \psi_t + \epsilon_{it} \quad (5.2)$$

This study considers a reduced form approach for examining the supply of craft beer and Equations (5.1) and (5.2) include explanatory variables that are expected to impact this market. Each model also includes lagged values of the number of craft breweries and total craft production in a state. This analysis is performed at the state level and entry into the craft brewery market may be relatively slow because of the high fixed cost and time consuming activities associated with entry, such as the purchase of physical capital (e.g., brewing facilities and fermentation tanks) and applicable permits and licenses (e.g., wholesaler's licenses and taproom permits). Because these activities can last longer than a year, the number of breweries in the current year is expected to be related to the number of breweries in a previous year. That is, entry and exit by breweries occurs gradually over time and the number of breweries in the current year is similar to the number of breweries in the previous years. A similar relationship holds for total production in the current year and total production in the previous year. That is, expanding facilities and improving productive capabilities is costly. Consequently, changes in production occur slowly over time and the total production in the current year is similar to the total production in the previous years. Therefore, lagged dependent variables for the number of breweries (LNB_{it}) and total production (LTP_{it}) are included in the model to account for the possible stickiness in the dependent variable between years.

Without lagged dependent variables, the independent variables represent the full set of observed/measurable information that generate the observed dependent variables, NB_{it} and TP_{it} (Greene, 2012). However, when the lagged variables are added, the model includes "the entire history of the right-hand-side variables, so that any measured influence is now conditioned on this history" (Greene, 2012). Therefore, the effect of the explanatory variables with lagged dependent variables included indicates the effect of contemporary information.

The state level unemployment rate (UR_{it}) is included because research suggests that it has an impact on both the number of breweries and beer consumption. For example, Carroll *et al.* (1993) find that the unemployment rate has a positive effect on the number of breweries. The authors' rationalization for this finding is that unemployment increases the amount of consumer leisure time, which coincides with an increased demand for beer and is likely to be manifest in a quantity supplied response in the form of more breweries and higher production.[21] In contrast, Freeman (2011) finds a negative relationship between the unemployment rate and the consumption of beer.

The models also includes median age (MA_{it}) to account for potential variation associated with consumers of different ages having different beer consumption preferences. Studies consistently find that younger consumers have a higher demand for beer than their older counterparts (*Beer,* 2013; Freeman, 2011; Kerr *et al.*, 2004; Tremblay and Tremblay, 2005). For example, according to Tremblay and Tremblay (2005), consumers between the ages of 18 and 44 are more likely to drink beer than consumers over the age of 44. Similarly, Freeman (2011) finds that a larger share of young adults in the population is associated with higher beer consumption per capita. As changes in age affect demand, we expect breweries to respond by changing the number of firms in the market and/or changing the levels of beer production. These studies indicate

[21] However, the authors state that this explanation might need more investigation because the economic losses associated with unemployment often leave consumers with less disposable income.

that, ceteris paribus, we would expect that states with younger populations would have a higher demand for beer resulting in more breweries and higher levels of production.

Median income (MI_{it}) is included to control for the impact of changes in consumer income on the demand for beer within a state. The standard error of median income ($SEMI_{it}$) is also included as a proxy for income distribution. Several studies find that beer is an inferior good (Fogarty, 2010; Lynk, 1984; Niskanen, 1962; Tremblay, 1985) while others find that it is a normal good (Clements and Johnson, 1983; Freeman, 2011; Hogarty and Elzinga, 1972; Lee and Tremblay, 1992; Penm, 1988). Johnson and Oksanen (1977) find that income does not have an effect on the demand for beer. However, these inconsistencies may arise from the types of beer included in these analyses. For example, several studies use aggregated beer data that represents a combination of craft beers and macrobrews. Others estimate income effects using only specific brands of beer, such as Hogarty and Elzinga (1972) who estimate income elasticities using data relating to beer produced by Blatz and Pabst Blue Ribbon, both macrobreweries. Other studies find that income affects the type of alcohol consumed. For example, McGuiness (1980) finds that on average, consumers substitute toward higher quality types of alcohol as income rises and toward cheaper quality alcohol with lower incomes.[22] It is unclear whether the results from these studies hold across different types of beers and breweries. This study considers only the craft beer market only and analyzes

[22] McGuiness (1980) uses the average price paid for different types of alcoholic beverages as an indicator of the average product quality. While the author finds that there are quality tradeoffs associated with different levels of income, this conclusion is from an analysis of all alcoholic beverages (beer, wine, and distilled spirits). Therefore, it is unclear whether this finding holds for beer alone.

the relationship of income using data from a period of rapid growth in this market, implying that a clearer impact of income will be estimated.

The average total production in border states (TPB_{it}) and average number of breweries in border states (NBB_{it}) are included in Equations (5.1) and (5.2), respectively, to account for unobservable and/or unmeasurable factors such as overall regional demand and market saturation, spillover effects, and competition pressure across states. That is, when there are more breweries in neighboring states, there may be spillover effects across state lines in the form of information sharing of improved brewing and marketing techniques between breweries. Or, when production in neighboring states increases, the market might become more saturated, making it harder for new craft breweries to profitably increase production.

The model also includes individual own-state (δ_i) and time (ψ_t) fixed effects.[23] Including state fixed effects implies that the coefficient estimates of other explanatory variables are identified only by variation within each cross-sectional observation (state). The inclusion of state fixed effects accounts for the impacts of state characteristics that are not explicitly controlled for but may have an impact on total production and/or the number of breweries within a state. These include other state-level regulation pertaining to breweries (e.g., Sunday alcohol sales restrictions, self-distribution laws) that have not changed within the sample period, other alcohol-related policies and cultural norms,

[23] Fixed effects are more sensitive to violating the Gauss-Markov assumptions when there are a small number of observations (Wooldridge, 2009), however the number of observations in this study is large. While fixed effects models also amplify measurement errors in the explanatory variables, resulting in attenuation bias (Greene, 2012; Wooldridge, 2009), there is little probability of measurement error in the explanatory variables used in this study. While there may be measurement error in the dependent variables because they were generated by a survey, we assume that this measurement error is statistically independent of each explanatory variable, therefore the parameter estimates are both unbiased and consistent (Wooldridge, 2009).

among others.[24] Time (year) fixed effects account for unmeasurable national factors that affect all breweries and production levels in the U.S. across time. These might include general technological advancements in the brewing processes that have impacted all breweries and changes to federal policies that affect the entire craft brewery market. By including state and time fixed effects, the parameter estimates are identified only by variation in the explanatory variables.

Fixed effects are appropriate if we assume that there are omitted variables that are correlated with the explanatory variables included in the models; if fixed effects are not included, the parameter estimates will be biased and inconsistent (Greene, 2012; Wooldridge, 2009). This assumption seems reasonable within the context of this study given that I consider the behavior of craft breweries operating across the entire United States and there are likely differences in unobserved state characteristics that vary between states and regions. For example, consumers in certain states might have a higher preference for craft beers than consumers in other states; however, empirically identifying and measuring consumer preferences is difficult. By controlling for demographic and socioeconomic factors and including state fixed effects, I address differences between states that are exogenous to state excise tax levels. Lastly, ϵ_{it} is the idiosyncratic, or time-varying, error that represents the remaining unobservable and unmeasurable state level characteristics that are not included either in the explanatory variables or the fixed effects portions of the model.

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[24] For example, self-distribution is not legal in most southern states (e.g., Alabama, Florida, Georgia, Kentucky, Mississippi, Missouri, and South Carolina) while it is allowed in most of the North West (e.g., Idaho, Montana, Oregon, Washington) (*Beer*, 2013b). By including fixed effects, I account for this type of time invariant cross state variation.

5.1 Generalized Method of Moments Estimation

Equations (5.1) and (5.2) account for temporal dependence (stickiness) between the dependent variable values in the current year and their values in previous years by including lagged dependent variables (LNB_{it}, LTP_{it}). Controlling for this stickiness helps account for a number of potential modeling issues, including omitted variable bias and autocorrelation in the errors; that is, $Corr(\epsilon_{it}, \epsilon_{i(t-1)}) \neq 0$. Biased estimates would result in incorrect inferences about the values of the population parameters and serial autocorrelation violates the Gauss-Markov assumption of autocorrelation for linear regression models, which states that the error term across different periods must not be related (Wooldridge, 2009). However, the lagged dependent variables are endogenous to the error term in period *i* because, by construction, they are related to the dependent variables in period *i*.[25]

Equation (5.3) characterizes a model with $y_{i,(t-1)}$ representing a lagged dependent variable, X_{it} representing additional explanatory variables, and δ_i and ψ_t representing cross-sectional and time series fixed effects:

$$y_{it} = \beta_o + \Phi\, y_{i,(t-1)} + X_{it} + \delta_i + \psi_t + \epsilon_{it} \qquad (5.3)$$

Arellano and Bond (1991) show that it is possible to generate a consistent estimator in panel data analyses even when a lagged dependent variable $y_{i,(t-1)}$ is included. Consider equation (5.4), a simple case of an autoregression in a panel setting with only individual effects for illustration purposes (adapted from Baum, 2013 and SAS, 2011).

[25] Endogeneity in the lagged dependent variable means that the variable is correlated with the error, even if the errors themselves are no longer correlated (Greene, 2012).

$$y_{it} = \Phi\, y_{i,(t-1)} + X_{it} + \delta_i + \epsilon_{it} \tag{5.4}$$

To eliminate the individual fixed effects (δ_i), we take the first-difference of Equation (5.4), which yields:

$$\Delta y_{it} = \Phi\Delta\, y_{i,(t-1)} + \Delta X_{it} + v_{it} \tag{5.5}$$

where

$$v_{it} = \epsilon_{it} - \epsilon_{i(t-1)} \tag{5.6}$$

After first-differencing equation (5.4), we see from equation (5.6) that Corr(v_{it} , ϵ_{it}) $\neq 0$ and Corr($y_{i(t-1)}$, v_{it}) $\neq 0$. This means that the dependent variable is still endogenous. Therefore, we need to find a way to identify Δy_{it} in a way such that the identifying information is unrelated to the contemporaneous error term, v_{it}. Arellano and Bond (1991) show that one approach to solve this problem is to identify the endogenous variable using exogenous and predetermined information (including that from variables that specify the model) from periods that are sufficiently far back in time. For example, assuming the first observation corresponds to the first time period, equation (5.7) shows $t = 2$.

$$\Delta y_{i2} = \Phi\Delta\, y_{i1} + \Delta X_{i2} + v_{i2} \tag{5.7}$$

where

$$v_{i2} = \epsilon_{i2} - \epsilon_{i1} \tag{5.8}$$

We can see that y_{it} is still not a good instrument because $Cov(\epsilon_{i1}, v_{i2}) \neq 0$. Now consider $t = 3$ in equation (5.9).

$$\Delta y_{i3} = \Phi \Delta y_{i2} + \Delta X_{i3} + v_{i3} \tag{5.9}$$

where

$$v_{i3} = \epsilon_{i3} - v_{i2} \tag{5.10}$$

We can now see that $Cov(\epsilon_{i1}, v_{i3}) = 0$. Therefore, since there is no longer a relationship between the error term in equation (5.10) and the error term in period $t = 1$, information from this time period would serve as an exogenous instrument.[26]

In the context of equations (5.1) and (5.2), the above means that $Corr(LNB_{it}, \epsilon_{it}) = 0$ and $Corr(LTP_{it}, \epsilon_{it}) = 0$. Additionally, because we established that there is a temporal dependence between the dependent variables and their corresponding lagged dependent variables, the lagged dependent variables meet the relevance condition for instrumental variables: $Corr(NB_{it}, LNB_{it}) \neq 0$ and $Corr(TP_{it}, LTP_{it}) \neq 0$. That is, the number of craft breweries and total craft brewery production in the current period is related to the number of craft breweries and total craft brewery production in the previous period, respectively. Therefore, when lagged differences and levels of both the dependent variables and all of the explanatory variables are used to identify LNB_{it} and LTP_{it}, these lagged dependent variables are valid instruments.

[26] Greene (2012) also states that in the presence of autoregressive processes, "the influence of a given disturbance fades as it recedes into the more distant past." That is, the error from 10 years ago in a time series context will have little relation to the error term today compared to the error term from 2 years ago, which is likely much more related.

5.2 Interpretation of Parameters

The parameter estimates from a GMM estimation are interpreted in the same way as linear parameter estimates (Greene, 2012). Since Equations (5.1) and (5.2) are specified as log-log models, the parameter estimates are interpreted as percentages (i.e. elasticities). For example, a one-percentage increase in excise taxes is predicted to change the number of breweries in a state in equation (5.1) by β_1 percent. This provides an indication for how responsive (i.e., elastic) the number of breweries in a state is to a change in the state excise tax. Similarly, a one-percentage increase in craft beer production in the previous year is predicted to change total production in a state in the current period in equation (5.2) by β_2 percent. This provides an indication for how responsive (i.e., elastic) the total production in a state is to a change in that state's total production in the previous year. However, it is important to note that how the inclusion of fixed effects affects the parameter interpretations. Specifically, by including both cross-sectional (state) and time (year) fixed effects, the parameter estimates represent very short-run elasticities because the year fixed effects control for the long run impacts.

CHAPTER 6

DATA DESCRIPTION

The lack of existing literature on the craft brewing market, as discussed in Chapter 4, is largely a function of the fact that historical price, production, and brewery data have not been consistently tracked or readily available. Additionally, data that were available for the craft brewing market were traditionally aggregated with information from all other non-craft breweries, making it difficult to analyze the craft brewing market separately. However, craft brewery specific data have become more available in recent years, with information from the Brewing Industry Production Survey (BIPS) administered by the Brewers Association being one of the most comprehensive sources. In this thesis, the BIPS data are used to generate information for the total number of craft breweries and total craft beer production in the U.S. State excise tax data are retrieved from the Federation of Tax Administrators, the Alcohol and Tobacco Tax and Trade Bureau, and state alcoholic beverage control boards. State-level socioeconomic and demographic data are retrieved from the U.S. Census Bureau.

6.1 Brewery and Production Data

The Brewers Association defines craft breweries as those that are small, independent, and traditional. Small refers to annual production of less than six million barrels and independent implies that less than 25 percent of the brewery is owned or controlled by an enterprise in the alcohol industry that is not a craft brewer themselves.[27] Traditional refers to the type of beer produced; craft breweries have either an all malt flagship beer or at least fifty percent of its production volume must be all malt beers. The Brewers Association does not consider flavored malt beverages beer, such as those brewed by Smirnoff (e.g., Smirnoff Ice) and Bacardi (e.g., Bacardi Breezer) (*Brewers,* 2013b).

The BIPS is administered at the beginning of every year by the Brewers Association, who publishes the results in the May/June issue of the *New Brewer* magazine. The survey collects production and location (state) data for craft breweries across all fifty states plus the District of Colombia (DC).[28] Breweries report the amount of taxable beer sold or produced during the calendar year.[29] Firms with multiple breweries provide information for each brewery separately. The BIPS data are a census in that they represent all craft breweries in the United States. that the Brewers Association is aware of at the time of publishing the *New Brewer*. The Brewers Association classifies craft breweries as one of the three types: brewpubs, microbreweries, and regional craft breweries (see Section 2.1 for more detail). However, micro and regional craft brewery

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[27] Goose Island Brewing Co. in Chicago is an example of a brewery that meets the small and traditional requirement for craft breweries, but is not independent. In 2011, the brewery was purchased and is now controlled by Anheuser-Busch InBev (Yue, 2013). Because Anheuser-Busch InBev is not a craft brewer, Goods Island Brewing Co. is not included in the Brewers Association craft brewery statistics.

[28] In addition, the Brewers Association collects data from breweries in the U.S. territories of Guam, Puerto Rico, the Virgin Islands, and the associated state of Palau. However, the BA only collected a total of 17 observations from seven breweries in these areas between 1991 and 2012. Breweries in these areas are subject to different laws and socioeconomic conditions than breweries in the United States and the District of Columbia and were therefore removed. The 17 removed observations accounted for less than 0.001 perecnt of the brewery production data.

[29] The U.S. Government Printing Office (GPO) does not require that breweries pay taxes on the following types of beer production: beer that is discarded because it is unfit for sale; beer used in research, development, or testing; or beer that is produced for personal or family use (e.g., homebrewing) (*GPO,* 2014).

data were combined for the purposes of this study because the only difference between these two types is the level of production. Annual brewery-level production data were collected from the Brewers Association for the years 1991 to 2012.

The Brewers Association publishes production data for the previous five years in each May/June issue of the *New Brewer*. The production values for four of these years overlap between issues. For example, the 2005 issue contains data for 1999-2004 and the 2006 issue contains data for 2000-2005. Occasionally, production values for the same brewery and year vary between issues, which occurs when a brewery reports updated production information in subsequent surveys. In these cases, the most recent production value is used because it is assumed to reflect the most accurate production information. Less than one percent of the production observations required updating.

Participation in the BIPS is voluntarily and production information is self-reported. Consequently, a number of breweries only had partial data. For these breweries, the missing data values were linearly interpolated when the available production information provided evidence that it was reasonable to do so. That is, for breweries that had production data prior to and after the period when output information was missing, the unreported values were estimated because these breweries were assumed to be in operation during the time when information was unreported. If this condition was not met, then the brewery was assumed to have not been in operation during the time when production volumes were not reported and, therefore, output levels during those periods were set to zero. Lastly, some breweries did not report any production levels or requested in the BIPS that their production information not be released.[30] Breweries that did not have any production information were removed from the final dataset. The number of breweries with no production values was less than one percent of the brewery production data.

Out of the 3,336 breweries in the original dataset, sixty seven percent (2,249 breweries) did not need interpolation; thirty three percent (1,087 breweries) had at least one missing value that needed to be interpolated. 4,301 production value observations (23 percent) of a total of 18,635 observations were interpolated. While the number of breweries that do not provide production information or the total number of openings and closings within a calendar year is unknown, the compiled data represent the most complete record of brewery level production using publicly available information.[31]

In addition to own-state craft brewery information, brewery number and production information from nearby states is included to account for unobservable and/or unmeasurable factors such as overall regional demand and market saturation, spillover effects, and competitive pressure across states. Specifically, the Brewers Association BIPS data were used to calculate the average production and the average number of breweries in neighboring states in each year. Neighboring states were considered those that share a common border with the state of interest. The geographic location of Alaska and Hawaii makes it problematic to calculate border state information, therefore these

[30] According to the Brewers Association, there is no systematic reason that breweries fail to report their production or request that their production information not be released (White, 2013).
[31] Another potential measure for brewery counts is the number of active federal and state brewer permits, maintained by the Alcohol and Tobacco Tax and Trade Bureau and state alcohol control boards. However, permits may not accurately represent the number of operating breweries because there is a lag between the time when a permit is obtained and the beginning of production.

two states are excluded from the final dataset. Both Alaska and Hawaii had few breweries and low total production throughout the sample period.[32]

Equations (6.1) and (6.2) show the calculation for the average number of breweries in border states (NBB_{it}) and average total production in border states (TPB_{it}) to state *i* in year *t,* respectively, with *j* representing the border states, *k* is the first border state, *l* is the last border state, and *n* is the total number of border states.

$$NBB_{it} = \frac{1}{n}\sum_{j=k}^{j=l} NB_{jt} \quad (6.1)$$

$$TPB_{it} = \frac{1}{n}\sum_{j=k}^{j=l} TP_{jt} \quad (6.2)$$

6.2 Excise Tax Data

State excise taxes on beer production vary across time. However, there is not one central repository with both current and historical state excise tax rates. Therefore, data relating to state excise tax rates between 1991 and 2012 were compiled from several sources. 2011 and 2012 rates were collected from The Federation of Tax Administrators, which reports the most current tax rates. Data for 1991 to 2010 were collected from the Alcohol and Tobacco Tax and Trade Bureau (TTB) and state alcoholic beverage control boards. Federal excise taxes are imposed by the TTB in addition to state excise taxes.

[32] Between 1991 and 2012, the combined craft beer production between Alaska and Hawaii totaled 1.29 percent of the total craft beer production in the U.S. and 1.32 percent of the total number of breweries.

However, federal excise taxes on beer do not vary across states and have not changed within this study's sample period. Therefore, these data are not included in the final dataset.

6.3 Socioeconomic and Demographic Data

State level demographic and socioeconomic information was collected from various reports maintained by the U.S. Census Bureau. These data help account for differences between states and over time that could affect the number of breweries and production and are exogenous to variation in state excise taxes on beer. State population data for 1991 to 2010 were collected from Intercensal Estimates calculated by the U.S. Census Bureau Population Division.[33] The U.S. Census Bureau estimates state and county annual intercensal estimates every decade in an effort to smooth population estimates between decennial census counts.[34] Because intercensal data are not available for the last two years in the sample, state population data for 2011 and 2012 were retrieved from the U.S. Census Current Population Survey Reports (CPS). The annual CPS estimates are calculated by the U.S. Census Bureau from information collected in monthly surveys conducted in each state. The CPS sample covers roughly 60,000 housing units from each state plus the District of Columbia. Each state sample is customized to

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[33] State population density and the number of metropolitan statistical areas (MSAs) within a state might also have an impact of the number of breweries and total production within a state. Research indicates that physical proximity to alcohol outlets, places where alcohol can be legally sold for consumption on- or off-side, is positively related to alcohol consumption (Gruenewald, Ponicki, and Holder, 1993; Scribner, Cohen, and Fisher, 2000). That is, alcohol consumption is lower when alcohol outlets are farther away from consumers. However, state is the lowest level of brewery location provided by the Brewers Association so we are unable to determine the distance between breweries and state MSAs.

[34] The U.S. Census Bureau calculates these estimates by incorporating information on births, deaths, and migration within states by year.

the specific demographic and labor market conditions within the state. Population data are important to control for higher quantity supplied of breweries and beer in states with a larger consumer base.

Information relating to state median income was retrieved from the U.S. Census Bureau American Community Survey. Income is measured in 2012 CPI adjusted dollars. Additionally, the standard error associated with each state's median income level is included as a proxy for income distribution. Median age data were retrieved from Intercensal Estimates (for 1991–2010) and the American FactFinder (for 2011–2012), both maintained by the U.S. Census Bureau. Research suggests that consumers of different ages have different beer consumption patterns. Annual state level unemployment for the population sixteen years and older for 1991 to 2012 were collected from the Geographic Profile of Employment and Unemployment, which provides data collected by the U.S. Census from the CPS.

6.4 Final Dataset

The final dataset is a balanced panel with years representing the time series units and states representing the cross-sectional units. Table 6.1 provides a summary of the variables included in the final dataset and Table 6.2 provides summary statistics for these variables. The dataset is for the years 1991 to 2012 for all craft breweries reported by the Brewers Association, excluding those in Alaska and Hawaii. A key feature of the cross-sectional units is that the BIPS data represent all breweries known to the Brewers Association at the time of the survey. Therefore, to the best of our knowledge, the same breweries in each of the cross cross-sectional units (states) are followed over the entire sample period. Following the same units (breweries) over time allows us to control for unobserved characteristics within each state. Additionally, a balanced panel data provides an opportunity to model the impacts of temporal consistency.

Table 6.1: Description of variables

Variable name	Description	Source
Breweries per capita	Number of breweries reporting positive production per million people	Brewers Association BIPS
Production per capita	Total production in barrels per thousand people	Brewers Association BIPS
Excise tax	State excise tax rate per gallon	Federation of Tax Administrators, the TTB, and state alcoholic beverage control boards
Unemployment rate	State unemployment rate	U.S. Census Bureau
Age	State median age	U.S. Census Bureau
Median income	State median income in 2012 CPI adjusted dollars	U.S. Census Bureau
Standard error of median income	Standard error of state median income in 2012 CPI adjusted dollars	U.S. Census Bureau
Number of breweries per capita in border states	Average number of breweries reporting positive production in bordering states per million people	Brewers Association BIPS
Total production per capita in border states	Average total production in barrels in bordering states per thousand people	Brewers Association BIPS

Table 6.2: Summary statistics

Variable	N	Mean	Std Dev	Min	Max
Breweries per capita	2,882	1.508	2.603	0.000	29.847
Production per capita	2,882	9.818	32.603	0.000	359.124
Excise tax (rate per gallon)	2,882	0.241	0.210	0.190	1.053
Unemployment rate (percentage)	2,882	5.706	1.930	2.200	14.400
Median age	2,882	35.910	2.412	26.500	43.500
Median income	2,882	52.777	7.902	32.018	77.506
Standard error of median income	2,882	1.675	0.579	0.494	4.498
Number of breweries per capita in border states	2,882	1.335	1.756	0.000	12.450
Total production per capita in border states	2,882	12.548	28.469	0.000	356.989

NOTES: Breweries per capita, production per capita, number of breweries per capita in border states, total production per capita in border states are all per million people. Median income and standard error of median income are both measured in thousands of dollars.

CHAPTER 7

EMPIRICAL REULTS

Tables 7.1 and 7.2 show the estimation results of the Generalized Method of Moments (GMM) model. I estimate Equations (5.1) and (5.2) for brewpubs and for micro and regional breweries. Prior to model estimations, the data were transformed in two ways. First, each of the dependent variables was divided by the state population to create the per capita dependent variables specified in Equations (5.1) and (5.2). Standardized per capita measures create a continuous dependent variable and allow for meaningful comparisons across states, which is helpful in many cases where the levels of the dependent variable are considerably different among states. For example, in 2012, California had the highest number of craft breweries (272) while Washington only had slightly over half of that (142). However, California also had the largest state population in 2012 (38.04 million), almost six times the population of Washington (6.89 million). In per capita terms, Washington had almost three times as many breweries (20.6 breweries per million people) as California (7.3 breweries per million people).

Next, I transform all continuous variables into natural logarithm form. While this transformation allows estimated parameters to be interpreted as elasticities, it also helps reduce possible overdispersion in the data. Figure 7.1 provides a density plot of the unlogged number of brewpubs per capita and total brewpub production per capita, which illustrates that these variables are positively skewed.[35] A log transformation significantly reduces the presence of this overdispersion (Wooldridge, 2009).[36]

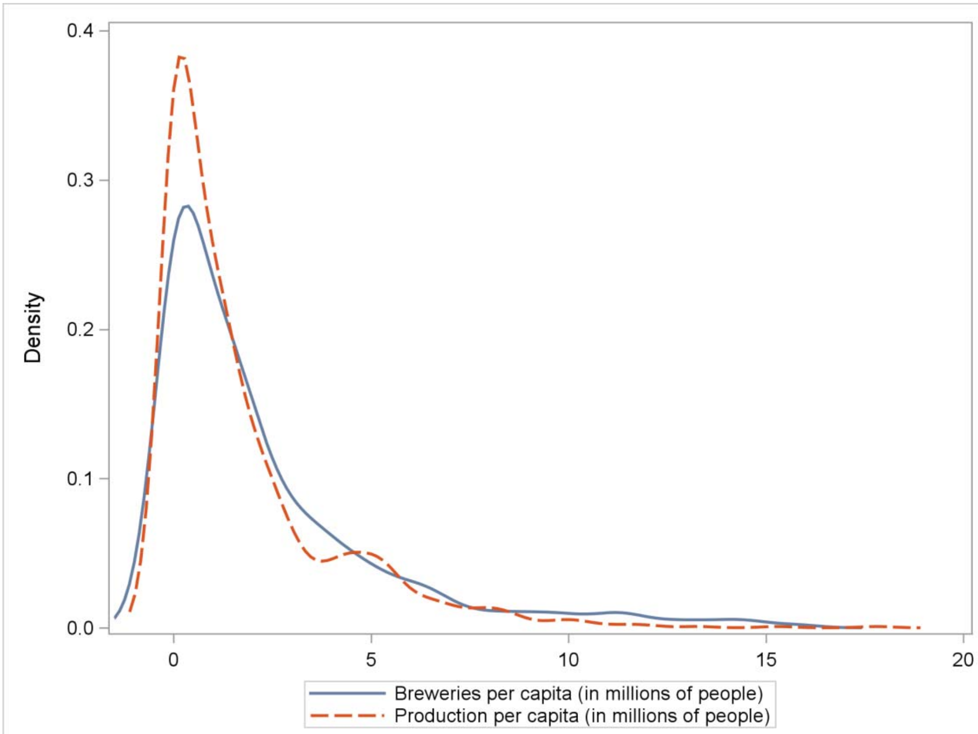

Figure 7.1: Density plot of the number of brewpubs per capita and total brewpub production per capita, 1991 to 2012

SOURCE: Brewers Association Beer Industry Production Survey (BIPS) production data.

All models are estimated using heteroscedasticity-robust standard errors. Furthermore, even though I include state fixed effects in the model specifications, there may be correlation among production and/or the number of breweries within a state but the correlation might not be identical across states. Greene (2012) notes that, "there might

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[35] A density plot for micro and regional breweries looks similar, with even longer tails.
[36] There are instances where there are zero breweries (ant therefore zero production) in a state. Because the natural log of zero is undefined, a log transformation is not possible in the dataset's original state. Therefore, an epsilon $\varepsilon = 0.00001$ is added to all observations.

be a residual correlation within groups that is not fully accounted for by...a fixed effects model." If this is the case, the estimator is inefficient and there is an increased probability of incorrect statistical inferences about the estimated parameter values. Clustering standard errors reduces the risk of committing a Type I error (Kézdi, 2004; Wooldridge, 2009). A comparison of estimated standard errors indicated that clustered standard errors were different than non-clustered standard errors for all variables, providing evidence that within-state correlations are likely not the same across all states.

A Sargan test is performed to test the validity of the lagged dependent variables (instruments) in Equations (5.1) and (5.2). The null hypothesis for this test is that the instruments are valid. The p-value for this test is equal to 1 for both equations so therefore I fail to reject the null hypothesis which provides evidence that the instruments are valid.[37] In addition to the Sargan Test, I test for the autocorrelation in the residuals (SAS, 2011). That is, Corr(ϵ_{it}, $\epsilon_{i(t-1)}$) ≠ 0. The null hypothesis for this test is that there is no autocorrelation in the errors. The p-value for this test is greater than 0.761 for brewpubs and 0.175 so therefore I fail to reject the null hypothesis which provides evidence that there is no autocorrelation in the errors.

[37] Because of rapid growth in both the number of breweries and total production during the sample period, non-stationarity is also considered as a possible issue. The results from a series of panel data unit root tests (Choi, 2001; Fisher, 1932; Harris and Tzavalis, 1999; Maddala and Wu, 1999; SAS, 2013) all suggest the presence of non-stationarity, meaning that existing sample data cannot be used to predict future behavior (Wooldridge, 2009). However, research suggests that when the long-run covariance matrix Ω of the differences of a non-stationary vector has full rank, an ordinary least squares (OLS) regression is said to be spurious and the pooled least squares estimate of β is consistent (Granger and Newbold, 1974; Phillips, 1986; Phillips and Hyungsik, 2001; Phillips and Moon, 1999). A calculation of the covariance of the differenced values for both the number of breweries and total production revealed that the dataset has full rank. Therefore, even though there is non-stationarity in this time series data, the parameter estimates will still be consistent.

Table 7.1 Estimation results: Impacts on the logged number of breweries per capita (in millions of people)

	Elasticity Estimate	
Natural log of variable	Brewpubs	Micro and regional breweries
State excise tax ($/gallon)	-0.233**	-0.217***
	(0.112)	(0.015)
Number of breweries per capita (t-1)	0.582***	0.805***
	(0.017)	(0.005)
State unemployment rate (%)	-0.308***	-0.163**
	(0.119)	(0.077)
State median age	-0.064	-2.435***
	(1.632)	(0.602)
State median income ($)	3.337***	-0.101
	(0.269)	(0.350)
Standard error of median income ($)	-0.230***	-0.167**
	(0.047)	(0.067)
Average number of breweries per capita in border states (t-1)	0.022	0.002
	(0.017)	(.009)
Microbrewery dummy (relative to regional)	--	0.710***
	--	(0.075)
Fixed effects	State	State
Standard error clustering	State	State

All continuous variables are logged with an epsilon ε = 0.00001 added to all observations to enable the transformation for all observations. The models were estimated using heteroscedasticity robust clustered standard errors. Alaska and Hawaii are excluded from estimates. Estimates are reported with standard errors in parenthesis. Statistical significance is reported based on a two-tailed test where *p<0.10, **p<0.05, ***p<0.01.

Table 7.2 Estimation results: Impacts on the logged total production per capita (in millions of people)

	Elasticity Estimate	
Natural log of variable	Brewpubs	Micro and regional breweries
State excise tax ($/gallon)	-0.177**	-0.208***
	(0.088)	(0.033)
Total production (t-1)	0.533***	0.847***
	(0.016)	(0.004)
State unemployment rate (%)	0.0127	0.060
	(0.103)	(0.096)
State median age	-0.288	-2.077***
	(1.440)	(0.706)
State median income ($)	3.210***	0.435
	(0.298)	(0.332)
Standard error of median income ($)	-0.216***	-0.282***
	(0.050)	(0.071)
Average total production in border states (t-1)	0.097***	0.000
	(0.019)	(0.004)
Microbrewery dummy (relative to regional)	--	0.394***
	--	(0.073)
Fixed effects	State	State
Cluster	State	State

Production is measured in thousands of gallons. All continuous variables are logged with an epsilon $\varepsilon = 0.00001$ added to all observations to enable the transformation for all observations. The models were estimated using heteroscedasticity robust clustered standard errors. Alaska and Hawaii are excluded from estimates. Estimates are reported with standard errors in parenthesis. Statistical significance is reported based on a two-tailed test where *p<0.10, **p<0.05, ***p<0.01.

7.1 Impacts on the Number of Craft Breweries

The parameter estimates in Table 7.1 represent the elasticities of the number of breweries per capita with respect to each variable. That is, they provide a measure for how responsive the number of breweries per capita in a state is to a change in the explanatory variables. Estimates for brewpubs and micro and regional breweries are presented in separate columns. The dependent variables are scaled per million people, so each parameter estimate can be interpreted as the estimated effect per million people within a state.

The estimated coefficient associated with state excise taxes on craft beer production is negative and significantly different from zero for both the number of brewpubs and micro and regional breweries per capita within a state. The parameter estimates also indicate that the supply of both brewpubs and micro and regional breweries is inelastic with respect to state excise taxes on beer production. This might be the case if excise taxes amount to a smaller share of the marginal cost of production relative to other production costs (e.g., inputs). This might mean that breweries are more responsive to changes in those costs than variation in the excise tax, but that the relationship between the number of breweries and excise taxes might become more elastic if excise taxes become a higher proportion of total costs. It is also possible that this inelastic relationship is a result of excise taxes being low in absolute terms. Since we do not know the entire range of the relationship between the number of breweries and excise taxes, it is possible that breweries exhibit a more elastic response as the overall level of excise taxes increases. However, the parameter estimates in Table 7.1 represent short run elasticities, as discussed in Section 5.2. That is, the elasticity estimate represents breweries' short run response to a change in the state excise tax rate.

The impacts of excise taxes is similar in magnitude between the two different types of breweries; a ten percent increase in state excise taxes is associated with a 2.3 percent decrease in the number of brewpubs per million people and a 2.2 percent decrease in the number of micro and regional breweries per million people. These results suggest that, on average, increased excise tax costs drive breweries to exit the market and/or result in fewer craft breweries entering the market. For example, in a state like Montana, with a population of just over a million, it would take close to a fifteen percent increase in excise taxes for one brewery to close. In contrast, a fifteen percent increase in the excise tax in Washington, with a population of 6.9 million in 2012, would drive at least three breweries to close in the state. Table 7.3 shows the predicted effect on the number of breweries per million people for the five states with the highest number of breweries per capita by their respective type in 2012 if the state excise tax increased by twenty percent. For example, in Montana, which had the highest number of micro and regional breweries per capita in 2012, the predicted impact is a little over one fewer breweries if the excise tax rate were to increase by twenty percent.

Table 7.3 Number of brewery per capita response to a twenty percent increase in state excise taxes

Micro and regional breweries				
State	2012 state excise tax rate (per barrel)	2012 breweries per capita	State excise tax rate after twenty percent increase (per barrel)	Predicted change in breweries per capita
Montana	$4.30	30.84	$5.16	-1.357
Vermont	$8.22	20.74	$9.86	-0.912
Oregon	$2.60	15.64	$3.12	-0.688
Maine	$10.85	14.29	$13.02	-0.629
Washington	$23.81	13.48	$28.57	-0.593

Brewpubs				
State	2012 state excise tax rate (per barrel)	2012 breweries per capita	State excise tax rate after twenty percent increase (per barrel)	Predicted change in breweries per capita
Oregon	$2.60	15.64	$3.12	-0.719
Wyoming	$0.59	15.61	$0.71	-0.718
Colorado	$2.48	13.88	$2.98	-0.638
Vermont	$8.22	11.18	$9.86	-0.514
Maine	$10.85	9.03	$13.02	-0.415

Both brewery per capita measures (levels and changes) are measured in millions of people. Alaska and Hawaii are excluded. States are selected based on the highest number of breweries per capita in 2012 by their respective type.

The results in Table 7.1 also suggest that the number of breweries in previous years is significantly related to the number of breweries per capita in the current year within a state. A ten percent increase in the number of brewpubs per capita in the previous year is associated with a 5.8 percent increase in the number of brewpubs per capita in the current period. The number of breweries in the previous year has a larger effect on the number of micro and regional breweries, with a ten percent increase in the number of breweries per capita in the previous year estimated to result in an 8.1 percent increase in breweries per capita in the current year. The effect might be larger for micro and regional breweries because they have larger distribution areas than brewpubs and are therefore able to sell to more customers. In contrast, since many brewpubs typically do not distribute outside of their establishment, they might be more constrained by the number of customers in their more immediate vicinity.

These results might be a function of spillover effects among breweries within a state, which may manifest as the sharing of improved brewing and marketing techniques that allow more breweries to successfully enter and remain in the market. This supports findings by Mathewson and Winter (1984) who find that territorial protection in the form of excluding other firms from entering distribution regions "is never implemented … when there are informational spillovers." Similarly, Rojas and Peterson (2008) find that there are regional cooperative effects, indicating that if the number of breweries per capita increases in previous years, we would expect breweries to continue to enter the market as firms will engage in mutually beneficial cooperation.

While the state unemployment rate has a significant negative effect on the number of breweries per capita for both types of breweries, the effect on brewpubs is almost twice the magnitude as that for micro and regional breweries. This might be a result of the fact that brewpubs are typically smaller operations than micro and regional breweries and are therefore less able to withstand negative demand shocks. A ten percent increase in the state unemployment rate is predicted to result in a 3.1 percent decrease in the number of brewpubs per million people and only a 1.6 percent decrease in the number of micro and regional breweries. This suggests that brewpubs are more responsive to the prevalence of unemployment within their state than micro and regional breweries. These results also support Freeman (2011), who finds that unemployment is negatively related to total beer consumption. Combined, this and Freeman's study indicate as unemployment rises the decrease in beer consumption will be sufficiently large such that fewer breweries will operate in the market.

The results in Table 7.1 indicate that median age has a significant negative effect on the number of micro and regional breweries, implying that states with older populations are expected to have fewer breweries than states with relatively younger populations. The sign of the parameter estimate is consistent with previous findings that younger consumers consume more beer than older consumers (*Beer,* 2013; Freeman, 2011; Kerr *et al.*, 2004; Tremblay and Tremblay, 2005). The magnitude of the coefficient on median age for micro and regional breweries is considerably large. The results indicate that a five percent increase in a state's median age is predicted to result in 12.2 percent fewer breweries. This means that more than two breweries would close in a state like Vermont, which had roughly twenty one micro and regional breweries per capita in 2012, if median age increased by five percent. The fact that the effect of age on the number of brewpubs is insignificant is perhaps not surprising. One plausible explanation is given that brewpubs most often operate more like restaurants, individuals under the drinking age and families with young children are still able to patronize brewpubs, making them less sensitive to the consumer age in their state.

Brewpubs are most responsive to changes in state median income, with a ten percent increase in state median income predicted to result in a 33.4 percent increase in the number of brewpubs. In contrast, state median income does not have a significant effect on the number of micro and regional breweries in a state. The differences in the effects of median income between brewery types might be a result of the fact that micro and regional breweries generally distribute in larger areas whereas brewpub distribution areas are much smaller because they sell most of their beer within their establishment. Therefore, brewpubs are likely to be more sensitive to incomes of consumers in their immediate geographic area than micro and regional breweries, some of which are able to distribute to different areas (e.g., states) where consumer income might be higher. Income distribution, as measured by the standard error of median income, has a significant negative impact on both the number of brewpubs and micro and regional breweries. This might suggest that breweries are less likely to open in a state where there is greater socioeconomic uncertainty.

The number of breweries in neighboring states does not have a significant impact on own-state number of breweries per capita. This indicates that breweries in border states do not impose competitive pressure in a way that pushes breweries in other states out of the market. On the other hand, it also suggests that the existence of breweries in border states may not result in positive pressure on the number of breweries within a state. It is possible, therefore, that factors within a state are more important in determining the number of breweries that operate within that state than characteristics of surrounding states.

7.2 Impacts on Total Craft Beer Production

The parameter estimates in Table 7.2 represent the elasticities of the total production per capita with respect to each variable. That is, they provide a measure for how responsive total craft beer production in a state is to changes in the explanatory variables. Estimates for brewpubs and micro and regional breweries are presented in separate columns. Total production is scaled in thousands of barrels per million people in a state, so each parameter estimate can be interpreted as the estimated effect per thousand people within a state.

State excise taxes on craft beer production has a significant negative effect on the total production of both brewpubs and micro and regional breweries per capita within a state. The parameter estimates also indicate that total production by both brewpubs and micro and regional breweries is inelastic with respect to state excise taxes on beer production. That is, a one percent increase in the state excise tax is expected to cause a 0.18 percent decrease in brewpub production and a 0.21 percent decrease in micro and regional brewery production. However, similar to the estimates in Table 7.1, the parameter estimates in Table 7.2 represent short run elasticities (see Section 5.2). That is, the elasticity estimate represents how breweries adjust production levels in response to changes in the state excise tax rate in the short run.

The parameter estimates from Table 7.2 suggest that brewpubs in a state like Colorado, which produced almost 53 thousand barrels in 2012, would be expected to reduce production by 946 barrels if the excise tax increased by ten percent. The effect is slightly larger for micro and regional breweries, with a ten percent increase in the state excise tax predicted to cause a 2.1 percent decrease in micro and regional brewery production. This means that micro and regional breweries in a state like Pennsylvania, which produced 3.1 million barrels in 2012, would reduce production by 65 thousand barrels if the excise tax increased by ten percent. Table 7.4 shows the predicted effect on total craft beer production per million people for the five states with the highest total production per capita by type in 2012 if the state excise tax increased by twenty percent. For example, Oregon, who had the highest total production by both brewpubs and micro and regional breweries in 2012, is predicted to have almost 17 fewer breweries if the state excise tax rate were to increase by 20 percent.

The results in Table 7.2 also suggest that total production per capita in the previous year has a significant positive effect on total production per capita in the current year. A ten percent increase in total production in the previous year is estimated to result in a 5.3 percent increase in total brewpub production and an 8.5 percent increase in total micro and regional production in the current year. This indicates that present production levels by both types of breweries is a function of past production and that increases in production in the current year have an effect not only in the current year, but also in future years.

Table 7.4 Production per capita response to a twenty percent increase in excise taxes

Micro and regional breweries				
State	2012 state excise tax rate (per barrel)	2012 production per capita	State excise tax rate after twenty percent increase (per barrel)	Predicted change in production per capita
Oregon	$2.60	384.90	$3.12	-16.936
Massachusetts	$3.29	359.12	$3.95	-15.801
Pennsylvania	$2.48	243.13	$2.98	-10.698
Colorado	$2.48	234.07	$2.98	-10.299
Delaware	$4.84	220.54	$5.81	-9.704

Brewpubs				
State	2012 state excise tax rate (per barrel)	2012 production per capita	State excise tax rate after twenty percent increase (per barrel)	Predicted change in production per capita
Oregon	$2.60	17.80	$3.12	-0.819
Colorado	$2.48	10.12	$2.98	-0.466
Montana	$4.30	7.94	$5.16	-0.365
Wyoming	$0.59	7.87	$0.71	-0.362
Maine	$10.85	6.54	$13.02	-0.301

Both brewery per capita measures (levels and changes) are measured in millions of people. Alaska and Hawaii are excluded. States are selected based on the highest total production per capita in 2012 by their respective type.

In contrast to its effect on the number of breweries from Table 7.1, Table 7.2 indicates the state unemployment rate does not have a significant impact on total production by either brewpubs or micro and regional breweries. This indicates that if the state unemployment rate increases, we would expect some breweries to go out of business and/or decide not to enter, but the ones that continue operations will increase production. That is, even though some breweries terminate operations when the unemployment rate increases, the breweries that remain meet existing demand by increasing their own production so that the total state production remains unchanged.

Similar to its effect on the number of breweries from Table 7.1, state median age only has a significant effect on the total production by micro and regional breweries. The results in Table 7.2 indicate that a ten percent increase in the state median age is predicted to reduce total state production by 20.7 percent. The sign on the parameter estimate is consistent with previous findings, which indicate that younger consumers consume more beer than older consumers (*Beer,* 2013; Freeman, 2011; Kerr *et al.*, 2004; Tremblay and Tremblay, 2005). Consider a state like Rhode Island, where the median age and total micro and regional craft beer production in 2012 was 39.8 years and 63.2 thousand gallons, respectively. A ten percent increase in the median age in this state is expected to be associated with a decrease in production by roughly 13 thousand barrels. The fact that median age is does not have a statistically significant relationship with total production by brewpubs may be related to the explanation provided for the effect of age on the number of brewpubs.

Table 7.2 indicates that production by brewpubs is most responsive to the state median income, which is similar to the effect of income on the number of brewpubs in Table 7.1. A ten percent increase in the state median income is predicted to result in a 32.1 percent increase in brewpub production within a state. These results suggest support for previous findings that beer is a normal good (Clements and Johnson, 1983; Freeman, 2011; Hogarty and Elzinga, 1972; Lee and Tremblay, 1992; Penm, 1988). This study also extends previous analyses by considering the craft beer market alone, indicating that some of the discrepancies between previous studies might be a function of the types of beer included in the analysis.

Average total production per capita in border states is only significantly related to the total production by brewpubs. However, the coefficient estimate is relatively small; a ten percent increase in the average total brewpub production in border states is predicted to result in a 0.97 percent increase in own-state brewpub production. While the effect of border state production is statistically significant, the magnitude on the coefficient suggests suggest that craft beer production in border states is not necessarily economically significant. This means that for a state like Washington, whose brewpubs produced almost forty thousand barrels of beer in 2012, a ten percent increase in the average production in Idaho and Oregon will only result in 374 more barrels produced by Washington brewpubs.

7.3 Summary of Results

The primary purpose of this empirical analysis is to understand how excise taxes imposed on beer production impact the number of craft breweries and their production while controlling for other state characteristics that might also have an impact. The results from Tables 7.1 and 7.2 indicate that excise taxes have a significant negative effect on both the number of craft breweries and craft brewery production within states, with the largest effect on the number of brewpubs per capita. However, the magnitude of parameter estimates for the independent variable of interest indicate that there is a consistent inelastic relationship between the dependent variables and state excise taxes across both brewery types. This means that while excise taxes increase the marginal cost of beer production, a one-percentage increase in the tax rate results in less than a one percent decrease in both the number of craft breweries and craft beer production. However, by including state and year fixed effects in the models, the elasticity estimates represent short run responses in both the number of breweries and total production.[38]

The results from this study also find strong temporal dependence between the number of breweries in the current period and the number of breweries in the previous year as well as the total production in the current period and the total production in the previous period. The inclusion of lagged dependent variables controls for the stickiness between years. Because an OLS regression with lagged dependent variables will produce biased estimates, a GMM dynamic panel estimator is employed in order to generate consistent estimators (Wooldridge, 2009). That is, through the use of a GMM model the estimated parameter values are expected to asymptotically approach the true parameter values. Additionally, the use of heteroscedasticity robust standard errors controls for within-state correlation between the errors and reducing the probability of committing a Type I error.

[38] We estimated the models without state and time fixed effects to try to understand the long run elasticity. The parameter on excise taxes was not significantly different from zero, which may suggest that excise taxes might only have a short run impact on both craft beer production and the number of craft breweries. However, future research might include a more rigorous model of long run elasticities to gain better insights into these effects.

CHAPTER 8

CONCLUSION

This research empirically estimates the effect of state excise taxes on beer production on the number of craft breweries and total craft beer production within a state. The growth in the overall number of breweries operating in the U.S. since the 1990s has been primarily driven by craft breweries. However, a historical lack of data specific to the craft brewery market has limited the empirical analysis of this industry. Additionally, existing literature on the effects of excise taxes on the brewery market primarily relates to their effects on beer prices and consumption. This thesis expands upon the existing literature by considering the craft brewery market separately from macrobreweries and seeks to model the effect of excise taxes on the supply side of the market.

The results from a Generalized Method of Moments (GMM) estimation indicate that there is a consistent negative relationship between state excise taxes on beer production and both the number of craft breweries per capita and total craft beer production within a state. That is, an increase in state excise taxes is predicted to result in both fewer craft breweries and lower levels of craft beer production. Additionally, the magnitude of the coefficient estimates indicate that there is an inelastic relationship between state excise taxes, which indicates that breweries are not extremely responsive to the increased marginal costs of production associated with higher excise tax rates.

Findings from this study support Keat and Young (2009), who state that the short-run supply curves for beer are relatively inelastic because breweries “cannot immediately remove resources from this industry to another pursuit." This has implications from a government revenue perspective because the inelastic relationship suggests that increasing excise taxes on beer production will generate additional tax revenue. However, by including state and year fixed effects in the models, this study considers only the short run impacts of excise taxes while future analysis might consider the long-run impacts.

I also analyze the impact of brewing markets in border states by including the number of breweries and total production in neighboring states. The results reveal that only brewpubs are affected by total production in neighboring states. However, the coefficient estimate is relatively small, suggesting that its impact has little economic significance. The results indicate that the number of breweries in border states does not have a significant impact on either the number of brewpubs or the number of micro and regional breweries, suggesting that factors within a state likely have a greater influence on determining the supply of craft breweries than the condition of the craft brewery market in neighboring states.

The results of this study are important from a regulatory perspective because there are currently two bills before Congress that propose changes to the existing federal excise tax schedule. The Small Brewer Reinvestment and Expanding Workforce Act (Small BREW Act) seeks to cut the small brewer excise tax rate in half for the first sixty thousand barrels produced and institute a new higher rate for production between sixty thousand and two million barrels (*Brewers*, 2013d). This act would be most applicable to craft breweries because they traditionally have lower levels of production than their macrobrewery counterparts. The act would reduce the marginal cost of production for the smallest breweries, which, as suggested by the analysis in this study, would increase the incentives for more small craft breweries to enter and/or expand operations in the market. In contrast, the Brewers Excise and Economic Relief Act of 2013 (BEER Act) seeks to cut the federal excise tax on beer in half, from $18 per barrel to $9 (*Congress,* 2014). A passage of this act would have a greater influence on macrobreweries because their high production levels make them subject to the non-reduced federal excise tax rate.

While this thesis specifically focuses on state, and not federal, excise tax levels, it offers some insight into how breweries are predicted to respond to changes in these types of production costs. That is, both state and federal excise taxes are imposed on each barrel of beer produced within a state, with the difference between the two being the receiver of the tax revenue (i.e., state government and federal government, respectively). Therefore, it is possible that the effect of changes in the federal excise tax on beer is similar to the predicted impact of state excise taxes estimated in this study.

The direction and significance levels of the parameter estimates found in this study were robust to multiple specifications, including non-GMM estimators (e.g., OLS) with and without lagged dependent variables, providing evidence for the existence of a causal negative relationship between state excise taxes and the number of craft breweries and total craft breweries. However, further analysis is likely needed as the estimates in this study are from a reduced form model and the estimation method does not consider the possibility that the number of breweries and total production within a state are likely jointly determined. If this is the case, there is the risk of omitted variable bias and therefore the possibility of biased coefficient estimates. Additionally, the inclusion of price data would allow a more complete analysis of the effects of excise taxes on the market equilibrium. This thesis provides the important first steps for understanding the complexities of the rapidly growing craft brewery market.

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