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Theme Overview: Beer, Policy, and a Changing Global Market

Joshua Berning and Michael P. McCullough
JEL Classification: Q13, Q18, N50
Keywords: Agriculture, Beer, Consumption, Industry

Articles in this Theme:

The connections among beer, agriculture, and society are apparent in the earliest civilizations. While the exact date is not certain, beer is estimated to have been invented by 10,000 BCE at the latest and was an integral part of early Mesopotamian societies. Some theories suggest that beer production was one motivation for adopting early farming practices and moving from hunter/gatherer to agricultural lifestyles. In fact, archaeologists debate whether baking bread led to the brewing of beer or whether bread was actually invented to facilitate beer production (Standage, 2006).

Beer quickly spread throughout the ancient world. Egyptians paid wages in beer. Later, workers during the Industrial Revolution expected beer to be on the premises during work hours, and English colonists made it a priority to establish beer brewing upon first arriving in the Americas (Smith, 1995). In many industrialized cities, boiling water to make beer is likely to have saved lives as well, as it killed harmful pathogens found in city water (Johnson, 2015). Perhaps most importantly, beer plays a significant role in ceremonies and celebrations in cultures all over the world.

Widespread beer production has important and significant economic impacts in the United States and abroad. Global beer production in 2016 was around 1,955.7 million hectoliters, with the United States producing around 225 million. Globally, this quantity of beer requires roughly 20 million tons of malted barley for production. Global hops production in 2016 covered 134 thousand acres, producing 236 million pounds (Hop Growers of America, 2016). The United States produced 39% of total hops, which are exported to over 40 countries. The brewing industry directly creates 49 thousand jobs in the United States and has an economic impact of $252 billion and 1.7 million jobs indirectly (John Dunham & Associates, 2015).

Naturally, important policy issues surround beer production, distribution, and consumption. The U.S. federal government has established a variety of beer regulations, from the 18th Amendment prohibiting alcoholic beverages to the 21st Amendment repealing prohibition, legalization of brewing at home, and laws regarding distribution. States can also choose the extent to which they regulate beer production, distribution, and taxation.

One of the drivers of such regulations has been a concern for personal and public health, emerging as an interesting mix of paternalistic federalism that seeks to control beer consumption in the United States. This includes determining the age at which people can legally drink, the days on which they can buy beer, where they can buy beer, and how much alcohol beer can contain. It has also spilled over into evaluating how much beer is

healthful to consume. Taken altogether, beer consumption and production provide relevant and important topics of research for agricultural and applied economists with implications for the public, industry, and government.

This *Choices* theme covers topics related to both the global and domestic beer industry. Swinnen provides a broad overview of global beer consumption over the last 50 years in which he identifies specific trends and drivers affecting traditional beer-drinking countries and countries where per capita consumption is increasing.

Next, Berning and McCullough provide an overview of the U.S. beer industry, focusing on beer production over the past 40 years. They examine changes in industry structure, including the incredible growth of the craft beer industry. They also discuss agricultural inputs to beer production and provide a broad overview of beer regulation.

Malone and Stack explore beer laws as they examine how regulatory barriers affect beer production in the United States. Specifically, they provide a history of regulation, discuss the rationale for and consequences of such policies, and examine the implications for economic growth.

Finally, McCullough and Volpe examine the topic of healthful beer consumption, specifically looking at current federal recommendations regarding beer and alcohol consumption. Then they dive into the health literature, which discusses the benefits and consequences of beer consumption and how beer can be part of a healthful diet.

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Beer Consumption and Trade in an Era of Economic Growth and Globalization

Johan Swinnen

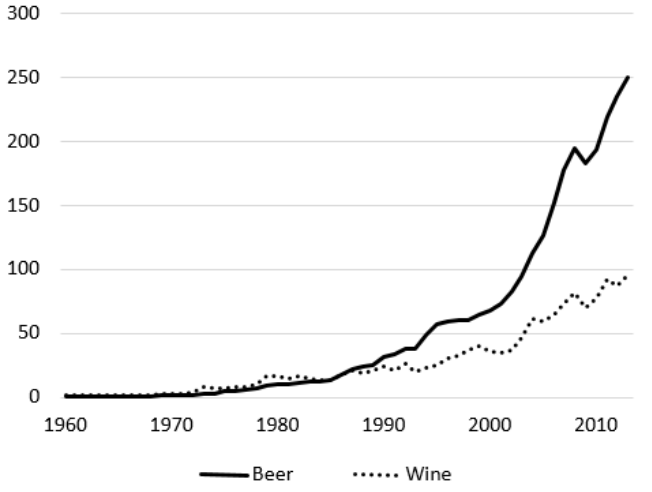
JEL Classification: F10, N50, Q13
Keywords: Beer, Consumption, Convergence, Economic Growth, Globalization, Trade

Globally, beer consumption and trade have grown significantly over the past decades. Total beer consumption has increased rapidly since 1990 (Figure 1). The global beer market is around 250 billion U.S. dollars, 2.5 times as large as the global wine market and roughly double the global spirits market. The differences in volume are much larger (beer consumption is more than seven times larger than wine consumption by volume) since wine and other alcohol are typically more expensive than beer (Swinnen and Briski, 2017).

However, the growth in beer consumption has been uneven. For a long time, the majority of beer was consumed in three nations: the United States, UK, and Germany (Table 1). In 1960, these three accounted for more than half of worldwide beer consumption by volume. Fifty years later, in 2010, they claimed less than a quarter. Over the past decade, China surpassed the United States as the single largest beer market, Russia overtook Germany, and Brazil surpassed the UK.

These observations indicate major changes in global beer markets but not what caused them. It may be that beer consumption declined in the leading countries, or that beer drinking increased in the emerging economies or in countries that traditionally consumed other alcoholic beverages such as spirits or wine. It turns out that all three are true.

Figure 1: Global Consumption of Beer and Wine in Value (billion US dollars), 1960-2013



Source: United Nations, Food and Agriculture Organization (2014).

Table 1: Top Five Beer Markets in the World, 1960–2010

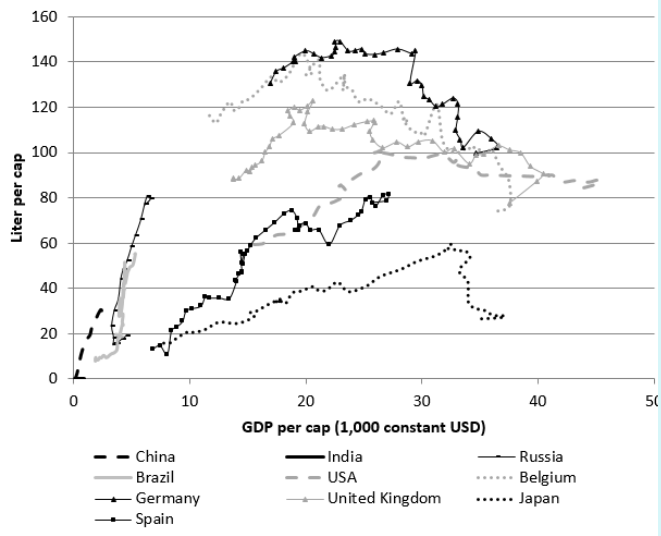
1960	Billion liters	Share of world consumption
1. USA	11.2	26.0
2. Germany	6.8	15.7
3. UK	4.7	10.9
4. Russia (USSR)	2.7	6.2
5. France	1.7	3.9
2010	**Billion liters**	**Share of world consumption**
1. China	45.5	25.8
2. USA	25.6	14.5
3. Brazil	12.8	7.3
4. Russia	9.9	5.6
5. Germany	8.1	4.6

Source: Swinnen and Briski (2017).

Consumption in traditional beer-drinking nations is shrinking. Per capita consumption in countries like Belgium, the UK, the United States, and Germany increased significantly after World War II and through the 1960s and the 1970s (Figure 2). But beer consumption did not grow forever, peaking in the 1970s or 1980s, depending on the country. Since then, beer consumption has experienced a long (almost 40 years in Belgium), deep (from 145 to less than 100 liters per capita in Germany) decline. Total beer consumption has declined as a consequence. The United States is something of an exception because immigration (and thus population growth) have kept the total beer market growing, even as per capita consumption declined.

The opposite has occurred in countries where people traditionally drank wine, such Spain, Italy, and Argentina, where wine consumption has declined and beer consumption increased. The same is true in countries where people traditionally drank mostly spirits; vodka consumption in Poland and Russia has declined over past decades and beer consumption has increased.

Figure 2: Beer consumption per capita vs. income per capita (1,000 constant US dollars) in selected countries (1961-2009)



Source: Colen and Swinnen (2016).

The strongest growth has come from emerging economies, reflected in China's rise in the global beer market. From close to zero beer consumption as recently as 1980, China overtook the United States as the largest beer market in 2003. In Russia and Brazil, beer consumption has increased strongly over the past two decades and these countries are now larger beer markets than Germany. In all these countries the combination of income growth and economic liberalization has been associated with dramatic growth in beer production and consumption.

The size of these markets is highly dependent on population, of course. The Chinese still don't drink anywhere near the volume of beer per capita that Germans, Czechs, and Irish do. The Czechs are world-class beer drinkers, with an annual 143 liters per capita in 2014. Still, China's per capita beer consumption has grown rapidly from a feeble annual one liter per capita in the early 1980s, when their economic liberalization process started, following the country's economic growth. Today's 25 liters of beer per capita represents a 25-fold increase over the past 30 years. Similarly, Russian per capita beer consumption grew dramatically during its transition from a Communist, vodka-drinking nation to a capitalist regime.

What caused these changes? The fact that both China and Russia started consuming more beer when they switched from communism to capitalism may suggest that economic ideology (or the market) has something to do with it. However, two other factors seem to have played a bigger role: economic growth (income) and globalization.

Beer Consumption and Income

Psychologists suggest that alcohol consumption, particularly alcohol abuse, increases during recessions as a response to the stresses of economic downturns. However, economists generally predict that people's incomes fall during recessions, leaving them with less money to spend; beer consumption will fall as a result. In the short run, Freeman (2011)—who analyzed various datasets using different methodologies—concludes that, at least for the United States, beer consumption does fall when incomes decline, and vice versa, but that the effect is modest.

However, in the long run, the relationship between income and beer consumption is not linear (see Figure 2). In poorer "emerging countries," there has been a clear increase in beer consumption over the past decades, in which

most of these countries have seen a period of rapid income growth. Yet in the richer "beer-drinking nations"—such as Germany, the United States, and Belgium—where incomes have also increased, the evolution of beer consumption is very different: it has declined with income growth. If people are poor and become wealthier, they can afford to spend more, and they consume more beer. But at some point this trend hits a turning point and beer consumption begins to fall as incomes rise.

Why would beer consumption decline as incomes rise? The simplest explanation is that, at some point, people have had enough. There is likely an upper limit to how much consumers appreciate beer consumption. Another explanation is increased awareness and concerns about the potential negative health effects of alcohol consumption when income rises. Since the 1970s and 1980s, the health and social risks of alcohol consumption have become more apparent. Governments have responded by taxing alcohol, imposing limits on advertising and the sale of alcohol, and passing laws against drinking and driving. Health concerns and regulations also work indirectly: Studies find that the ban on smoking in bars has contributed to reduced beer consumption.

Using data from countries across the globe from the past 50 years, we calculated the turning point (i.e., the income level at which beer consumption starts declining with growing incomes) to be approximately $21,000 USD per capita. This income level was reached by Belgium and the United States in the 1970s, by Germany in the early 1980s, and by the UK in the mid-1980s (Colen and Swinnen, 2016).

These countries also demonstrate a tendency toward consuming different types and more expensive beers. The trend away from pilsners in traditionally beer-drinking nations is reflected in a general attitude of "drink less, taste more." So while beer-drinking countries may be drinking less beer, they are also drinking more expensive beer (Garavaglia and Swinnen, 2017).

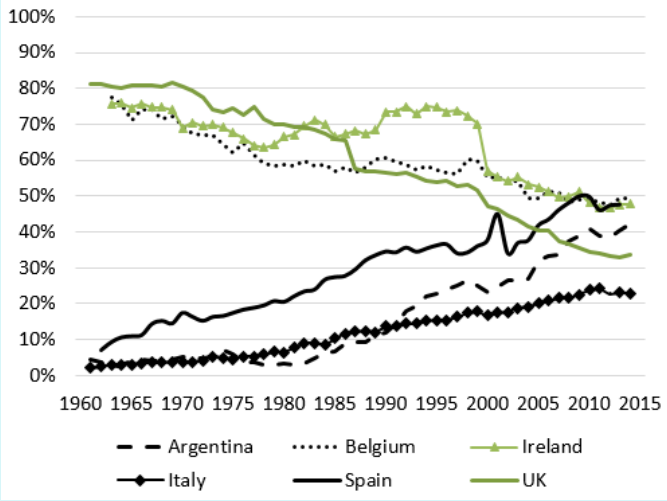
The Global Convergence of Tastes

As consumers in traditional beer-drinking nations get richer, they can also afford to drink more expensive, imported beverages, such as wine. They also travel more, becoming more exposed to different tastes and other alcoholic drinks. At the same time, globalization has reduced the cost of imported wines and other drinks. The combination of increased demand for variety, changing preferences, and reduced costs of imported products induced a shift from beer to wine in those countries. Interestingly, the same factors cause the opposite trend in countries where spirits and wine were the traditional drink. While Dubliners and Berliners now increasingly sip on wines, Parisians, Romans, and Russians have shifted to beer.

This change is dramatic, as Figure 3 illustrates. The graph shows the share of beer in total alcohol consumption for three traditional "beer-drinking nations" (Ireland, the UK, and Belgium) and three traditional "wine-drinking nations" (Spain, Italy, and Argentina). In the 1960s, the share of beer in the beer countries is around 80% and less than 10% in the wine countries. However, the gap has consistently narrowed since then. There is now little difference between beer and wine consumption in these categories. In fact, some of the traditional wine countries have overtaken some of the traditional beer countries. The share of beer in total alcohol consumption has fallen from around 80% in the 1960s to less than 50% today in Ireland, the UK, and Belgium.

Meanwhile, the opposite has occurred in countries like Spain, Italy, Greece, and Argentina, where beer is the new favorite drink and wine is on its way out.

Figure 3: Share (%) of Beer in Total Alcohol Consumption 1960-2010



Source: Colen and Swinnen (2016).

All of these countries experienced sharp increases in the share of beer. In Spain, the share of wine in alcohol consumption fell from 65% to 38% between 1960 and 2010, and Greece experienced a similar fall in wine consumption from 86% to 50%. A similar trend appears to be at work in traditional spirits-drinking nations. In China, spirits consumption fell from 98.5% to 60% from 1961 to 2010. During the same period, beer consumption increased from 2% to 36%. Arguably the most dramatic change occurred in Russia. After centuries of a close relationship between Russians and vodka, the nation unexpectedly switched to beer in the 1990s. The share of vodka as a percentage of total alcohol consumption fell from 40% to 15%, while per capita beer consumption rose from 15 to 80 liters between 1995 and 2008 (Deconinck and Swinnen, 2015). In 2005, Russia's beer consumption surpassed Germany's, making it the third largest beer market in the world.

Nations that have long consumed a majority of their alcohol as one traditional drink are now consuming non-traditional forms in higher quantities. The concept of beer-drinking nations (like Ireland and Belgium), wine-drinking nations (like Spain and Italy), and vodka-drinking nations (like Russia and Poland) is a thing of the past. Globalization and income growth have made the world's alcohol consumption patterns much more homogeneous. A global "convergence of tastes" is changing alcohol consumption patterns.

Beer Trade Expansion in the 21st Century

These global changes in consumption have been mirrored by changes in beer trade. For most of the 20th century, beer trade was largely domestic. Beer exports were limited to a few global branding successes—such as Heineken, Corona, and Guinness—and otherwise to neighboring regions, such as Belgian exports to the Netherlands and northern France and Canadian exports to the northern United States. Beer trade made up less than 2% of global beer consumption until late in the 20th century.

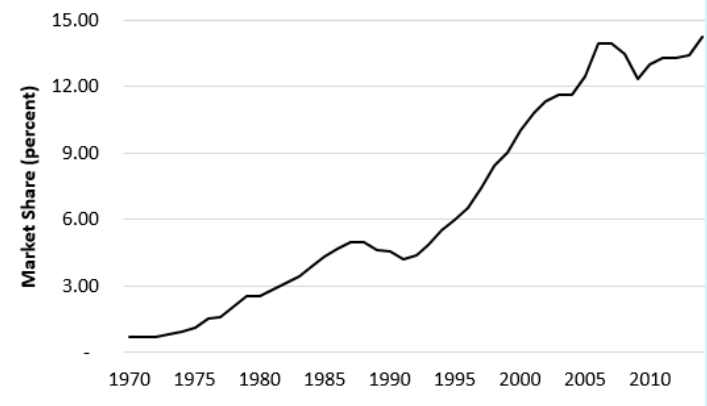
However, trade has grown rapidly since then. International beer markets and trade have fundamentally changed in the 21st century. The volume of beer exported more than doubled over the past two decades—from around 6 billion liters in 1990 to around 15 billion liters in 2014 (see Figure 4). Moreover, the share of production that is exported has increased as well: from less than 2% in 1990 to more than 7% most recently. In the United States, beer imports increased from around 5% in 1990 to almost 15% in recent years (see Figure 5).

Interestingly, the increase in beer trade seems to have been caused by two very different, almost opposing developments: (1) the spread of multinational brewers using takeovers of foreign brewers (and their infrastructure) to launch and sell their premium exports and (2) the shift in consumer preferences toward more local and craft beers, creating increased demand for variety and specialty beers, which are partially imported. The rapid growth of beer multinationals through mergers and acquisitions in the 1990s and 2000s has provided these multinationals

Figure 4: Beer Trade in the World (billion liters, % of production), 1960-2013

Source: United Nations, Food and Agriculture Organization (2014).

Figure 5: Share of Beer Imports in US Beer Consumption, 1970-2014 (%)



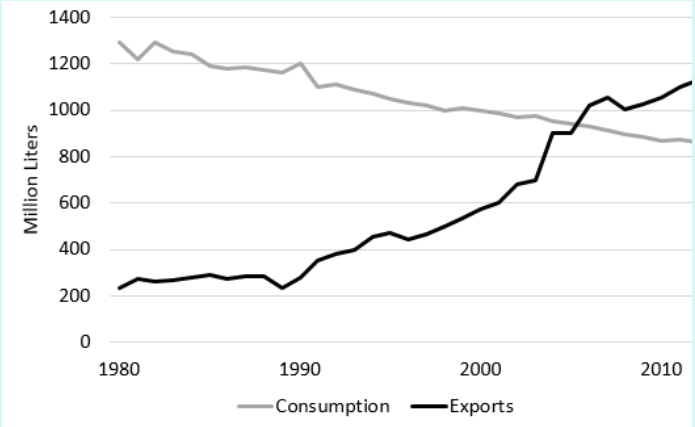
Source: Elzinga, Tremblay and Tremblay (2017).

with local infrastructure and access to beer retailers, pubs, and consumers in many more countries. In this way they have been able to channel their export brands into many more markets and areas where they were not able to go before.

At the same time, the rapidly growing demand for craft beers in many countries and 21st-century consumers' willingness to pay extra for specialty beers has created export opportunities for smaller brewers. With craft and specialty beers linking their quality more closely to their geographic location, the beer trade has fundamentally changed in the 21st century.

This is nowhere better to be observed than in countries like Belgium. The recent global fascination with Belgian beer is matched by tremendous growth in Belgian beer exports. The export boom started in 1990; since 2005, Belgium has exported more beer than it consumes domestically (see Figure 6). The export growth is driven both by mergers and acquisitions—culminating in AB Inbev, and the associated global spread in sales of Stella Artois, Hoegaarden, and Leffe—and by the strong growth in exports among much smaller Belgian breweries, mostly selling specialty beers. Small Belgian breweries are now selling their beers in the United States and faraway places in Asia and Latin America.

Figure 6: Belgian Beer Exports and Domestic Consumption (Million Liters)



Source: Union of Belgian Brewers (2014).

In Summary

A historic overview of the evolution of global beer consumption indicates that consumption and trade of beer has changed dramatically in recent decades. Over the past 50 years, consumption patterns have changed substantially, with decreasing consumption in the traditional beer-drinking countries and strong growth in emerging economies and in countries that traditionally consumed mostly wine or spirits. These changes have created convergence in global consumption patterns of alcoholic beverages and a rapid rise in beer trade, accompanied by global mergers and acquisitions among brewing companies.

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The US Brewing Industry from Farm to Pint

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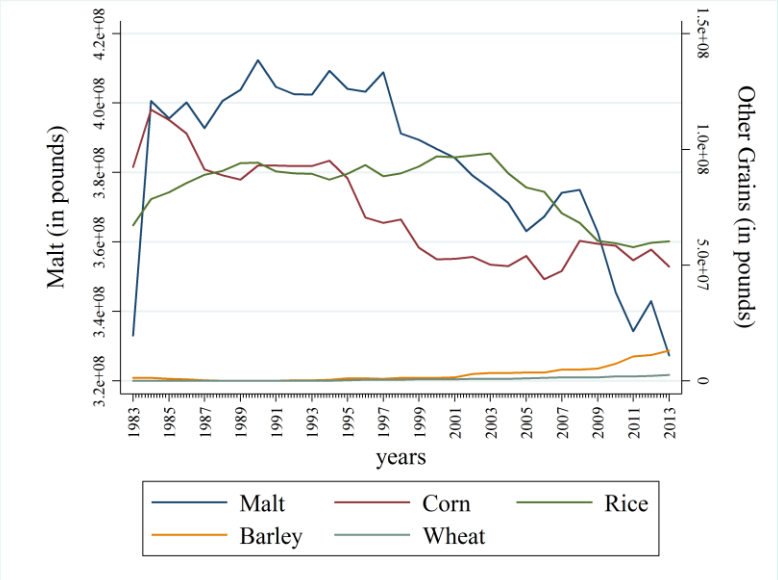
JEL Classifications: I18, Q18
Keywords: Beer, Regional Brewing, State Policy

The story of the U.S. beer brewing industry from the late 1800s to the present is a remarkable tale of steady decline followed by exponential resurgence. In the 1870s, the United States had over four thousand brewers, but that number had steadily declined by the 1980s to only 40–80 breweries (Brewers Association, 2017a). No single cause can be blamed for this decline, but major contributors include the decline in agricultural production during the Dust Bowl, the Great Depression, Prohibition, and World War II (Tremblay and Tremblay, 2005). When the 1950s ushered in the age of mass advertising, large brewers engaged in national television campaigns that gave them a competitive advantage over smaller breweries.

The U.S. brewing industry has evolved through several remarkable periods, each distinguished by unique market structure, competition, and performance. An industry that took around 100 years to erode required less than half that time to recover. Over the last four decades, the U.S. brewing industry has exceeded its previous mark, bouncing back with roughly five thousand brewers in 2016. Most of this growth has been in the craft beer and brewpub sectors (Brewers Association, 2017a).

In addition, the industry is governed by complex local, state, and federal regulations that change frequently, making the industry highly policy relevant. This article offers a brief overview of changes in the U.S. brewing industry over the past 40 years, specifically looking at the industry's link to agriculture and the regulatory environment, then industry structure and growth by size and region.

Figure 1: Average Specific Grain Usage, 1983–2014



Source: Alcohol and Tobacco Tax and Trade Bureau (2017a).

Brewing is Value-Added Agriculture

As a product, beer is directly linked to agricultural production both in the United States and abroad. The barley used to make malt is grown in the northern United States and Canada. The hops used to flavor beer are produced mostly in Washington, Oregon, and Idaho, although global varieties are also sought out for numerous brews. Other

grains—such as wheat, corn, and rice—are also used in lesser amounts as primary ingredients or adjuncts in certain styles of beer (Figure 1).

These products have important value-added components as well. Maltsters turn barley, and to a lesser extent other grains, into a usable malted grain for brewing or produce a malt extract—a condensed malt syrup or powder. Hop processors turn raw hops into condensed pellets or hop extract—a highly potent syrup. In both cases, processors play a pivotal role in quality control as well by monitoring specific standards required for brewing a consistent beer.

As the composition of the brewing industry has changed from large brewers to smaller craft brewers, use of these agricultural inputs has started to change as well. One example is the use of grains in production. Malted grains have long been a staple of brewing, providing the necessary sugars for fermentation. In addition to malted grains, brewers use some amount of unmalted adjunct grains to help balance the brewing process. These can include corn, rice, wheat, and barley.

As overall production has declined and breweries have gotten smaller, the use of malts, corn, and rice has also declined (Figure 1). Yet the use of barley has been steadily rising. Many potential factors drive this substitution in grain inputs across the industry. Anecdotal evidence suggests that it may be related to changes in the brewing process that allow brewers to use cheaper unmalted grains. The fuel ethanol boom may have caused a substitution away from malting barley in the field, driving up prices, or other general changes in commodity prices may have incentivized brewers to substitute inputs.

Figure 2: Average Hops and Hop Extract Usage, 1983–2014

Source: Alcohol and Tobacco Tax and Trade Bureau (2017a).

Similarly, the use of hops in brewing has also been changing. Hop extracts have long dominated regular hops as an input (Figure 2). In the mid-1990s, the use of extract fell drastically and steadily decreased. Starting around 2007, the use of dry hops began to increase. This input shift is directly reflective of the types of beers being produced. Light lagers tend to only use small amounts of hop extract for slight bittering, whereas India Pale Ales (IPAs)—which are very popular in the United States—use more hops and tend to be produced with either whole-cone unprocessed hops or hop pellets. On Beer Advocate (https://www.beeradvocate.com/lists/top/), an online community beer-rating forum, five of the top ten beers are Imperial IPAs, which require a large amount of hops relative to the typical light lager.

Again, the reasons for these industry-wide changes in input usage are uncertain, but they have important marketing and production implications. The hop industry has traditionally operated in a contract market where 80–90% of all sales are forward contracted. Given the sheer volume of breweries and their differing input requirements, we can envision how this may create difficulties for small producers trying to secure smaller contracts.

Beer Policies Vary by State

A variety of laws governs the brewing industry, its wholesalers, and its suppliers. Differences in state policies have important implications within and across states. Franchise laws, which govern the relationship between brewers and wholesalers, differ considerably from state to state (Brewers Association, n.d.). In general, most states define how the two parties in the supply chain interact, but the flexibility of the agreement can vary widely. For instance, Massachusetts law states that a brewer can only terminate a contract with a distributor in the state after 120 days of notification with the wholesaler and the state Alcoholic Beverage Control Commission; termination can only for "good cause." The termination can be suspended, however, upon the wholesaler's request and a hearing by the ABC Commission. Many other states, such as Colorado, mandate exclusive territories for wholesalers, so that if they deliver outside of their territory they can face hefty fines or other penalties, while other states prohibit exclusive dealing contracts altogether.

Franchise laws such as these were initially put in place to protect small independent wholesalers from large breweries with substantial market power (see Malone and Stack in this issue for a discussion of the historical significance of these and other beer laws). There is controversy, however, over their current effectiveness given the recent exponential rise of small breweries. In a *New York Times* opinion piece, Steve Hindy, founder of Brooklyn Brewery, relayed a contract dispute with a distributor that ended up costing the brewery $300,000 in legal fees and settlement costs (Hindy, 2014). The brewery claimed the distributor was selling out-of-date beer, selling outside their designated territory, and generally not performing to their contractual agreement. The distributor filed suit, disputing these conditions as "good cause." This type of anecdotal evidence appears often and can certainly persuade breweries not to operate in areas they otherwise would have. In response to Hindy's opinion piece on the detriments of franchise laws, Craig Purser, president of the National Beer Wholesalers Association, responded in a letter to the *Times* editor (Purser, 2014). In Purser's view, franchise laws actually benefit consumers and the public by providing "an independent system that generates tremendous choice." Without this system, the double-digit growth rate experienced by the craft beer segment would not have been achievable. Several states have recently passed self-distribution exemptions for small breweries, allowing them to bypass distributors altogether provided their production stays below a given level.

In addition to franchise laws, a number of other state beer policies affect the local beer industry. The National Institute on Alcohol Abuse and Alcoholism has created an interactive interface, called the Alcohol Policy Information System (https://alcoholpolicy.niaaa.nih.gov/), for exploring many of these policies. For example, some states limit the alcohol content (typically 4% alcohol by volume) in beer sold for on-premise consumption (in restaurants and bars) and/or off-premise consumption (in grocery or liquor stores). Up until 1998, 20 states banned Sunday sales of alcoholic beverages. Since then, eight of those states have repealed the law and three have authorized local options. Seven states prohibit happy hours at on-premise locations and another nine allow them, but only during restricted hours, such as before 10pm. At the other end of the spectrum, states such as Idaho allow off-premise retailers to provide consumers samples up to 1.5 ounces, and 34 states allow on-premise establishments to provide free beers as a promotion or for a special occasion. All of these laws influence a brewery's ability to reach their target consumers. We would expect relatively larger industry growth in states where it is easier for a brewery to move its beers to market and practice perfected marketing techniques.

Taxation and pricing policies also vary widely. Seven states currently require wholesalers to establish a minimum markup and maximum discount for retailers. Whether or not the wholesaler can provide retailers with product on credit varies across states, with some states prohibiting this type of sale and others establishing maximum days on credit. Fourteen

Table 1: Specific Excise Tax per Gallon for 5% Alcohol by Volume

Descriptive Statistic	Excise Tax ($/gallon)
Mean	0.31
Standard Error	0.04
Median	0.19
Standard Deviation	0.30
Minimum	0.02
Maximum	1.29
Count	50.00

Source: National Institute on Alcohol Abuse and Alcoholism (2017).

states ban the practice of offering volume discounts altogether. Finally, there is a huge difference in state excise tax on beer production. Table 1 lists descriptive statistics for excise tax equivalents on a gallon of 5% beer. The taxes range from a minimum of $0.02 to a maximum of $1.29 per gallon. This is on top of the federal excise tax of $0.58 per gallon. The Beer Institute estimates that more than 40% of the final sale price of beer goes to federal, state, and local taxes (Beer Institute, 2017a). Altogether, these rules and others have important implications for interstate distribution of beer.

Industry Structure: Brewery Production by Size

The U.S. brewing industry can be split into two broad categories: macrobreweries and craft breweries. Macrobreweries (e.g., Anheuser-Busch, Miller, and Coors) collectively produce the largest volume of beer each year and individually produce well over 6 million barrels each, where a barrel equals 31 gallons. Craft breweries are defined by the industry as being smaller, with less than 6 million barrels of annual production, and being independently owned (less than 25% ownership of by a macrobrewery) (Brewers Association, 2017b). Craft breweries generally produce more unique and varied styles of beer compared to the traditional American lagers and light lagers (e.g., Budweiser, Miller Lite, and Coors Original) that have dominated the beer market for decades.

Within these two broad categories, there are still more specific segments: Regional breweries produce between 15 thousand and 6 million barrels annually, while microbreweries produce fewer than 15 thousand barrels annually. Brewpubs (restaurant-breweries) generally produce less than 15 thousand barrels and sell 25% or more of their beer on site. More recently, nano-breweries have been defined as those producing around 3–4 barrels per year.

Some breweries only brew beer for other breweries that handle the marketing and sales of the product. Both brewers in this relationship (the buyer and seller) are referred to as contract brewers—although there are subtle variations to these types of contracts. For example, contract brewing was an important step for the Boston Beer Company (i.e., Sam Adams beer), which used the excess capacity of other brewers to make their own beer early on, thus saving on investment in capital costs.

The large macrobrewers dominate the industry with respect to sales and are poised to achieve economies of scale (Tremblay and Tremblay, 2005). They also have greater access to inputs and wholesale distribution. Yet smaller brewers have found ways to compete more on quality than on quantity (Berning and McCullough, 2016).

Table 2: Number of Breweries by Production Size, 2007 and 2016

	Number of Breweries				
Production Size	2007		2016		CAGR
Over 6m Barrels	17	1.05%	14	0.28%	-2.13%
2m to 6m Barrels	3	0.19%	7	0.14%	15.53%
1m to 2m Barrels		0.00%	4	0.08%	
500k to 1m Barrels	10	0.62%	6	0.12%	-5.52%
100k to 500k Barrels	24	1.48%	45	0.90%	7.23%
60k to 100k Barrels	20	1.24%	37	0.74%	7.07%
30k to 60k Barrels	34	2.10%	53	1.06%	5.06%
15k to 30k Barrels	26	1.61%	74	1.49%	12.32%
7,501 to 15k Barrels	41	2.53%	143	2.87%	14.89%
1k to 7,500 Barrels	356	21.99%	787	15.80%	9.21%
1 to 1k Barrels	909	56.15%	2,811	56.43%	13.36%
Under 1 Barrel	179	11.06%	1,000	20.08%	21.06%
Total	**1,619**		**4,981**		13.30%

Source: Alcohol and Tobacco Tax and Trade Bureau (2017b).

Table 3: Number of Barrels Produced by Production Size, 2007 and 2016

	Total Barrels				
Production Size	2007		2016		CAGR
Over 6m Barrels	167,562,085	84.93%	131,659,359	69.59%	-2.64%
2m to 6m Barrels	13,003,842	6.59%	26,452,765	13.98%	10.31%
1m to 2m Barrels		0.00%	4,999,264	2.64%	
500k to 1m Barrels	6,641,984	3.37%	4,293,997	2.27%	-4.73%
100k to 500k Barrels	4,972,431	2.52%	10,469,048	5.53%	8.62%
60k to 100k Barrels	1,513,844	0.77%	2,932,775	1.55%	7.62%
30k to 60k Barrels	1,441,865	0.73%	2,385,360	1.26%	5.75%
15k to 30k Barrels	538,170	0.27%	1,565,280	0.83%	12.60%
7,501 to 15k Barrels	452,233	0.23%	1,510,468	0.80%	14.34%
1k to 7,500 Barrels	819,159	0.42%	2,070,681	1.09%	10.85%
1 to 1k Barrels	355,171	0.18%	845,845	0.45%	10.12%
Under 1 Barrel	1	0.00%	0	0.00%	-100.00%
Total	**197,300,785**		**189,184,843**		-0.47%

Source: Alcohol and Tobacco Tax and Trade Bureau (2017b).

Over the past decade, the U.S. beer industry as a whole has been stagnant or declining. At the same time, the craft beer segment has seen continuous growth. Table 2 presents the number of breweries reported by the Alcohol and Tobacco Tax and Trade Bureau. The number of macrobrewers producing over 6 million barrels has declined over the past decade, with a compound annual growth rate of –2.13%, currently representing less than 1% of the total number of breweries. Alternatively, the number of brewers producing 100 thousand barrels or less has shown significant growth, with breweries producing 7,500–30,000 barrels showing double-digit growth. Notably, more than half the breweries produce fewer than 1,000 barrels a year.

With respect to barrel production, these smaller breweries have also grown faster than their macro counterparts (Table 3). While macrobrewer production in barrels has steadily declined, craft breweries have steadily grown, displaying double-digit growth in many size categories. Within the craft segment, regional breweries make up 73% of craft barrel production, microbreweries 20.4%, brewpubs 5.5%, and contract brewing companies rounded out total 2016 production with 1.1% (Brewers Association, 2017c). It is relevant to note that the largest brewers still owned nearly 70% of total beer production in 2016, down from roughly 85% in 2007. The smaller production categories have roughly 1% or less of total production. In summary, the U.S. brewing industry is still led by a few dominant firms, but this share is declining as the fringe continues to gain market share.

Brewery Growth by Region

Those familiar with the brewing industry are well aware of exponential growth in the number of U.S. breweries over the past 40 years. Given the commercial and cultural differences across the United States, it is informative to break down this growth by state. Table 4 compares the total number of breweries by state in 1970 and 2012. Not surprisingly, California, Colorado, and Washington lead the way in growth, as these states have well-known and expansive brewing communities in San Diego, Fort Collins, and Seattle, respectively. California and Colorado are also homes to the early home brewing industry that helped launch early craft brewers (Hanson, McCullough, and Berning, 2016). Other states—Michigan, Montana, North Carolina, Oregon, Texas, and Wisconsin—have exhibited growth as well. Although not as large as California, these states all have established craft beer industries that distribute brews well beyond their borders.

Table 4: Total and Breweries per Capita by State in 1970 and 2012

	Total Breweries		Breweries Per Capita			Total Breweries		Breweries Per Capita	
State	1970	2012	1970	2012	State	1970	2012	1970	2012
AL	0	6	0.00	1.25	MT	0	30	0.00	29.84
AK	0	13	0.00	17.80	NE	2	4	1.34	2.16
AZ	0	9	0.00	1.37	NV	0	8	0.00	2.90
AR	0	3	0.00	1.02	NH	0	8	0.00	6.05
CA	18	100	0.90	2.63	NJ	8	8	1.11	0.90
CO	2	57	0.90	10.98	NM	0	9	0.00	4.32
CT	0	8	0.00	2.23	NY	15	40	0.82	2.04
DE	0	6	0.00	6.54	NC	0	32	0.00	3.28
FL	5	19	0.73	0.98	ND	0	1	0.00	1.43
GA	1	7	0.22	0.71	OH	10	19	0.94	1.64
HI	4	4	5.24	2.88	OK	0	4	0.00	1.05
ID	0	15	0.00	9.40	OR	1	48	0.48	12.31
IL	8	20	0.72	1.55	PA	20	35	1.69	2.74
IN	4	18	0.77	2.75	RI	2	3	2.10	2.86
IA	0	14	0.00	4.55	SC	0	7	0.00	1.48
KS	0	3	0.00	1.04	SD	0	1	0.00	1.20
KY	3	4	0.93	0.91	TN	0	12	0.00	1.86
LA	3	7	0.82	1.52	TX	12	43	1.07	1.65
ME	0	13	0.00	9.79	UT	0	5	0.00	1.75
MD	7	6	1.78	1.02	VT	0	14	0.00	22.37
MA	5	20	0.88	3.01	VA	0	21	0.00	2.57
MI	7	34	0.79	3.44	WA	5	69	1.46	10.01
MN	8	20	2.10	3.72	WV	0	1	0.00	0.54
MS	0	1	0.00	0.33	WI	18	32	4.07	5.59
MO	5	16	1.07	2.66	WY	0	1	0.00	1.73

Source: National Archives Catalog (2017).

Many areas exhibit a conspicuous lack of growth. Excluding Florida and North Carolina, growth in the Southeast has been slow over the past 40 years. This could be due to cultural differences or possibly economic climate. Differences across states could also be driven by variation in the regulatory environment. When Prohibition was repealed by the 21st Amendment in 1933, most alcohol-related policy was deferred to the state and local levels, resulting in a complex and arguably convoluted

system of production, distribution, and sales laws. These differences in state beer policies are wide and no doubt have had lasting effects on the development of the brewing industry within state borders.

When we present the number of breweries on a per capita basis, a slightly different story emerges. Some states with large brewing industries, such as California, are not growing as fast relative to the population. Assuming constant per capita consumption, this could indicate that these states may be reaching the limit of their growth potential. It also shows that states not typically in the conversation regarding industry growth—particularly Alaska, Montana, and Vermont—exhibit much steeper growth rates per capita and have burgeoning market potential.

These per capita differences could also reflect state-specific industry conditions. Beer supply chains rely on wholesalers that not only distribute their product but also help market and promote it. In some states, the growth of distributors has also been stagnant or distributors and breweries face excessive regulation.

Breweries also rely on access to necessary malted grains and hops. The growth of breweries has led to competition for these inputs. Climatic events such as drought (hops) and freeze (barley) have led to periodic shortages as well. Consequently, these external factors may favor breweries in certain regions of the country or breweries producing at a larger scale with greater bargaining power.

In Summary

Given the wide variety of state and local policies regarding beer production, distribution, and sale, it is no wonder that states have experienced disparate growth rates. A number of supply chain factors have also impeded or fostered growth in an industry that has been a pivotal part of this country's rich history. As the local agricultural movement continues to grow, we can expect to see an increase in local production of barley and hops as well as value-added industries such as maltsters. We can also expect to see changes in local, state, and federal policies, whether they be prohibitionist or supportive. The Craft Beverage Modernization and Tax Reform Act is currently under legislative review and looks to substantially alter federal excise taxes rates. These are interesting times for an industry that provides more than $48.5 billion in tax revenue annually and employs over 1.75 million workers throughout its supply chain.

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What Do Beer Laws Mean for Economic Growth?

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Some of the best songs are about beer drinking. They tell you to drink a six-pack of beer for breakfast because you'd have a better time with a drink in your hand since it makes you a jolly good fellow. A "B-double-E-double-R-U-N" can bring you 40 ounces to freedom. Whether it's in Mexico or at the lake, beer makes vacation better. But for as many songs as have been written about the pleasures of drinking beer, other songs convey a different, more tragic message. As famously crooned by Jerry Lee Lewis, too much beer drinking can make a loser out of you. Demon alcohol can ruin your family's Christmas.

Given the tension between the positives and negatives of beer drinking, it should come as no surprise that beer markets have long been a target for government intervention. Just as beer has always been a part of American cultural history, so too has beer regulation been interwoven into American political history. In the United States, government intervention has largely been motivated by concern for the health of American citizens and as a way to generate tax revenue. According to the Centers for Disease Control and Prevention (2017), 88,000 adults die from alcohol consumption each year, with heavy drinkers generating a potential social cost of $2 per beer consumed (Sacks et al., 2015). These negative consequences are especially dire for certain portions of the population. As noted by Case and Deaton (2015), the mortality rate for white middle-aged non-Hispanics has increased over the past few decades, with some of the largest increases attributed to chronic liver diseases and drug and alcohol poisoning. Student grades tend to fall upon being able to drink legally (Lindo, Swensen, and Waddell, 2013). These and other social costs can translate to economic consequences, as Cesur and Kelly (2014) find that reducing per capita beer consumption might lead to a significant increase in per capita GDP growth.

Because it is often more difficult for governments to directly influence demand for a product, policymakers often opt to indirectly influence demand by enacting supply-side restrictions, passing regulations with the potential to restrict producers. These regulatory constraints are particularly burdensome for brewing, as estimates suggest that the beer value chain is subject to more than 90,000 federal regulatory constraints (Malone and Chambers, 2017). Brewers are acutely aware of this government tendency: in the mid-19th century, they founded the first-ever trade association in the United States as a response to new government regulations (Mittelman, 2008). In the modern era, changes in social norms coupled with economic development goals have led policymakers to reconsider Prohibition-era policies, which have unintentionally restricted the emergence of craft breweries. Unfortunately, understanding the side effects of beer policy is likely even more difficult than identifying the positive and negative consequences associated with beer drinking.

A Brief History of American Alcohol Regulations

In part because beer has often historically been safer than drinking water, beer—and alcohol more generally—played a pivotal role in many of the most famous events in American political history (Cheever, 2015). Instead of continuing their voyage to Northern Virginia as planned, the Pilgrims landed illegally at Plymouth Rock because they had run out of beer. One of the first policies implemented by the government of the British Crown on the American colonies was a tax on alcohol. Drinking in pubs and taverns was instrumental to the development and dissemination of American ideals during the years leading up to the American Revolution (Scribner, 2013). In fact,

the first battle of the American Revolution occurred just outside Buckman Tavern in Lexington, Massachusetts, where the colonial minutemen had been drinking tankards of rum. After the war, federal alcohol regulations fell to the newly formed government. The first domestic tax (and warrantless search-and-seizure) imposed by the American federal government was implemented by Alexander Hamilton to curb alcohol consumption and raise money; it unfortunately incited the infamous "Whiskey Rebellion."

As Americans moved westward, alcohol remained a crucial link to civilization. By the 1830s, American per capita alcohol consumption was the world's highest. Americans drank an array of alcohols during this period, including hard cider. Johnny "Appleseed" Chapman famously planted apple orchards to help meet this demand. Even babies and young children were provided alcoholic beverages to help them sleep or to provide them with sustenance. As one historian describes it, "They drank from the crack of dawn to the crack of dawn" (Rorabaugh, 1981, p. 21).

The American perspective on beer and alcohol drastically changed over the course of the 19th century. The Industrial Revolution made inebriation far more dangerous, as a drunken factory worker was far more likely to be maimed or killed on the job than was a drunken farmer. Concurrently, a powerful political movement emerged with temperance at its core and Protestant American women on its front lines. By the 1830s, many Americans were members of temperance societies, and there was growing sentiment that the government needed to curb alcohol consumption. Not coincidentally, the federal government implemented the first beer excise tax during the Civil War, a step taken both to raise revenue and to discourage beer consumption (Mittelman, 2008).

By the early 20th century, anti-drinking fervor and the belief in women's suffrage reached new levels of national popularity. Women such as Carrie Nation and Susan B. Anthony had become folk heroes in part for their radical stance against alcohol, thereby interconnecting temperance with women's rights. At the time, taxes levied on alcohol accounted for approximately 30% of the federal budget, so the goal of prohibition depended in part on new revenue streams. Congress obliged in 1913 when it passed the 16th Amendment, which created a huge new revenue source: a federal income tax.

As is the case with some alcohol laws today, many well-intentioned people believed prohibition was a solution to the destruction of American family values. But there were also a few dark reasons for prohibition's popularity. Xenophobia played an important role in America's push toward prohibition. Italian, Irish, and German immigrants were commonly portrayed as alcoholics, so some politicians and voters supported prohibition in an effort to restrict immigration. German-American brewers experienced some of the most substantial anti-immigrant pressure, as they dominated the U.S. brewing industry and had emigrated from what had become America's biggest enemy in World War I (Ogle, 2007). Organizations such as the Anti-Saloon League eagerly generated anti-German propaganda, contributing to the bureaucratic search-and-seizure of German-American brewers (Figure 1). In one of the most notorious cases, agents of the federal government conducted a warrantless body cavity search of then 74-year-old Lilly Anheuser Busch upon her return to American soil in 1918 (Ogle, 2007). A few months later, Congress ratified the 18th Amendment, which set the stage for Prohibition.

Figure 1: Using the anti-German slur "Hun," the Anti-Saloon League often exploited anti-German sentiment to promote prohibition during the 1910s

Source: University of Richmond (2014).

Although the *implicit* goal was to restrict drinking, the 18th Amendment and the corresponding Volstead Act did not *explicitly* mention drinking. Instead, they prohibited businesses from selling, manufacturing, and transporting most alcohol. This legislation created many grey areas. For example, cider and homemade fruit brandies were exempted, while wine was allowed for religious purposes and physicians could (and frequently did) provide prescriptions for alcohol. Not surprisingly, these laws created many unintended consequences: As Prohibition left consumer demand for alcohol unchanged, the supply of beer consequently shifted onto the black market, thereby greatly increasing profits for organized crime. As explained by Raab (2016; p. 36), "Prohibition had been the catalyst for transforming the neighborhood gangs of the 1920s into smoothly run regional and national criminal corporations." Yandle's (1983) bootlegger-and-Baptist narrative was born: Even when the intentions of some lawmakers are pure (the Baptists), business interests have an incentive to subvert the law and use it for their own gain (the bootleggers). Not only did Prohibition contribute to the rise of violent organized crime, it also increased the production of sometimes-deadly homemade alcohol. The number of deaths annually associated with poisonous alcohol rose from 98 at the beginning of Prohibition in 1920 to 4,145 in 1925.

By most accounts, Prohibition was only partially successful in reducing drinking. In the early 1920s, even President Harding hosted booze-filled parties in the White House. Perhaps more troubling for policymakers was the decline in tax revenue, a need exacerbated at the end of the decade with the onset of the Great Depression. The economic collapse of the late 1920s and early 1930s led many policymakers to favor the repeal of Prohibition so the brewing industry could employ workers and the government could collect business, income, and excise taxes.

Modern Regulations

As policymakers began to prepare for the repeal of Prohibition, they set to work crafting the regulations that would guide the alcohol industries. Some of the largest breweries actively advocated for policies that might promote their own standing, sometimes to the detriment of smaller brewers (Stack and Gartland, 2005). After prohibition, many beer laws were delegated to the states, but the federal government made producing beer at home illegal until 1978, when President Jimmy Carter signed H.R. 1337, which allowed state governments to determine the legality of homebrewing. While many states quickly voted to permit homebrewing, a few did not capitalize on this opportunity; Mississippi and Alabama only legalized homebrewing in 2013 (Brewers Association, 2013). Those restrictions constrained growth in the craft beer market for decades (McCullough et al., 2015).

In the decades leading up to prohibition, some brewers had engaged in a series of "price wars," where large breweries would enter a new city and offer their beers at a deeply discounted price in an effort to drive rival breweries out of the market (Ogle, 2007). Worried that these low prices encouraged consumption, federal and state policymakers increased excise taxes on brewery production. Today, federal excise taxes vary from $7.00 per barrel (a barrel is equal to 31 gallons) to $18.00 per barrel depending on the size of the brewery (Alcohol and Tobacco Tax and Trade Bureau, 2017), while state excise taxes range from $0.62 per barrel in Wyoming to $40.00 per barrel in Tennessee (Drenkard, 2016).

Regulators were also concerned about youth consumption of alcohol, and whether the alcohol level in beer was too high. Although it was later overturned by the Supreme Court in 1995, a 1935 federal law prohibited displaying alcohol content on beer labels in hopes of reducing the average alcohol content in beer. While the law was largely unsuccessful in changing consumer behavior, the spirit of the law lives on. To this day, states such as Kansas, Oklahoma, and Minnesota attempt to curb alcohol consumption through alcohol content restrictions, while other state regulatory agencies restrict how brewers can label their beers (Brown, 2016). As established by the passage of the Cullen-Harrison Act in 1933, these content restrictions are calculated as alcohol by weight (ABW), while alcohol content is traditionally defined as alcohol by volume (ABV). Mathematically, 3.2% ABW is equal to 4% ABV. As such, contrary to popular belief, the actual difference in an American-style lager beer (i.e., Bud Light) is very slight across state lines, as it traditionally contains 4.2% ABV.

States also implemented an array of rules regarding the minimum drinking age (Carpenter and Dobkin, 2011). For example, until Craig v. Boren ruled the law unconstitutional in 1976, the drinking age in Oklahoma had been 21 for men and 18 for women. In 1984, the federal government passed the Uniform Drinking Act, which cut transportation funds to states that allowed for under-21 drinking. Groups such as Mothers Against Drunk Driving

continue to lobby for an array of alcohol restriction, including higher excise taxes, random alcohol checkpoints, and reduced blood-alcohol content limits for DUI offenders.

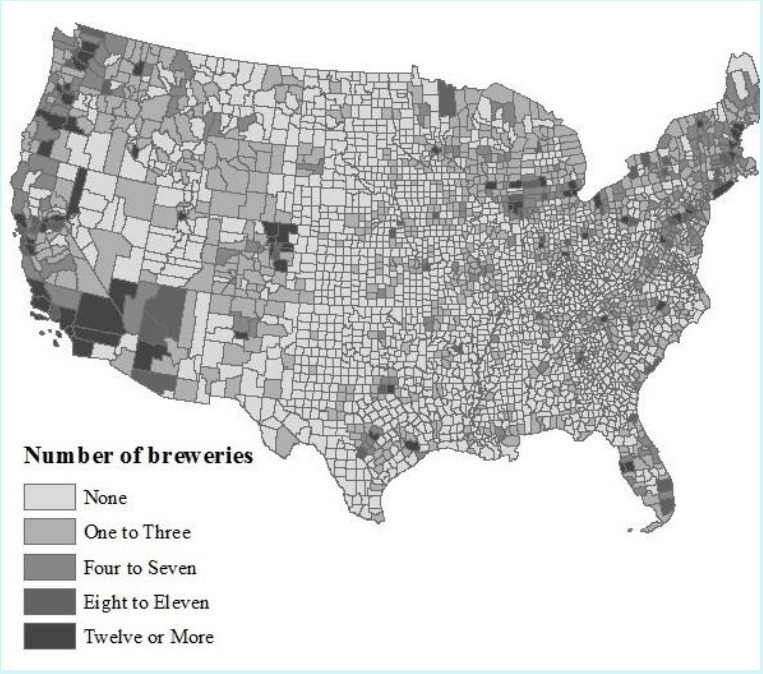
Anti-drinking groups have long complained that brewers market their beers too aggressively. Before Prohibition, nearly all beer was sold on draft in bars and saloons that were controlled by individual breweries, or "tied houses." This relationship contributed to a substantial number of drinking establishments: Manhattan Island was home to more than 9,000 bars and fewer than one million people, for example (Lender and Martin, 1987). To increase beer sales, some bar owners would reportedly resort to tricks as simple as selling (or even giving away) overly salty foods and as sinister as offering low-priced prostitution. In an effort to curb the problems attributed to the tied houses, post-Prohibition policymakers mandated that breweries could only sell alcohol through a wholesaler. For many states, this three-tier system of brewery to wholesaler to retailer remains in effect today (Burgdorf, 2016). However, this regulatory system, which was designed for the 1930s, created significant barriers for the craft beer industry that began to emerge in the 1980s. For example, state three-tier systems did not allow brewpubs, since these would allow breweries to sell their beer directly to consumers, bypassing wholesalers. Early entrepreneurs had to lobby state legislatures for exemptions from or changes to state distribution laws.

Unintended Consequences

Crafting a government policy that successfully reduces overconsumption of alcohol can be difficult, especially because the American beer market has undergone such drastic changes over the past few decades. In 1980, there were fewer than 100 breweries in the United States; today many counties are home to more than a dozen. The United States currently has more than five thousand breweries (Figure 2), with thousands more planned.

While many alcohol regulations may be based on good intentions, they often lead to unintended consequences. For example, dry counties are also home to more meth labs (Fernandez, Gohmann, and Pinkston 2016) and mandating that bars close earlier might actually *increase* traffic accidents (Green, Heywood, and Navarro, 2014). Similarly, banning the sale of alcohol in grocery stores might actually *increase* negative outcomes: According to Rickard, Costanigro, and Garg (2013), legalizing the sale of wine in grocery stores is actually correlated with *decreases* in traffic fatalities.

Figure 2: Map of All Beer-Producing Firms in the Continental United States, July 2015



Source: Malone and Lusk (2016).

Not surprisingly, some policies were passed to protect the profits of existing breweries (Gohmann, 2016). For example, the "Come to Rest" clause embedded in Nebraska Bill LB632 requires all beer to be placed within a wholesaler's warehouse before it goes to retail outlets, forcing small breweries to ship their beer upwards of 200 miles before it can be sold in their own taproom (Pluhacek, 2017). The outcome of bills such as these is obvious: States that do not allow breweries to distribute their own beer have fewer craft breweries (Malone and Lusk, 2016). Conversely, when states choose to legalize self-distribution, they experience a significant increase in the number of breweries. Loosening distribution laws can also promote tourism and service revenues within a county. For example, when legislators in West Virginia allowed on-premises sales, counties with breweries experienced an increase in tourism-related wages (Malone and Hall, 2017).

Of course, not all proposed beer laws are so blatantly crony capitalist in nature. But even the most well-intentioned restrictions can have negative consequences. As noted, one objective of alcohol taxes is to reduce the quantity of beer consumed by raising prices (Cook and Durrance, 2013). Unfortunately, because beer demand is relatively inelastic and does not respond significantly to small price changes, modest tax increases are unlikely to substantially reduce consumption. Furthermore, taxes specifically on beer typically encourage consumers to purchase beverages with a higher alcohol content (Malone and Lusk, 2017). Finally, beer taxes can also influence the number of breweries that might open in a given state: Elzinga, Tremblay, and Tremblay (2015) find that increases in state excise taxes tend to decrease the number of breweries.

In Summary

A couple of common themes emerge when considering beer laws as they relate to economic growth. First, the history of beer regulation runs parallel to a history of unintended consequences, making it near impossible to find a clear answer to the title question. Restricting the sale of alcohol is likely to reduce tax revenue, which has historically played a key role in government funding. As was the case during Prohibition, American beer policymakers often overlook the economic consequences of their newly formed regulations. When considering the entrepreneurial nature of craft breweries, restrictions on self-distribution seem especially onerous and counterproductive. A second theme emerges if one considers the structure of many beer laws: While the stated purpose of these laws is often to promote consumer health, many alcohol laws are targeted at the supply side rather than the demand side. As is the case for self-distribution laws, Prohibition sought to reduce the supply of alcohol but did little to target consumer demand.

Thankfully, it appears that modern government policies have started taking note of these unintended consequences. From 1997 to 2012, the number of federal restrictions within the beer value chain decreased slightly (Malone and Chambers, 2017). More recently, the Craft Beverage Modernization & Tax Reform Act has generated further discussions of reductions in excise tax rates and further reductions in regulatory burdens for breweries. Although some local governments remain hesitant to embrace craft brewing, many states have become much more welcoming to brewing, particularly as they see the potential gains in tourism and entrepreneurship. As such, future policy discussions would benefit by more thoroughly considering both the benefits *and* the costs associated with beer regulation.

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Can Beer Consumption be Part of a Healthy Diet?

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Owing largely to the "French Paradox," wine—particularly red wine—was long considered the alcoholic beverage most likely to impart significant health benefits. This idea has permeated academic research, food and beverage marketing, and the popular press. Our purpose is not to dispel the notion that moderate wine consumption has health benefits but rather to discuss the growing literature on the health benefits of beer, which is comparable to wine in many respects, but not popularly viewed as a healthy choice.

This article synthesizes and discusses the research that may inform updated and more nuanced recommendations on beer consumption and health on the part of the federal government. There is also the potential to inform policy on alcohol sales, taxation, and consumption. For example, federal, state, and local governments have laws and regulations in place regarding the allowable alcohol-by-volume (ABV), distribution limits, techniques for manufacturing alcohol, and allowable container types. Most of these laws are intended to curb unhealthy and binge drinking, but they are debatably effective. There is certainly precedent for government regulation with respect to beer consumption by type and likely room for the laws to be improved and refined and educational efforts to be put in place.

Before we dive into the potential benefits of moderate beer consumption, we must emphasize that this discussion centers on *moderate* consumption. There is no question that alcohol is an addiction for some individuals and alcoholism is very costly, both for society and for the individual. A wealth of literature examines the underpinnings of addiction (see Gilpin and Koob, 2008, for a discussion of the neurobiology of dependence) and some individuals may be better off not drinking at all. Furthermore, we stress that the inclusion of moderate alcohol in a healthy diet is not a substitute for foods such as fruits and vegetables.

Alcohol and Health Impacts

Researchers in nutrition, epidemiology, and the social sciences have been studying the health impacts of alcohol consumption for decades. Empirical research across disciplines find the relationship between alcohol consumption and health to be "U-shaped" or "J-shaped." For example, Marmot et al. (1981) was one of the earliest studies to illustrate this phenomenon explicitly, studying the alcohol intake and mortality of 1,422 men over 10 years. The authors found that moderate drinking (less than 34 grams of alcohol per day, the equivalent of 2.4 alcoholic drinks, defined in detail below), was associated with a decreased risk of mortality relative to both heavy drinking and not drinking at all. Since that time, studies have shown moderate alcohol intake to have protective effects with respect to cardiovascular disease (Marmot and Brunner, 1991), stroke (Berger et al., 1999), type-2 diabetes (Baliunas et al., 2009), cancer (Tsugane et al., 1999), and other ailments.

Originally, much of the discussion regarding the purported health benefits of alcohol consumption revolved around the so-called "French Paradox." Among developed countries, the French have low rates of chronic heart disease relative to their per capita consumption of saturated fats. In an influential study, Renaud and de Lorgeril (1992) argued that moderate alcohol consumption reduces blood platelet aggregation, thereby reducing the risk of heart disease and helping resolve the "paradox." A wealth of studies and literature reviews since that time (Bertelli and

Das, 2009) has discussed the protective effects of resveratrol, an antioxidant found in wine grapes. It is due to this research, in part, that wine is often noted to be the most healthful alcoholic beverage, when consumed in moderation (Gronbaek et al., 1995).

However, the research on alcohol and health continues to evolve and evidence is mounting that beer has its own health-protective attributes and effects. Notably, beer contains xanthohumol, a flavonoid found in hops, one the key ingredients in the beer-brewing process. Xanthohumol has been shown to inhibit cancer growth at the cellular level (Vanhoecke et al., 2005) and to impart health impacts through the mechanism of beer drinking (Magalhaes et al., 2009). Beer also contains a number of nutrients not found in wine or spirits, including fiber, minerals, and B vitamins (Denke, 2000; Bamforth, 2002).

Beer Consumption Impacts on Health

Keil et al. (1997) and Brenner et al. (2001) both demonstrated the familiar health impacts of moderate alcohol consumption on predominantly beer-drinking populations. The former study identified a U-shaped curve between alcohol consumption, mostly beer, and both coronary heart disease and mortality. The lowest health risks were associated with men drinking between 20 and 39.9 grams of alcohol per day (approximately 1.43 to 2.85 drink equivalents). The latter study found a significant inverse relationship between alcohol drinking, again mostly beer, and coronary heart disease among adult German men. Burger and Mensink (2004) also studied the German population using the National Health Interview and Examination Survey, which combines dietary recall data with health outcomes. The authors calculated total upper alcohol limits, or daily consumption levels up to which no significant harmful health affects occur with drinking, of 20–24 grams/day for men (1.43–1.71 equivalent drinks) and 10–12 grams/day for women (0.71–0.86 equivalent drinks).

Many additional health benefits specific to beer have been identified using longitudinal data. Wannamethee et al. (2004) found a strong inverse relationship between alcohol consumption and weight gain among women over an eight-year period, with the effects of beer drinking comparable in magnitude to those of wine drinking. Thadhani et al. (2002) identified a reduced risk of hypertension associated with light beer drinking among younger women. The authors noted that both wine and beer demonstrate significant health impacts, though the wine effect seems to be larger in magnitude across studies. Wannamethee et al. (2003) demonstrated an inverse relationship between alcohol consumption and type-2 diabetes among women drinking wine and beer but not spirits. The extracts from hops and yeast, when drunk via beer, have been shown to impart skin health and even hasten the healing process of wounds in laboratory experiments (Chen et al., 2014). In yet another example, Pedrera-Zamorano et al. (2009) demonstrated the potential of beer drinking to increase bone mass in adult women.

A number of studies have compared the health effects of beer to other alcohol types directly. One of the earliest studies to do so was Hennekens et al. (1979), who found that moderate beer drinking reduced the risk of coronary heart disease even more than drinking wine or liquor. However, for all types of alcohol, consumption above 59.2 ml per day was associated with increased risks. In a large-scale meta-analysis, Di Castelnuovo et al. (2002) analyzed the impacts of beer and wine drinking on cardiovascular health risks. More recently, Volpe et al. (2016) used household scanner data and self-reported health outcomes to demonstrate that beer consumption has comparable protective effects to wine with respect to coronary heart disease and type-2 diabetes.

The potential associations between alcohol consumption and dementia and cognitive decline have also been examined extensively. Peters et al. (2008) reviewed 23 studies on the topic and concluded that light to moderate alcohol drinking likely has protective effects against dementia late in life. Beer is unique among alcoholic beverages in that it contains silicon. Gonzalez-Munoz et al. (2008) note that beer may have additional benefits for preventing Alzheimer's Disease, as silicon has been shown to prevent the absorption of aluminum, one of the likely contributing factors to the ailment.

The U.S. Dietary Guidelines: Total Consumption and the Frequency of Drinking

The *Dietary Guidelines for Americans*, issued jointly by U.S. Department of Agriculture and Department of Health and Human Services, are intended to summarize the extant research on nutrition and biology in order to inform Americans about healthy eating habits. The 2015–2020 edition of the *Dietary Guidelines* addresses alcohol as follows:

> Regarding alcohol, the Committee confirmed several conclusions of the 2010 DGAC, including that moderate alcohol intake can be a component of a healthy dietary pattern, and that if alcohol is consumed, it should be consumed in moderation and only by adults.

A major change in the *Dietary Guidelines* from the last edition is how much alcohol is contained in a "standard" drink. Various trade associations voiced concern that the previous definition of a standard alcoholic drink was too vague and that consumers could potentially assume a martini and a pint of beer to have the same alcoholic content. Table A9–1 of the 2015 *Dietary Guidelines* shows the basic calculation for determining the number of standard drinks in an alcoholic beverage:

> One alcoholic drink is defined as containing 14 grams (0.6 fl oz) of pure alcohol… To calculate drink-equivalents, multiply the volume in ounces by the alcohol content in percent and divide by 0.6 ounces of alcohol per drink-equivalent. For example: 16 fl oz beer at 5% alcohol: (16 fl oz)(0.05)/0.6 fl oz = 1.3 drink-equivalents.

The *Dietary Guidelines*, however, do not address any of the health effect differences across types of alcoholic beverages. Moreover, research suggests that the health effects of moderate alcohol consumption may depend on factors such as age or gender, neither of which are addressed in the *Dietary Guidelines* comments on alcohol. Furthermore, without a clear discussion of healthful and unhealthful consumption, there is the potential for individuals to misinterpret the current body of research.

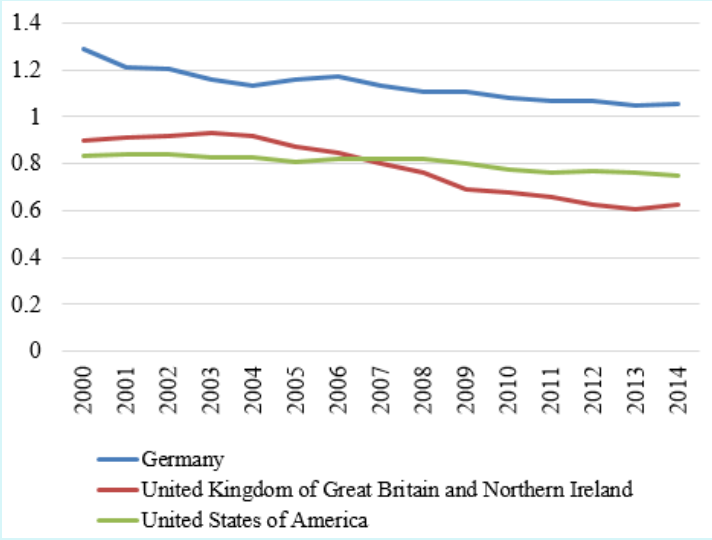
Despite the extensive body of evidence supporting moderate beer drinking as a component of a healthy diet and lifestyle, there are risks associated with alcohol consumption. Such risks should also be taken into account in dietary recommendations and regulations. Most, though not all, studies identifying inverse relationships between alcohol consumption and risk factors for ailments have found that high or excessive alcohol consumption is harmful to health and longevity. This is consistent with the familiar U-shaped curve. Corroborating the health and societal risks of excessive drinking, the Centers for Disease Control estimates that the annual cost of alcohol abuse is about $223 billion. This includes medical and legal costs, among other damages, 75% of which can be attributed to binge drinking.

We argue that perhaps the most important cautionary guideline regarding beer consumption and health is to avoid binge drinking. The National Institute on Alcohol Abuse and Alcoholism defines binge drinking as that which raises the blood alcohol content above 0.08. This typically translates into five drinks within two hours for men, four for women. They further summarize national health surveys indicating that 70% of binge drinking episodes involve adults 26 years and older, even though 90% of alcohol consumed by youth under the age of 21 is in the form of binge drinking. Furthermore, binge drinkers are 14 times more likely to report alcohol-impaired driving than non-binge drinkers, binge drinking is more prevalent among men than women, and more than half of alcohol consumed in the United States is in the form of binge drinking.

According to the World Health Organization (WHO) (2014) on per capita annual alcohol consumption for individuals 15 and older, each individual in the United States consumed 4.16 liters of pure alcohol in beer in 2010. Using the *Dietary Guidelines*' conversion to standard drinks, this equates to 0.64 drinks per day. Some studies have suggested that moderate alcohol consumption may include at least one day a week of non-drinking (Anderson, 1996). If we then average the quantity of alcohol consumed over a six-day drinking week, the average number of beers consumed by all Americans per day is 0.75.

We know, however, that not all of the population over the age of 15 drinks. According to the 2015 National Survey on Drug Use and Health (SAMHSA, 2015), 70.1% of people ages 18 or older reported drinking in the past year. Adjusting the WHO alcohol consumption statistics to this drinking population, average annual beer consumption becomes roughly 1.07 drinks per day for a six-day drinking week, well below the definition of moderate alcohol consumption. Figure 1 compares the number of alcoholic drink equivalents in the United States to the United Kingdom and Germany (comparable drinking countries where binge drinking is considered a serious social problem) for a six-day drinking week. Note that per capita beer consumption has been decreasing in each country and, in all cases, falls below moderate consumption levels.

Figure 1: Annual Per Capita Daily Standard Alcoholic Drink Equivalents of Beer



Source: World Health Organization (WHO, 2017).

Given the average amount of beer consumed in the United States and the prevalence of binge drinking, we can conclude that the major issue of unhealthy consumption is not related to total quantity of alcohol consumed but the timing of consumption. It stands to reason then that efforts toward education should emphasize what healthy consumption is and is not and the benefits of beer as a component of a healthy diet and lifestyle. Current guidelines and educational efforts could therefore be improved to highlight the benefits of beer, relative to spirits or malt beverages for example, and to further caution against the practice of binge drinking.

Healthful Consumption

So, what is healthy consumption of beer? Given all that we have observed from previous studies, unhealthy consumption is clear. However, it appears that there exists a need to educate Americans on how beer can be incorporated into a healthy diet. Adjusting the culture of beer consumption away from binge drinking could drastically reduce the economic burden of unhealthy consumption. Private efforts are being made to try to do this, but these may be misleading without a clear discussion of the healthy components of beer, via the *Dietary Guidelines*.

An example is the proposal for nutrition labeling of major beer brands. Anheuser-Busch InBev, Molson Coors, Constellation Brands, and Heineken have all agreed to provide nutrition facts on labels by 2020. These will include serving size, servings per container, calories, carbohydrates, protein, and fat content. Nutrition fact labels will not, however, educate consumers on how different beers have different ingredients that may contain more beneficial vitamins and minerals then others. For instance, niacin (vitamin B3) has been shown to significantly increase HDL cholesterol and reduce LDL cholesterol. Depending on the major ingredients of the beer—rice or malted barley or residual brewer's yeast after filtration—the amount of beneficial niacin can drastically differ. Just as the *Dietary Guidelines* discuss the different components of beneficial ingredients contained in foods such as animal protein and their relationship to a healthy diet in moderation, there is a possibility to do so with beer and all alcoholic beverages.

Moreover, we argue that some current state and local alcohol policy (such as restrictions to access) may incentivize unhealthy drinking behavior. As an extreme example, take early 20th century common law in Australia and New Zealand, which required pubs to close at 6pm. This requirement led to what became known as the "Six O'clock Swill," a period of excessive binge drinking between the end of the workday and closing time. Across the United States today, various laws prohibit the sale of alcohol on certain days of the week. Research has suggested that these laws do not affect total alcohol consumption as much as the timing of consumption. For example,

Carpenter and Eisenberg (2009) showed that repealing a Sunday alcohol sales ban in Canada resulted in consumers shifting some of their Saturday consumption to Sundays. The ban may actually have promoted binge drinking among certain consumers. Understanding that total beer consumption on average is below what is considered a moderate amount and that there are significant health benefits to moderate consumption should help better inform policy and avoid restrictive policy with unintended consequences.

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