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The Italian beer market and estimation of a hedonic regression model for Italian craft beer price

Supervisor
Luigi Benfratello

Candidate
Valentina De Palma

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ABSTRACT

The aim of this thesis is to examine the Italian beer market, with an emphasis on the craft beer movement, and to evaluate the determinants of the Italian craft beer price, which has not been so far the object of any empirical analyses, through a hedonic regression model.

Before analyzing the Italian market in detail, an overview of the global market is provided, with insights for each continent and their major brewing countries.

The analysis of the Italian beer market begins with a description of the Italian legislation and continues with a snapshot view of the sector: production and consumption, imports and exports, main competitors, distribution channels and suppliers are discussed in detail.

The estimation of the hedonic regression model for Italian craft beer prices is carried out thanks to data provided by several sources: *Guida alle birre d'Italia 2020*, which is the most important publication in Italy for craft beer enthusiasts; websites and online shops of craft breweries; the internationally-known beer community websites *Untappd* and *RateBeer*; other websites addicted to Italian craft beer (www.microbirrifici.org and www.fermentobirra.com). These data, about sensory, chemical and objective characteristics of the beer, placements of the beers in national and international contests, objective characteristics of the breweries and consumer ratings of both beers and breweries, are processed using the STATA software. The empirical analysis proposes regression models for both beer ratings and prices, in order to address the endogeneity problem associated with the impact of consumer ratings on beer prices.

The main result suggests that Italian craft beer prices are not influenced by beer consumer ratings, while there is a reputation effect of the brewery: breweries awarded as "Le Chiocciole" on *Guida alle Birre d'Italia 2021* tend to raise their prices. In addition, beers awarded as "slow" or "imperdibili" on the guide have a positive impact on the beer rating. As far as the chemical characteristics of the beer are concerned, ABV is one of the main determinants of the beer price, while bitterness and calories are positively related to the consumer rating.

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1 INTRODUCTION

Beer is one of the oldest drinks in the world, and the brewing process has not changed so much over the centuries. However, important technical improvements have allowed to produce beer in a more sophisticated and efficient way.

In addition, beer is also one of the most widely consumed beverages. In some places, such as parts of Germany, it is the drink of choice for accompanying food. [1]

Beer has four main ingredients: water, malt, hops, and yeast. It is derived from a source of starch through a complex series of interacting steps, each of which influences the character of the final product.

The word beer comes into present-day English from Old English *bēor*, itself from Common Germanic. There are different theories about the earlier etymology of the word. Some experts think that the word for beer comes from the Proto-Germanic word *beuwoz*, derived from *beuwo* – meaning "barley". According to others, beer comes from the Latin infinitive *bibere* meaning "to drink." [2]

1.1 The History of Beer

The first evidence of grain-based fermented beverages mainly originates from the regions where grain cultivation first flourished – the Fertile Crescent (the current Israel, Jordan, Syria, Turkey and Iraq territories), Mesopotamia and Egypt. However, the oldest evidence for such drinks comes from China. In the 1980s, archaeologists working in north-central China at Jiahu, the site of a Neolithic village occupied between 9,000 and 7,600 years ago, found evidence of a remarkably sophisticated society. From the very beginning, the Jiahu people had used pottery containers and, in some of the very oldest ones, chemical analyses revealed the presence of a mixed fermented beverage of rice, honey and fruit. [3] [4]

In the west, the beer brewing process has begun in Mesopotamia. Sumerians, who lived in the land between the Euphrates and Tigris rivers, considered beer a very important part of their diet, indeed even as an essential part of the civilization process. In fact, in the *Epic of Gilgamesh*, the poem on a Sumerian king who reigned around 4,700 years ago, a wild man called Enkidu is 'civilized' by a woman teaching him to eat bread and to drink beer.

The Sumerian Empire, like the Babylonian one that followed it, was built on grain, and on the beer and bread made from it thanks to the productivity of the vast and fertile cereal-growing land between the two rivers. [3] [4]
The earliest chemical traces of barley beer, dated between 3,500 and 3,100 BCE, were discovered in the form of calcium oxalate, a deposit from grain also known as "beer stone", in a pottery jar from the Sumerian Godin Tepe settlement, in northern modern-day Iran. [5]
An inscription, become known as the *Hymn to Ninkasi* is both a song of praise to the Sumerian goddess of beer, Ninkasi, and a recipe for beer, first written down around 1800 BCE [5]. According to this recipe, the basic ingredients of the beer were "*bappir* (a barley bread, presumably as a vehicle for getting yeast into the beer), *munu* (a hulled cereal that is malted during the brewing process) and *titab* (probably a mash prepared from malted grain that is dried after cooking) [3]".
Beer was also an important means of distributing wealth in Mesopotamian society. Taxes were often paid in the form of grain offered to the temple. Priestesses of Ninkasi and other deities would then turn this grain into beer (and bread) and distribute it to the population as payment for services rendered. Cuneiform tablets indicate that laborers would be given one sila (corresponding to more or less one liter) of beer per day, while low-level functionaries would receive two, and so on up to the highest officials, who would get five sila. [4]

Under Babylonian rule, Mesopotamian beer production increased dramatically, became more commercialized, and laws were instituted. The Babylonian king, Hammurabi, in the second millennium BCE, published a legal code just about everything, including beer, which he categorized into 20 different varieties, 8 of which had to be made entirely from barley, while others could be made from a mixture of grains. [6] His laws regulated the conduct of his citizens, including their drinking habits. One of them was a sort of consumer protection, specifying that tavern-keepers (feminine) who shortchanged their clients should be drowned. But another is more darkly political, threatening those same tavern-keepers with death if they failed to report conspiracies to the court. [4]

As Sumerians and Babylonians, the ancient Egyptians were enthusiastic about barley-based beers and brewed a generally more sophisticated version. The most popular beer in Egypt was Heqet (or Hecht). This was a honey-flavored brew and their general word for beer was *zytum*. [5] The Egyptian goddess of beer was Tenenit, although the beverage was commonly associated with a more senior goddess, Hathor, at whose temple in Dendera an inscription from around 2,200 BCE reads, "The mouth of a perfectly contented man is filled with beer." The Egyptians believed that brewing had been taught to human beings by the great god Osiris himself. But chances are that, very early in their history, the Egyptians actually adopted the brewing habit of the Sumerians. [4]

As it was for the Sumerians, beer was often used throughout Egypt as compensation for labor. The workers at the Pyramids of Giza received beer rations three times a day to a total of about four liters. [4]
Beer was drunk so regularly among the Egyptians that Queen Cleopatra VII lost popularity toward the end of her reign more for introducing the first-ever beer tax than for her wars with Rome which the tax on beer went to help pay for (although she claimed the tax was to discourage public drunkenness). [5]

Beer brewing techniques made its way from Egypt to Greece but did not find the same enthusiasm there. The Greeks favored strong wine over beer (called *zythos*, from the Egyptian *zytum*), as did the Romans after them, and both cultures considered beer a low-class barbaric drink. As example, in a poem of Emperor Julian it is claimed that the scent of wine was of nectar while the smell of beer was that of a goat. [5]
Nevertheless, beer, called *cerevisiae,* was one of the most common drinks on the outskirts of the Roman empire, where the necessity to accommodate legions in regions without viniculture with suitable drinks required the provision of beer. [3]

During the Dark Ages, as the Romans had regarded wine as the gift of the gods, and beer as something infinitely inferior, the emerging Christian church highly valued wine for its sacramental importance, while having a rather negative view of beer. There was a widespread perception among Christians that beer was the drink of pagans. Nevertheless, the church authorities opted to accommodate the tasting preferences of the people they wanted to convert. [4] From the 9th century, the spread of the Holy Roman Empire encouraged the construction of monasteries throughout Europe. While monasteries located in southern Europe continued to grow grapes and produce wine, many monasteries located in northern Europe became brewing centers. The cold climate facilitated the cultivation of barley rather than grapes and led to the emergence advent of the monastic brewing which spread to the British Isles, Germany and Scandinavia. Originally, monks brewed beer mainly for their own consumption or to refresh guests and pilgrims. Later, however, between the twelfth and thirteenth centuries, monks started to sell their beers in so-called ‘monastery pubs’, becoming a useful source of revenue. [7]
Around 1000 CE, the introduction of *Humulus Lupulus* to the brewing process by German monks represents an important innovation of monastic brewing. Hops are not only a powerful flavoring agent, providing a refreshing bitterness to counterbalance the rather sweet flavor of the malt, but also a natural preservative that prolongs the life of beer. Without hops, beer had to be drunk when it was fresh, i.e. locally. Only strong beers with lots of alcohol, which is itself a preservative, could be shipped any distance at all. But with hops, any beer could be transported farther than before, allowing the development of a relatively long-distance trade. [4]
All the early monastery beers fell under the very general category of ales, i.e. beers fermented at room temperature, mainly using the yeast *Saccharomyces cerevisiae*, the

same species used in baking bread and fermenting wine, but occasionally adopting wild yeasts. During fermentation, the yeast rises to the top of the liquid, forming a dense froth. The longest continuously operating brewery in the world was born as a monastic enterprise. The Bavarian Weihenstephan brewery in Freising, currently state-owned, started brewing beer the auspices of the Benedictine Weihenstephan Abbey. [4]

In the early fifteenth century, brew masters in and around Einbeck in Lower Saxony began producing beers in a radically new style. Bavarian brewers were already in the habit of storing and aging their ales in limestone caves, where cool conditions inhibited the growth of undesirable bacteria. But the beer from Einbeck, after spending the winter gently maturing in the cool caves, became clear and bright, with a crisp finish and not cloudy as ales of the time. In German, this process of cold storage is known as *lagering*, and nobody at the time had the slightest idea why this phenomenon occurred. Only in the nineteenth century, when Pasteur discovered that fermentation was accomplished by the tiny living organisms we know today as yeasts, it was realized that the brewers of what had become known as lager were making their beer with a particular type of yeast. Unlike the traditional *Saccharomyces cerevisiae* fermenting at 16-24˚C [8], this type of yeast used for lagers, known as *Saccharomyces pastorianus*, flourished at much lower temperatures of around 6-12˚C [8] and descended to the bottom of the fermenting tank, bringing with it other detritus with it and leaving the overlying liquid clean and bright.

In 1516 CE, in Germany, the beer purity law, known as *Reinheitsgebot* (deeply discussed in 3.3.1), was instituted. It regulated the ingredients which could legally be used in brewing beer: water, barley, and hops. Yeast was added centuries later, after Pasteur's discoveries, being unknow in those days. The decree also established how beer could be sold, and at what price. This might appear as a consumer protection law, but barley was specified as the only cereal for beer largely because wheat shortages often placed bread in short supply. [4]

In the Bohemian town of Plzeň (Pilsen in German), in the western part of today's Czech Republic, by the early nineteenth century brewing declined so much that, in 1838, rioting residents dumped several dozen barrels of low-quality, dark and top-fermented local beer on the steps of its town hall. At that point, the burghers of Plzeň invested in a new, state-of-the art brewery, the Měšťanský pivovar (Burghers' Brewery), and hired Josef Groll, a Bavarian brewer, to produce a bottom-fermented beer. He had traveled to England and knew the secrets of brewing a light ale using a coke-fired pale malt. So, Groll invested in a British kiln and put the resulting malt through a fermentation in the Bavarian lager style. Made from local soft water and Saaz hops, Groll's "Pilsener" was characterized by golden color and clarity, setting a standard for pale lager. The brewery has changed name many times, until it was called Pilsner Urquell Brewery, as it is known today. There are now "pilsners" made all over the world, in a variety of styles, but enthusiasts argue that only in Pilsen do all the ingredients come together to such perfection. [4]

While in Germany ales were gradually abandoning in favor of lagers, ales continued to flourish in Belgium. As in Germany, Belgian beer-making was originally the province of monastic brewers. Due to regular political upheavals from the sixteenth to the eighteenth century, many of the old foundations eventually disappeared. So, today's Belgian abbey beers are largely brewed either in monasteries that have been re-founded or are simply beers made "in the style" of Belgian abbey beers. One special category of monastic ales inludes those with the Trappist designation, i.e. they are brewed in one of six monasteries belonging to the Trappist Order originated in France in the seventeenth century. For being a small country, Belgium produces an incredible variety of beers and styles, in particular an endless array of ales, even if more lager than ale is nowadays both produced and consumed in the country. [4]

Britain has a long tradition of making top-fermented beers. Chemical traces dated 3,200 - 2,500 BCE have been found in Skara Brae, a Neolithic site in the remote and windswept Orkney Islands north of Scotland. Instead, the habit of brewing and drinking lager did not significantly penetrate the United Kingdom until the later twentieth century. By the fourteenth century, brewers were forming guilds, and though they mainly produced for their own establishments, they also supplied others. For this reason, an early form of consumer protection became necessary, in the form of "ale conners" employed by municipalities to assess the strength of the product sold and to set a fair price for tax purposes. Sometimes it was necessary to force individuals to take on this job, maybe because the beers the conners had to taste were not always of good quality. Spoilage was a particular issue in medieval Britain since preservative hops became a regular component of British beers only in the sixteenth century. By the turn of the eighteenth century, the larger British brewers were producing a new style of ale, known as porter, which was highly hopped and made from darkly roasted malts. With a typically high ABV of 6 percent or more and made with the aid of early scientific instrumentation such as thermometers and hydrometers, this was the first beer that could be produced and distributed as an industrial product. The economies of scale enjoyed by the large brewers who manufactured it soon made it impractical for individual hostelries to brew their own beer. [4]. Barley roasting kilns were traditionally fueled by wood or coal, producing a rather dense, smoky malt. For this reason, porters were heavy, dark brews. But rapid technological advances in the early eighteenth century made clean-burning coke much cheaper and more widely available. This development paved the way for the large-scale production of the lighter-colored malts that were the basis for a rapidly expanding new category of pale ales. A highly significant variation in the pale ale trend was the India pale ale (IPA) that was produced specifically for the rising British Empire. India's hot climate made local brewing impractical. The market India offered was potentially hugely lucrative but transporting British ales there involved a very long journey that rarely allowed traditional beers to survive in ideal conditions. The solution to this problem was to increase the alcohol slightly, and the hopping greatly. In this way, the ale arrived in India

not only bright, fruity, and refreshing, but often slightly sparkling, due most likely to a secondary fermentation occurring in the barrels through the activity of *Brettanomyces* yeasts. Copious quantities of IPA were exported to India, and to Australia beyond. [4]

In Ireland, when Arthur Guinness started his brewery in Dublin in 1759, the state of Irish beer was rather dire. Guinness's response was to up the game, and by the end of the century he was concentrating on the production of an excellent porter that soon conquered the market. Twenty years later his successors were brewing a very dark "superior porter" that evolved into the "extra stout" version that became internationally famous, with its almost black color and slightly burned flavor. Guinness was helped to dominate the dark ale market when, during World War I, the British authorities banned the heavy roasting of malts as an energy-saving measure. This decision led to the collapse in the production of porters and stouts in England, leaving the field open to the Irish. In addition, a taxation system based on ABV caused the weaker and significantly cheaper ales, marketed as milds and bitters, prevailed in the British market through the later nineteenth century, and well into the twentieth. [4]

Brewing in America dates to the first communities established by English and Dutch settlers in the early to mid-seventeenth century. The signing of the Declaration of Independence is described to have been celebrated with copious quantities of beer, in the very Philadelphia tavern in which Thomas Jefferson had drafted the document. [4] All this beer was ale, of course; but in the middle of the nineteenth century a significant number of German lager brewers arrived, and American tastes began to change. The Germans discovered ideal brewing conditions in the northern Midwest, including abundant ice from the Great Lakes that facilitated the lagering process. [4]

In the nineteenth century, technological discoveries and improvements, such as the introduction of refrigeration and the development of pasteurization techniques, radically changed beer brewing. By controlling the brewing process, the environment and type of fermentation, and the type of yeast culture, brewers were able to obtain a 'standardized' product, something that was not possible in the past. In addition, the expansion of the steam engine and the invention of the 'chilled iron mold' enhanced opportunities for mass production and consumption as well as large scale packaging and distribution, leading to the industrialization of brewing as a production process. In addition, the expansion of infrastructure and railway networks accelerated the spread of the beer. [7]

First and Second World Wars had a huge impact on beer production and consumption. They generated supply shortages for brewers who had to deal with rising prices of grain and a general scarcity of raw materials. Many central governments enacted laws to limit the distribution and consumption of alcoholic beverages, which encouraged brewers to turn to alternative products, such as soft drinks. Particularly in the United States, the rise of the 'Temperance Movement', a social movement promoting temperance or complete

abstinence from consumption of alcoholic beverages, and the advent of Prohibition at the beginning of 1920s wiped out the entire brewing industry in the country, with surviving breweries turning to producing mostly alcohol-free beverages. [7] When the ban was finally lifted in 1933, demand exceeded reasonable supply and a lot of inferior product came onto the market. Consumption consequently dropped, and many brewers went under or merged, resulting in an industry increasingly dominated by brewing giants (a trend that inexorably continues today). [4]

By the middle of the twentieth century, the legacy of Prohibition was the dominance of industrial beers. That could not fail to provoke a reaction, which duly came in the form of the craft beer movement that began to emerge in the 1970s. [4] Until the late 1990s, America was the world's largest producer of beer. But in the early 2000s it was overtaken by China that is currently the world’s largest commercial beer market. The making of beer in China in the modern age dates only from 1903, when Germans opened a brewery in Qingdao (Tsing Tao); and brewing there continues to be performed overwhelmingly in the German lager style. [4]

2 BREWING PROCESS AND BEER CHARACTERISTICS

2.1 Malting and Brewing Process

The production process that transforms water, malt, yeast and hops (whose role will be deeply discussed in Paragraph 2.3) into beer has not substantially changed over the centuries but has been refined thanks to scientific discoveries and technological innovations. Since medieval times, malting has been a separate craft from brewing, and malt is produced in specialized facilities. In the following, each step of the beer production will be described in detail, from the malting process to the packaging phase.

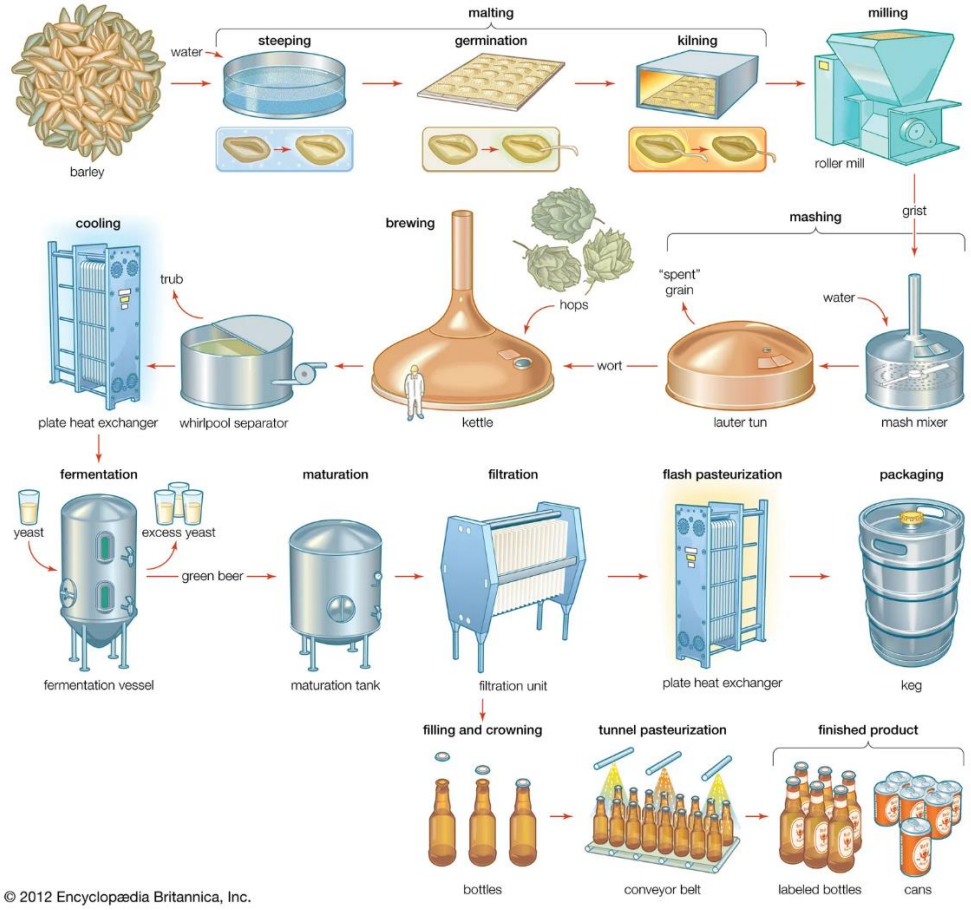

Figure 2-1. Malting and brewing process [9]

2.1.1 Malting

Malt is the product obtained by malting fresh barley (or other cereals) in order to activate enzymes which are contained within barley seeds. Those enzymes transform the starch in fermentable sugars.

Before describing how malting works, it is important to understand how the barley seed is.

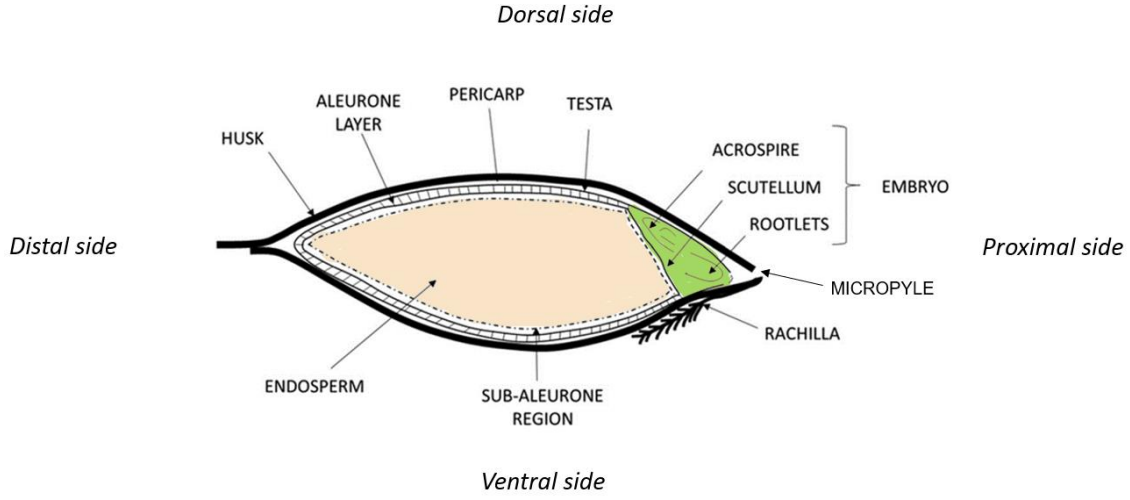

Figure 2-2. Representation of a barley seed

The seed or kernel has three main parts: the germ or embryo, the endosperm, and the seed coat, which includes the hulls, also called husks.

- The germ region, containing the *embryo*, will develop into the barley plant. During the malting process, the embryo starts to germinate and produce rootlets and a shoot (acrospire). The rootlets emerge through the micropyle and become the first obvious manifestation of germination. The acrospire, of course, heads in the opposite direction of the roots and grows beneath the hull, eventually to appear out of the distal tip.
- The *endosperm* consists of dead cells filled with starch granules, each surrounded by a protein-rich matrix. The granules are semicrystalline (partly crystal, partly glassy). They serve as an energy stock for the embryo, providing a source of sugar until the seedling can grow leaves and begin photosynthesis. But during the malting process, care is taken to limit consumption of the starch by the embryo. The outer covering of endosperm separates the embryo by a proteinous layer called aleurone layer.
- The barley *hull* usually consists mainly of cellulose, hemicelluloses (xylans), lignin and a smaller quantity of protein. It includes the pericarp (outer layer) and the seed coat (inner layer - primarily testa). The pericarp is a tough skin that protects the inner seed from soil organisms that may attack it. The inner seed coat controls the intake of water by the seed.

The malting process implies different steps.

1) **Harvesting**. Grain is harvested and dried at 11-12% moisture.
2) **Grain sorting and storage**. Before storage, the barley is cleaned in a series of sieves to remove stones, dust, and undersized seeds.
3) **Steeping**. The purpose of this stage is to increase the moisture content of the grain from 11-12% to about 43-46%, in order to activate enzymes and initiate germination. The grain is added to a tank of water. It is soaked for several hours, an operation called steeping, at a controlled temperature (14-18°C). Then the water is drained, and the barley is allowed to rest in air (often in flowing air). The embryo is activated at a moisture content of around 30-35%. Steeps can be repeated two or three times over a period of two days, according to the characteristics of the grain and the type of malt being produced. Each steep lasts approximately 4 hours, and each air rest is approximately 20 hours. By the end of steeping, most of the seeds will show a white spot at the base, called a *chit*, where the root sheath breaks through the husk.
4) **Germination**. The steeped grain is transferred into a separate vessel for germination. Here cooled, humidified air is blown through the grain bed to maintain the moisture level close to that reached in steeping. Germination is typically conducted at 16–20°C for a period of 4-6 days depending on the product type being made. In all germination systems, the malt must be turned regularly to allow oxygen to reach the seeds and to allow carbon dioxide and heat to escape. Modern methods adopt as container a Saladin box, which provides automated mechanical turning. During germination, the grain is allowed to develop a root and the acrospire grows without actually sprouting. This process requires the breakdown of starch and consumption of sugar for energy.
   For this purpose, two major changes occur: 1) enzymes that break down the endosperms cell walls to gain access to the starch are developed. To grow a new plant, the embryo needs energy provided by respiration. Before it grows large enough to make sugar through photosynthesis, it must rely on its own starch reserves in the endosperm. 2) other enzymes which break down proteins are produced.
   Further enzymes are developed which will convert the starch into fermentable sugars in the mash tun later on in the brewing process. These changes are known as “modification”.
   The germination step must be fine-tuned to maximize enzyme production and cell wall modification but minimize carbohydrate consumption. The more sugar used for the growth of acrospires and rootlets in this phase, the less remains for beer. Thus, over-modification leads to loss in extract or fermentable sugar in finished malt.
5) **Kilning**. When modification is adequate for the type of malt being produced, the germination process is stopped by drying the malt through a process called kilning. Malt before drying is called *green malt*. Green malt drying is accomplished by blowing hot air, for 24-36 hours, through a bed of malt in a device called a kiln. In this way,

most of the moisture is removed, leaving 5 percent in lager and 2 percent in traditional ale malts.

Kilning has two implications: the first is that these malts will be darker. The higher the temperature, the darker the color. The second implication of higher kilning temperatures is the development of complex flavors. The flavors associated with malts are produced during the kilning process. If malt is kilned to particularly high temperatures (roasting), it is possible to make especially dark products (used for stouts, for example) and to develop flavors described as “burnt” and “smoky.”

Malts destined for lager-style beers are generally less extensively modified than those aimed at ale production (i.e., they contain less amino acid and sugar), and they are kilned to a relatively mild regime. They therefore develop less color and give quite pale or straw- or amber-colored beers.

6) **Malt storage and packaging**. The malt, after being cooled, is cleaned by sieving, stored in a silo and later delivered to breweries in bulk or in bags.

2.1.2 Milling

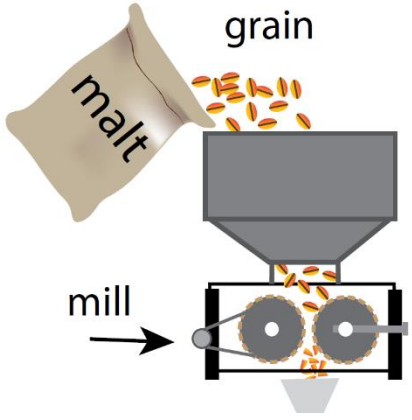

Figure 2-3. Brewing process - Milling

Before use in brewing, malt must be crushed into small pieces to extract the starch through a milling operation. Crushed grain is called *grist*. *Roller mills* are used to perform this operation. The primary purpose of milling is to allow starch from the grain, enzymes from malt, and water to come into contact during the mashing step. As said, a seed of grain is protected by a water-resistant seed coat, also called the testa. Milling breaks the seed coat and crushes the interior of the seed, producing additional surfaces at which water can react with starch. It is essential that malt hulls are split but not pulverized. They will aid, in a later step, wort separation. So, the design of the mill and the gap between the rolls are important in obtaining the correct reduction in size of the malt.

2.1.3 Mashing

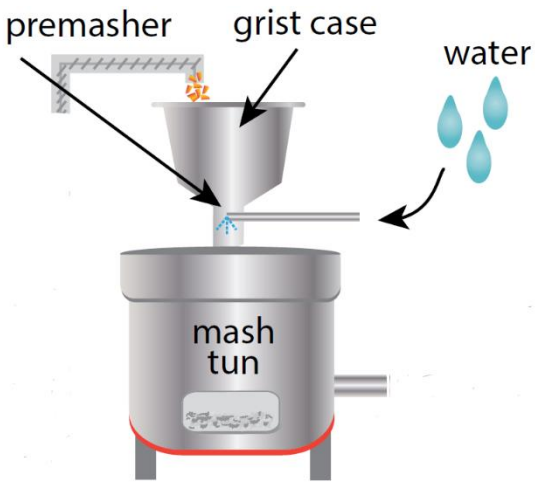

Figure 2-4. Brewing process - Mashing

During the mashing step, starch is converted to smaller sugars that brewing yeast can ferment, since it cannot directly ferment starch. During mashing, hot water, sometimes called brewing liquor, is mixed with the grist to give a temperature in the range of 60-70°C. Sometimes mashing starts at a lower temperature (45-50°C), and the temperature is raised continuously or in steps to influence the protein or carbohydrate profile. Mashing is conducted in a mash conversion vessel (MCV), also called a *mash tun*. The mash tun may contain an agitation paddle for gentle mixing. The details of the time–temperature profile, the activities of enzymes derived from malt, and the pH of mashing have a decisive effect on the character of the beer.

Three processes must occur for effective mashing.

1) *Gelatinization*: starch granules absorb water, swell, and burst, giving the starch molecules access to water. Some grains, including barley and wheat, gelatinize readily in the normal mashing temperature range. Others, like maize (corn) and rice, must be cooked in a separate vessel before addition to the mash.
2) *Liquefaction*: starch molecules are hydrolyzed in the interior of the molecular chain to give soluble fragments, still too large for fermentation.
3) *Saccharification*: starch chains and fragments are further broken down at the ends of the chains to yield the fermentable sugars: glucose, a monosaccharide; maltose, a disaccharide; and maltotriose, a trisaccharide.

The solute-rich liquid produced in mashing is called the *wort*.

Mashing temperature plays a key role in determining the fraction of starch that is liquefied and the fraction of dissolved carbohydrate that is fermentable. The amounts of unfermentable and fermentable carbohydrates are determined during mashing, influencing the character of the finished beer. The generation of more fermentable sugars results in a thinner, dryer beer with more alcohol. A mash with less fermentable sugars leads to less alcohol but more body and texture.

Ale and lager are mashed in the same equipment, but they require different temperature programs and grist composition. Modern breweries often practice *high-gravity brewing*, in which highly concentrated worts are made, fermented, and then diluted, allowing more beer to be brewed on the same equipment.

2.1.4 Wort Separation

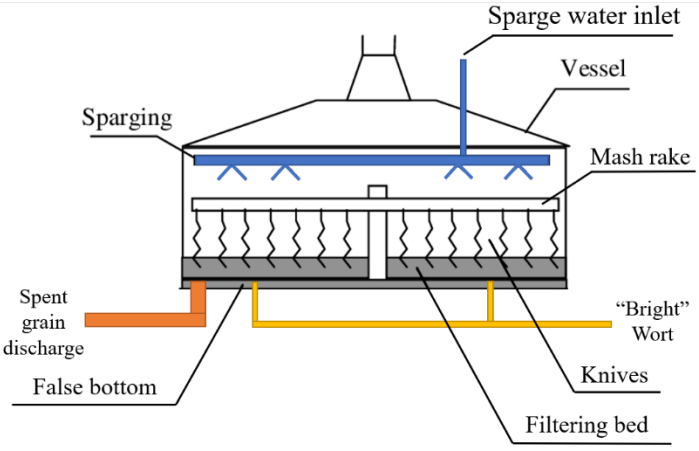

Figure 2-5. Brewing process - Wort separation

After mashing, when the starch has been broken down, the next step is to separate the liquid extract (the wort) from the residual undissolved solid materials found in the mash (*spent grains*). The aim is to produce a wort that is referred to as "bright", i.e. a clear solution of fermentable sugars that does not contain lots of insoluble particles (e.g. hulls) that may present great difficulties later on. The challenge is to achieve this without sacrificing wort, thereby limiting yields.

Wort separation may be carried out by any of a number of different methods: 1) the mash tun, 2) the lauter tun, 3) the mash filter, or 4) Strainmaster. The *lauter tun* is internationally accepted and continues to be the predominant wort separation device. In the lauter process, the solids are supported on a perforated false bottom above the true bottom of the vessel. Liquid is drawn through the grain and the false bottom via valves in the true bottom. The actual filtration is accomplished by the grain bed, the split hulls from the malt. The false bottom supports the grain bed and facilitates separation. At the beginning of the process, wort is recirculated to the top of the vessel and maintained until the wort runs clear, indicating the grain bed is set. The lauter tun is equipped with knives or rakes that cut through the grain bed to give it greater filterability and increase the filtration speed. During or after lautering, the grain is rinsed with hot water, a process called *sparging*. Sparging recovers sugar that is held up in the grain bed, so more beer can be made from less grain.

2.1.5 Boiling

The clarified wort is sent to a vessel called a brew *kettle* (also known as copper or wort boiler) and heated to boiling. The wort is usually boiled for 60-90 minutes with evaporation of up to 20% of the wort volume. Boiling consumes the most energy of any step of the brewing process.

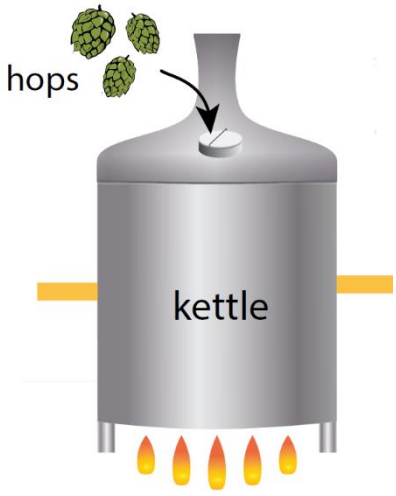

Figure 2-6. Brewing process - Boiling

Hops or hop products are generally added before or during boiling, often in stages so that different portions of the hops are subjected to different boiling durations. Boiling serves several purposes, including the following:

- Isomerization of hop compounds for bitterness.
- Sterilization, to eliminate any organisms that might jeopardize the subsequent good work of the yeast.
- Dissipation of off-flavors.
- Removal of proteins and lipids that affect beer clarity and stability.
- Concentration of wort, as water is driven off as steam during boiling.

The next step is to separate the solid material generated by the boiling process, called *hot break* or trub, so that the wort is bright and clear before cooling. The wort may be clarified by sedimentation or more commonly by a whirlpool or a combined kettle/whirlpool. It is recommended that clarification take place at the highest possible wort temperature in order to obtain optimum trub removal. In a *whirlpool,* the wort is made to move in a horizontal circular pattern that drives the solids into a compact mound at the bottom center of the vessel.

2.1.6 Chilling

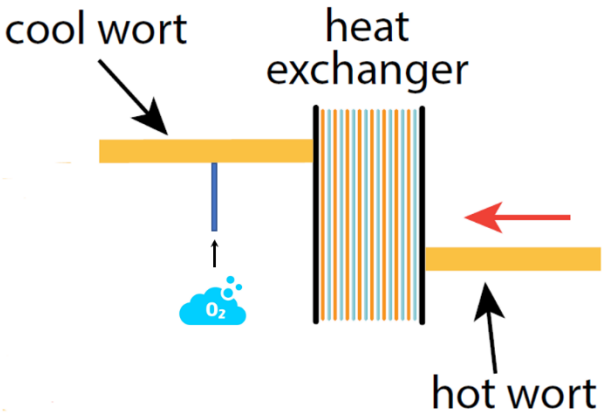

Figure 2-7. Brewing process - Chilling

Before fermentation, the temperature of the wort must be lowered, a process called chilling. The wort is preferably cooled to a temperature of 5 to 15°C for bottom-fermented beers and to 15 to 18°C for top-fermented beers. The standard equipment for chilling is a countercurrent plate heat exchanger, consisting of a series of closely spaced and parallel heat-conducting plates. The hot wort flows through half of the channels between the plates, and a coolant, typically water or an antifreeze mixture, flows through the rest. Each plate has wort on one side and coolant on the other.

In some traditional breweries, the hot wort is drawn into a wide, shallow vessel called a *coolship*, where it is slowly cooled by convection. A few breweries use this method to capture wild bacteria and yeast, but most brewers prefer a closed chiller to avoid the risk of contamination.

At the beginning of fermentation, the yeast needs dissolved oxygen (as a nutrient, not for respiration) to help prepare cell membranes. Because the boiling process strips the wort of all dissolved gases and because gases are more soluble at cooler temperatures, oxygen is injected into the wort as it exits the chiller. The oxygen requirement depends on the solids content of the wort and on the strain of yeast.

2.1.7 Fermentation

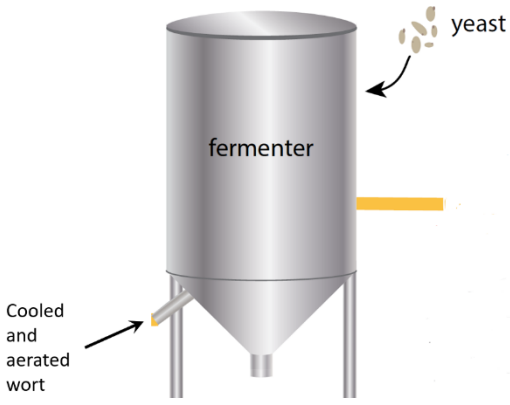

Figure 2-8. Brewing process - Fermentation

The next steps are fermentation and conditioning, often carried out in an underground room, or even a cave, called the *cellar*. Cooled, aerated wort from the chiller is transferred to a fermenter, also called a fermentation vessel. A selected strain of yeast, a single-celled fungus, is added to the wort. Fermentation converts certain sugars to ethanol and carbon dioxide. This reaction is carried out by yeast as a means for the yeast to make cellular energy in the absence of oxygen. In addition to the main reaction, fermentation is accompanied by a variety of side reactions whose products can affect the flavor profile of the beer. The fermentation reaction generates heat, so fermenters usually have provision for cooling.
Fermentation temperature and yeast type adopted vary according to the beer that has to be brewed: higher temperature and *S. cerevisiae* for ales, lower temperature and *S. pastorianus* for lagers.

2.1.8 Conditioning

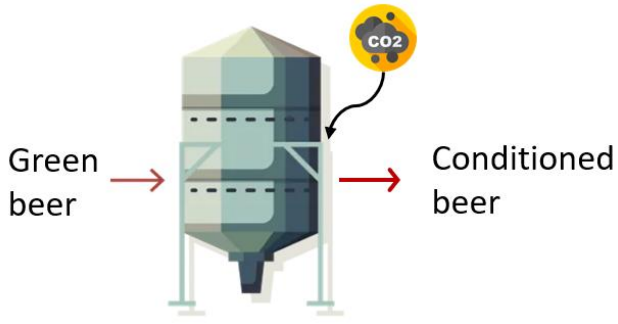

Figure 2-9. Brewing process - Conditioning

Conditioning, also known as maturation, is the achievement, post-fermentation, of a particular beer's correct character of maturation and carbonation (the word "condition" is often used to describe the level and texture of carbonation). Although most beer fermentations are technically complete within 3 to 10 days, the vast majority of beers are not yet ready to drink when the yeast finishes its primary work of metabolizing sugars. This is because fermentations tend to produce

flavors that are considered undesirable in finished beer. For this reason, beer must undergo some form of maturation to become palatable.

For this reason, after the primary fermentation, the new beer, called *ruh beer* or *green beer* (because it sometimes has the aroma of green apples), is held in contact with the yeast for a period that can be as short as a few days for a low-strength ale to several months for some types of lager beer. In this condition, a slow secondary fermentation of residual or added sugar (called priming sugars) or the addition of actively fermenting wort (called kräusen) generates carbon dioxide, which is vented and purges the green beer of undesirable volatile compounds. Continued yeast activity also removes strong flavoring compounds (the flavor of the beer matures). Allowing pressure to build up in the sealed vessel then increases the level of carbonation, giving the beer its "condition." Once flavor maturation is achieved, the beer is cooled, which facilitates separation of yeast and clarification of the beer.

Cold-fermented beers, i.e. lagers, tend to show more "green" flavors at the end of primary fermentation than do warm-fermented beers - thus the need for the weeks of cold maturation referred to as "lagering." Sometimes kräusening, the addition of a small proportion of fermenting beer, is performed before the beer is transferred to a lagering (cold storage) vessel. Ales are traditionally conditioned by relatively warm storage, usually by holding the beer at 10-20°C. Because most ale yeasts act quickly at warm temperatures, this storage period can be quite short. In the UK, cask-conditioned ales are traditionally matured unfiltered in the cask in the cellar of the retail outlet (bar or public house). Continuing fermentation in the cask gives the beer a light natural carbonation. Isinglass (collagen) is used to adsorb the yeast and other solid material and settle them to the bottom of the cask, clarifying the beer before service. Bottle-conditioned beers, instead, undergo a secondary fermentation in the bottle.

Maturation technique	Description
Lagering	For bottom-fermented lagers, it involves a long, cold storage at low temperatures.
Kräusening	It consists in the infusion of small portions of a strongly fermenting young beer (5-20% by volume) into a larger volume of green beer that has undergone primary fermentation, in order to start a secondary fermentation. This can help the beer mature more quickly and produce vigorous natural carbonation.
Casking	It is most widely used to make pale ales (bitters), porters, and stouts. The beer either has a small amount of fermentable sugar left after primary fermentation or a priming sugar is added to the cask, which contains unfiltered beer and clarifying agents (finings). The sugar is fermented by the yeast in the cask, which builds up condition over several days. If too little yeast is present in the beer, secondary fermentation is too slow and insufficient carbon dioxide is dissolved in the beer. However, if too much yeast is suspended in the beer, secondary fermentation may be too violent. The cask is ready to serve after the secondary fermentation is finished and the beer has been clarified by the finings. Beer that is cask conditioned, neither filtered nor pasteurized, is often called cask ale, real ale, or in Britain, traditional ale.
Bottle-conditioning	It consists in a secondary fermentation in the bottle, giving the beer a natural and often lively carbonation. In the case of bottle-conditioned beer, the kräusen or priming sugar is added to the beer and the secondary fermentation takes place in the bottle over a period of time.

Table 2-1. Maturation techniques

2.1.9 Filtration

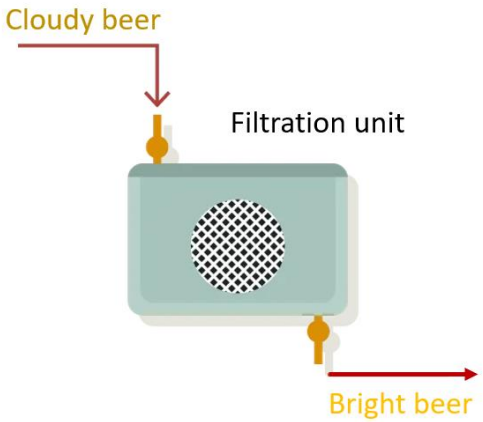

Figure 2-10. Brewing process - Filtration

Beer is often, but not always, subjected to one or more clarification processes, to give it appearance and remove elements, such as dead yeast, that otherwise would eventually make the beer unpalatable. Materials called *finings* may be added to beer to bind and remove haze-forming compounds. The beer may be kept in a tank to allow solids to sediment or may be clarified in a centrifuge, through a bed of diatomaceous earth or cellulose-containing membranes. It may be treated for microbial stability before packaging by filtering out microbes or after packaging by a heat process called *pasteurization*.

After filtration, bright beer is obtained, because the beer at this stage is free of yeast and haze. However, in several classic beer styles, yeast turbidity is a defining element of the style.

Unfiltered beer, served by many small breweries and brewpubs, is chilled after fermentation, carbonated, and served directly. Brewers should make sure that fermentation is complete before packaging unfiltered, unpasteurized beer to avoid the risk of excessive pressure from secondary fermentation.

2.1.10 Packaging

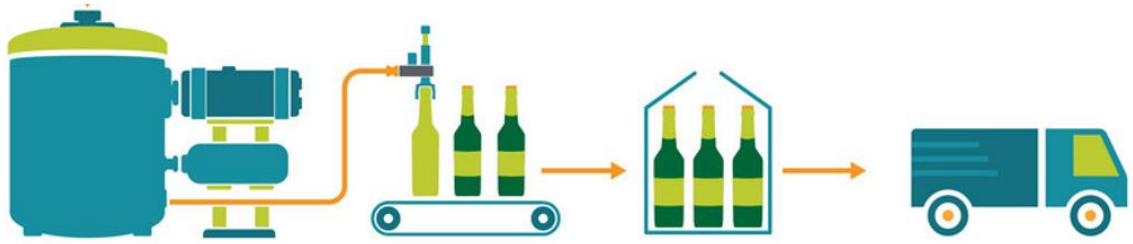

Figure 2-11. Brewing process - Packaging

Once the final quality of the beer has been achieved, it is ready for bottling. The major purpose of beer packaging is to protect the beer until it is served. Beer must be kept under pressure to maintain carbonation. Light and oxygen must be excluded to avoid (or at least defer) the development of off-flavors.

Small pack refers to packaging that is intended for single servings or direct consumer use (up to 2L). Standard small packaging is *aluminum cans* and *glass bottles*. In addition to protecting the beer, small pack has the very important function of enhancing sales. For this reason, bottles are festooned with paper or plastic labels. Some have front labels,

back labels, neck labels, and cap covers (often made of foil). Cans, if purchased in quantity, can be preprinted directly on the aluminum. Bottles and cans are packed in branded secondary packaging such as six packs and cases, usually made of cardboard or plastic.
The other type of packaging is *kegs and casks*. Kegs typically contain 50 L, although smaller sizes (mini-kegs) are available. Casks usually contain 40.9 L. Casks and kegs are used to serve beer in bars or at parties where large volumes of a particular brand of beer will be dispensed.
The handling of the beer and the packaging process are designed to minimize oxygen entry. The packages are purged with carbon dioxide before and after filling and are sealed within seconds.
The *bottling* process involves unpacking the containers, rinsing and sanitizing them, conveying them to the filling station, purging out air, filling, and then sealing the packages. Absolute sterility of the bottled beer is essential given the fact that bottles are shipped over long distances, subject to varying temperature regimes, and often remain on the shelf for fairly long periods. Traditionally sterility of beer was accomplished by pasteurizing the beer in the bottle after filling and crowning by a process known as tunnel pasteurization. When this process is adopted, the bottles are loaded at one end of the pasteurizer and passed under sprays of water as they move along the conveyor. The sprays are so arranged that the bottles are subjected to increasingly hot water until the pasteurization temperature is reached by the beer in the bottles. The bottles are then gradually cooled with water until they are discharged from the end of the pasteurizer. Alternatively, the beer can be sterilized prior to packaging either by flash pasteurization or sterile filtration. These two methods are more commonly used for *kegging*.
After the application of labels and adhesives, where necessary, secondary packaging is unloaded from its packaging and folded into shape. The filled cans or bottles are gently loaded into the cases, which are then sealed with adhesive and stacked on pallets.

2.1.11 Serving

Beer service can be as simple as handing the customer a bottle or can, but the usual expectation is that the beer will be delivered in a glass. Glasses for beer must be extraordinarily clean. Small traces of fats found on nominally clean glassware can interfere with the desirable appearance of the head of foam. For this reason, special procedures are needed for cleaning beer glasses. The beer must be served at the proper temperature and with the correct presentation of foam.
Beer served from casks or kegs is called *draft or draught beer*. Any draft system requires pressurized gas to propel beer from the keg to the dispensing valve, called beer faucet. For this purpose, CO_2 tanks (or CO_2 and nitrogen tanks) are used. When this pressurized gas is pushed into the keg through the coupler, the beer is forced through tubing called a *beer line* to the faucet. CO_2 has also another purpose: to keep the beer carbonated.

Sometimes, a glycol chiller or power pack is used to keep the draft beer at a consistent temperature as it travels from keg to faucet.

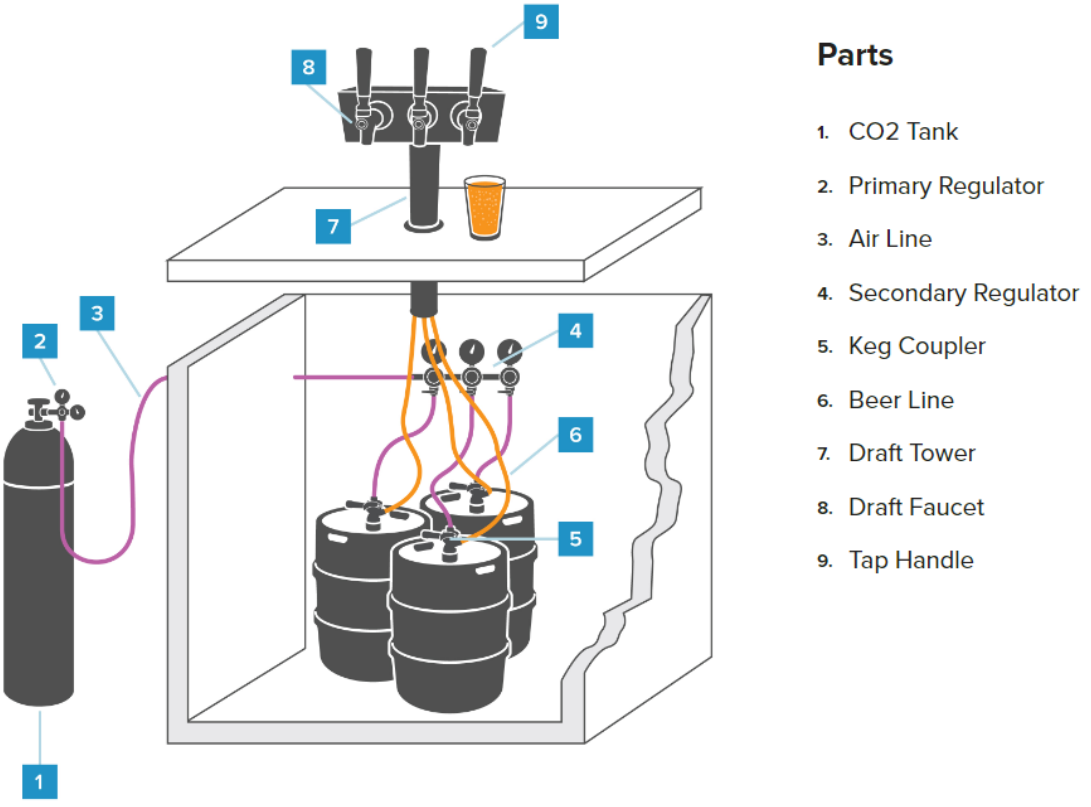

Figure 2-12. Kegerator [10]

2.2 Craft Beer versus Mass-Produced Beer

Every country has its own legal definition of craft brewery, regulating what craft beer is and what differentiates it from a mass-produced beer. Nevertheless, in general terms, the differences between craft beer and industrial beer are related to:

- *Filtration and pasteurization*. The artisanal beer is obtained without filtration and pasteurization steps, unlike industrial products. Pasteurization is widely adopted in the industrial production, and it involves high temperatures: 60-80°C up to 30 minutes. This heating-process ensures reduction of microbial contamination, extending the biological stability and increasing the shelf life of final product, but, at the same time, it can affect the nutritional quality of the beer. In addition, the sugars transformation mechanism in alcohol is stopped, reducing the multitude of flavors normally found into unpasteurized beers and so affecting also the sensorial quality of the beer. Furthermore, the heating step tends to standardize the organoleptic properties of the beer, with the consequence that in most cases it will be difficult to distinguish the product of one brewery from that of another. In industrial beers, the

pasteurization step is followed by a filtration phase, to remove coarse particles, yeast, and haze-responsible compounds. In absence of this treatment, the beer appears cloudy, and the yeasts can develop specific chemical reactions generating undesirable aroma; therefore, the unfiltered beers are adapted for limited distribution, with shorter shelf life (typically, from 90 days to one year) and storage under more restrictive conditions (low temperatures to avoid stressing the remaining yeast, causing the dispersion in beer of unpleasant compounds and the consequent development of off-flavor). For these reasons, pasteurization and microfiltration treatments are essential to multinational companies in order to extend the storage period and to standardize the taste of their products in order to be recognized by consumers.

- *Carbonation*. While carbon dioxide is generally added to industrial beers, most of the time craft breweries carbonate their beer through secondary fermentation. This means that prior to being packaged, sugars and eventually yeast are added to beer, if the one remaining from the main fermentation is not vital enough. After being filled, yeast consumes sugars, and produces alcohol and carbon dioxide, carbonating the beer.
- *Ingredients*. Industrial beers are often produced with chemical additives, preservatives and cheaper ingredients, which allow to lower production costs but negatively affecting the sensory profile, which is often flattered compared with one of its craft counterpart. In particular, barley malt is generally partially substituted by corn or rice. These cereals have a negligible impact on beer flavor, and their role is just to increase the fermentable sugars' content of the wort. However, their extensive use could impact fermentation performances, due to their lower free amino nitrogen content, which is a necessary nutrient for proper yeast metabolism. Instead, craft beers are produced with high quality raw materials, without the addition of chemicals and substitutes ingredients, and in small volume. Many of them also use local raw materials, in order to create a strong link between their beers and territories. These ingredients can be typical local products (vegetables, spices, herbs, fruits, etc.), or even self-grown barley and hops.

2.3 Beer Ingredients and How They Affect the Final Product

Beer, as said, has traditionally four main ingredients:

- water
- malt
- hops
- yeast

In addition to the main ingredients, beer can be brewed also with adjuncts, which are sources of starch or sugar other than malt, and processing aids, which are materials used to help give the beer desirable characteristics. [11]

2.3.1 Water

The main component of beer, as well as other beverages, is water: roughly about 90 to 95 percent of beer consists of water [12].
Water is also sometimes called *liquor* when it is associated with brewing. [12]
It can take as much as 12 volumes of water to make 1 volume of beer. [11] Some breweries have been able to cut this ratio to three or less, meaning less energy consumed and less negative impact on the environment.
Water itself is a characterless compound of fixed composition. However, it contains desirable and undesirable components present in trace amounts. The nature and amount of these trace components is important to the character and quality of the beer that, for this reason, is usually processed.

Some of the parameters for good brewing water are obvious. The water must comply with the legal limits like the World Health Organization (WHO) guidelines for drinking-water quality. In particular, the water must be clean and free of germs and harmful substances. [13]

Other values of interest are:

- **Total hardness**. Water hardness is the amount of dissolved calcium and magnesium in the water. Hardness is expressed as the equivalent amount of calcium carbonate in parts per million (mg/l). It can also be expressed in degrees. The following table shows the normal ranges of hardness.

Hardness as CaCO3 mg/l	Ca mg/l	Clark Degrees	French Degrees	German Degrees	Hardness Levels
0 – 50	0 – 20	0 – 3.5	0 – 5	0 – 2.8	Soft
51 – 100	21 – 40	3.6 – 7.0	6 – 10	2.9 – 5.6	Moderately soft
101 – 150	41 – 60	7.1 – 10.5	11 - 15	5.7 – 8.4	Slightly hard
151 - 200	61 – 80	10.6 – 14.0	16 - 20	8.5 – 11.2	Moderately hard
201 - 300	81 – 120	14.1 – 21	21 - 30	11.3 – 16.8	Hard
Over 300	Over 120	Over 21	Over 30	Over 16.8	Very hard

Table 2-2. Water hardness classification [14]

Different types of beer can be brewed depending on the hardness of the water. Hard water is best suited to stout type beers such as Guinness, whereas soft water is better for light, hoppy beers such as lager and pilsners. [15]

- **pH levels**. pH is a scientific scale used to define how acidic or how alkaline a particular substance is, with an acid having a pH less than 7, and an alkaline having a pH greater than 7. pH levels affect every step of the brewing process and will need to fall between specific ranges to optimize the brewing environment [16]:
  - In the mash, the pH should be between 5.2 and 5.6. This is the optimum range for the enzymes in the mash to function.
  - During the boil, the pH drops a little bit due to the reactions of the sugars and added hops.
  - As the yeast produces alcohol during fermentation, the pH of the wort lowers once again to around 4-4.5. This helps protect the beer against spoilage organisms.

A water report for brewing should measure the concentration of the following ions:

- **Calcium**. One of the main minerals affecting the hardness of water. Calcium can lower pH during mashing. It also promotes the clarity and stability of the final beer. In general, a range of 50 mg/L to 150 mg/L is preferred. [17]
- **Magnesium**. The other main mineral affecting hardness. It does not affect the pH as much as calcium. Both calcium and magnesium are important yeast nutrients. Magnesium levels between 10 and 30 mg/L are needed to aid the yeast, but too much may cause a bitter taste. [17]
- **Alkalinity**. Alkalinity is the capacity of water to resist changes in pH that would make the water more acidic. It is a measurement of the concentration of all alkaline substances dissolved in the water such as carbonates and bicarbonates which buffer pH in the water by neutralizing acids. Calcium concentrations must be balanced with low carbonate-bicarbonate levels as they have countering effect on calcium. These ions should be kept to less than 50ppm. Bicarbonates, being strong alkaline buffers, may raise the pH of the mash to unacceptable levels, if available in large amounts. [18]
- **Sulfate**. Sulfates are particularly important in hoppy beers, making both hop character and aroma more prominent and increasing the perception of bitterness. [16]
- **Chloride**. Chlorides enhance the beer flavor and perception of palate fullness (which is an important aspect of mouthfeel). This ion will also increase ‘sweetness’ or ‘mellowness,’ making it highly desirable in malt-forward beers. Long term, chlorides increase beer stability and improve clarity. The ratio of chloride to sulphates is important in every beer style as this dictates the “balance” of the beer. If the sulphate is proportionately higher than chloride, the beer is balanced towards hop-forward beers. On the other hand, if the chloride is proportionately higher than the sulphate,

the beer is balanced towards malt-forward beers. If they are approximately equal, then the beer is balanced. [16]

- **Sodium**. In small amounts, sodium will have minimal effects on the flavor of beer. It does contribute to the body and mouthfeel. At excessive levels, it is harsh tasting, salty and poisonous to yeast. [16] Sodium levels in the 10-70 mg/L range are acceptable. [17]
- **Nitrate**. Above 10 ppm, it suggests contamination by agricultural runoff. At high concentrations, it can be converted to potentially harmful nitrite. [11]

2.3.2 Malt

Brewing beer requires starch, whose source is cereal grain. After being harvested, the grain undergoes the malting process that turns it into malt. *Malt* is seeds of grain that are germinated and then dried. Malt influences the flavor of beer more than any other ingredient. The malt types selected for brewing will determine the final color, flavor, mouth feel, body, and aroma. The most common grain for malting is barley, but wheat, rye, and oat malt are available. Rice and maize (corn) can be malted, but these malts are rarely used in beer brewing. [11] More than 90% of the beer brewed worldwide is made with barley malt and it seldom accounts for less than 50% of the grist employed to produce a beer. [1]

Cultivated barley (*Hordeum vulgare* or *Hordeum distichon*) belongs to the grass family (the *Gramineae*) and it has been estimated that it emerged from its ancestor in Egypt about 20,000 years ago. [1] Endowed with a short growing cycle, barley does not require any particular type of soil and adapts easily to any climate, characteristics that have enabled its wide and millennial spread.

There are two main classes of barley malt.

- *Base malts* provides most of the enzymatic power to convert starches into fermentable sugars during mashing. The ability of malt enzymes to convert starch is called the diastatic power (DP), measured in the United States and the United Kingdom in degrees Lintner (°L). The minimum diastatic power that a malt requires to convert its own starch to sugar is about 40 °L. [1] Because base malt provides the highest extract potential, it is typically used at 70–100% of the grain bill [1]. Base malts are of different types [19]:
  - *Pilsner malt*, also known as lager malt, is the standard malt type used for most lager production. They produce less color and flavor than standard base malts and are very useful in producing beers in which other flavors and aromas are to be achieved.
  - *Pale ale malt* is the standard malt type used for the production of most ales. It has a lower protein content and a more easily accessible starch than Pilsner malt. Pale

ale malt is usually kilned at high temperatures, which gives it a darker color and more malt character than Pilsner malt.
    - *Mild ale malt* is kilned at a higher temperature than pale ale malt but still has enough diastatic power to be used as a base malt or as a substitute for a portion of the base malt.
    - *Vianna malt* is very close to pale ale malt but is kilned at a higher temperature to emphasize the production of melanoidins that are responsible for differing flavors and aromas.
    - *Munich malt*, like Vienna malt, is kilned at high temperatures to emphasize the production of melanoidins. It gives an amber color to the beer; however, its most important contribution is a nutty, rich malty aroma and flavor.

- *Specialty malts* are designed to provide a unique characteristic to beer, such as color, flavor, foam improvement, body, or other accentuating characteristics. Compared to base malts, specialty malts are used in relatively small quantities, provide little or no diastatic power but do contain some extractable material. Depending on the style of beer brewed, the brewer may use only one or two types of malts, or as many as seven or eight different types of specialty malts. [19] Specialty malts can be [19]:
    - *Crystal or caramel malt* has been processed to convert most of its starch into sugar in the kiln. Depending on processing conditions, some of the sugar is allowed to react with amino acids to give unfermentable but flavorful compounds. Crystal malts are often used at 2–10% of the total grain bill. [1]
    - *Roasted malt* is subjected to an additional heating step in a specialized roaster to give dark colors and intense flavors. Roasted malts are used at 1–8% of the grain bill. [1] There are many gradations and variations: amber malt, biscuit malt, brown malt, black malt, chocolate malt, and dark chocolate malt.
    - *Light-colored malts* are kilned at higher temperatures than base malts and impart a deeper color and a fuller malt flavor and aroma to the finished beer. Dextrin malts and honey malts are examples of specialty light-colored malts.
    - *Unmalted barley*. Two other specialty products made from unmalted barley are roasted barley and black barley.

Table 2-3 gives color according to the Lovibond scale or the more or less equivalent American Society of Brewing Chemists SRM scale (the higher the number, the darker) and diastatic power in degrees Lintner for the barley malt types described above. Values for rye and wheat malts are also reported.

Malt class	Malt type	Color (SRM or Lovibond)	Diastatic Power (°L)
Base malt	Pilsner/lager	1.2 - 2.5	140
	Pale ale	3.5	85
	Mild ale	5.5	65
	Vienna	3.5	80
	Munich	10	40
Specialty malt	Dixtrin	1.5	0
	Crystal/caramel	5 - 120	0
	Biscuit/amber	20 - 36	0
	Chocolate	200 - 500	0
	Black	400 - 600	0
Rye malt		4	105
Wheat malt		2.2 - 4	170

Table 2-3. Color and diastatic power of different malt types [14] [20]

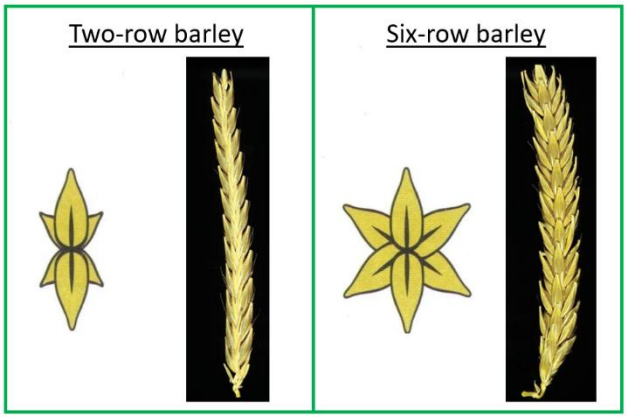

Figure 2-13. Two-row vs. six-row barley

Barley, used in brewing, can be of two types: *two-row* and *six-row* according to the morphology of the barley spike or head. Two-row barley varieties produce only a single fertilized seed at each seed point, or node, on their flowering head. The position of the corns alternates at each node, resulting in two-row barley having two rows of seeds along its length. Six-row barley varieties, by contrast, have three fertilized corns develop at each node and thus produce six rows along the length.

A number of generalizations apply to six-row and two-row malts: the latter generally have larger kernel sizes, lower protein levels and lower huskiness (tannic astringency). Two-row malts also have a higher starch-to-protein ratio because of their smaller aleurone layer compared with the endosperm.

Because of the larger kernel, two-row barley provides more extract potential than six-row barley. This often makes it more cost effective for larger breweries to use two-row. Though two-row barley offers more extract potential, six-row offers more diastatic power than two-row malt. This makes six-row barley ideal for brewing with high quantities of adjuncts and/or specialty grains (their relatively high enzymatic power assists in the conversion of the added material), while two-row malt tends to be more suitable for all-malt beers. [21]

As a general rule, six-row malts are preferred by large mass-market breweries in the United States and Mexico, whereas two-row malts are preferred almost everywhere else.

2.3.3 Hops

The hop, *Humulus lupulus*, is a climbing plant that is dioecious, indicating that it has separate male and female plants. However, only the female plants produce the hop cones, which are the part used for brewing.

Figure 2-14. Hop cones [22]

Hops are boiled with the beer wort to provide bitterness, balancing the sweetness of malt, and other flavors. Hop compounds also have an antibacterial effect that can help preserve the beer, retarding beer spoilage. In addition, they help stabilize beer foam, and they can prevent excessive foaming during boiling. Sometimes hops are added at other points in the brewing process to provide desired flavor effects. There are many varieties of hops with different flavor profiles. [11]

Hops contain hundreds of components, but the essential ingredients for brewing are the resins and hop oils.

- *Hop resins* are subdivided into hard and soft, based on their solubility. Hard resins do not contribute to the brewing value, while soft resins contribute to the flavoring and preservative properties of beer.
  Soft resins contain *alpha acids*, also known as *humulones*, that are important for taste and aroma. The alpha acids themselves are not bitter. To acquire this quality, they need to go through a chemical process called isomerization, achieved by boiling.
  Soft resins also contains a second group of acids known as the *beta acids*. The amount of beta acids, also known as *lupulones*, is normally lower than alpha acids and the ratio

of alpha to beta acids is variety dependent. Unlike the alpha acids, the beta acids do not undergo isomerization. In their original form, as alpha acids, they are largely flavor inactive, but they can produce bitter oxidation products, such as hulupone. So, their bittering effect is seen over the long-term, becoming more developed with long fermentation, storage, and aging. Dry hopping, the process of adding hops to the fermenting vessel without any other preparation, is another way to bring beta acids into the beer.

- *Hop oils* are largely responsible for the characteristic aroma of hops and, either directly or indirectly, for the overall perception of hop flavors. Due to their volatile nature, most of the initial oils from the starting hops are evaporated off during the boil. This is the reason why hops for flavor and aroma are typically added towards the end of the boil or in dry hopping. “Floral”, “lemony”, “earthy”, “citrus”, or “spicy” are all terms and fragrances that essential oils give to the beer.

So, hops can be of two types:

- *Bittering hops* have higher concentrations of alpha acids and are responsible for the large majority of the bitter flavor of a beer.
- *Aroma hops* usually have a lower concentration of alpha acids and are the primary contributors of hop aroma and (non-bitter) flavor.

International Bitterness Unit, with symbol IBU (sometimes, just BU) is a unit used by brewers to describe the bitterness of beer. One International Bitterness Unit is equivalent to 1 milligram of iso-alpha acid per liter of beer. Almost all beers fall in the 1-100 IBU range. An upper limit is reached when the beer is saturated with iso-alpha acid, somewhere around 110 to 120 IBU. [23]
IBU is not determined by the bitterness perceived while tasting the beer. For example, the bittering effect of hops is less noticeable in beers with roasted malts or strong flavors, so a higher proportion of hops would be required in strong flavored beers to achieve the same perceived bitterness in moderately flavored beers. For example, an imperial stout may have an IBU of 50, but will taste less bitter than a pale lager with an IBU of 30, because the pale lager has a lower flavor intensity. Light lagers without much bitterness will generally have 8-20 IBU, while an India pale ale that is a highly-hopped style may have 60-100 IBU or more. [24]

2.3.4 Yeast

Yeast, often cultivated at the brewery, is the single-cell fungus that converts sugar to ethanol and carbon dioxide. The action of yeast on sugar is fermentation. Most beer fermentation is carried out by one of two species of yeast, *Saccharomyces pastorianus,* formerly referred to as *Saccharomyces carlsbergensis* or *Saccharomyces uvarum* (bottom-

fermenting yeast), used for lager beer, and *Saccharomyces cerevisiae* (top-fermenting yeast), used for ale.

In the top fermentation, the yeast after remaining mostly in the wort during fermentation rises to the surface and can be skimmed off the top, whereas in the bottom fermentation, the yeast sinks to the bottom of the vessel. Top fermentation is conducted at a higher temperature (16-24 °C) than bottom fermentation (6-12 °C) and consequently its duration is shorter (at least 1 week vs. at least 1 month). [8] This largely accounts for the difference in flavor of the beers prepared by the two methods: top-fermenting tends to yield more flavor. Top fermenting yeasts produce beers that are more estery, fruity, and sometimes malty, whereas bottom-fermenting yeasts give beers a characteristic sulphurous aroma. [19]

Some specialty beer styles are fermented with *Brettanomyces bruxellensis*, *Brettanomyces lambicus*, or related species.

Within a particular yeast species, there are many variations, called strains. The species and strain of yeast affects the character of the beer.

2.3.5 Adjuncts

Adjuncts can be of different types.

They can be a source of fermentable material used as supplements to malted grain, seldom providing more than 30 - 40% of the fermentable sugar unless additional enzymes are added. [11]
In this case, adjuncts can:

1) provide starch that must undergo mashing. They are nothing more than unmalted grains such as corn, rice, rye, oats, barley, and wheat.
2) supply sugar that can be added directly to the kettle or even to the fermenter. In this case, adjuncts are syrups and sugars.

They are often used with the intention of cutting costs, but sometimes also to provide a crisp, light flavor and to enable high-gravity brewing. Some adjuncts increase fermentability to make beers with low final extract, like light beer and malt liquor.

In addition, beers may be brewed also with other adjuncts and flavorings.

- Fruit, by fermenting the fruit or adding flavored extracts to the finished product. Cherry, raspberry and lemon are common addition to beers.
- Vegetables. For example, pumpkin-flavored beers are brewed seasonally in the autumn by different beer producers.

- Herbs and spices, added to the wort during the boil or as extract during fermentation. Spices used in brewing include, for example, cinnamon, ginger, coriander, hot pepper and nutmeg.

Other adjuncts can be coffee, tea, vanilla, chocolate and milk. It is possible to find also beers with the addition of biscuits or even seafood (e.g., oysters, shrimp, and squid ink).

Also bacteria can be considered as adjuncts. Some brewers sometimes deliberately infect their brew with certain types of bacteria, such as *Lactobacillus* and *Pediococcus*. These alter how the beer ferments, contributing some very unusual flavors that tend to be distinctly sour.

2.3.6 Processing aids

Some common processing aids are

- *finings*, which help to clarify the beer
- *carbon dioxide*, which carbonates the beer
- *foam enhancers*, which provide desirable foam properties
- *colored materials*, which are used to adjust the color of the beer. For example, very dark wort is fermented to produce *Farbebier* (Ger: colored beer), which is sometimes used in small quantities to increase beer color.
- *enzymes,* which can be useful in many stages of brewing. For example, beta-glucan is a gum that, when dissolved in wort, raises the viscosity, slowing down lautering and other filtration processes.

2.4 Beer Styles and their Categorization

Although beers are brewed from similar materials, beers throughout the world have distinctive styles. Their uniqueness comes from color, flavor, strength, ingredients, production method, recipe, history, or origin.
The most general categorization of beer styles by yeast type is a modern craft brewing phenomenon. American brewers and most other craft brewers call beers *ales* if they use top-fermenting (ale) yeast and *lagers* if they use bottom-fermenting (lager) yeast. Most categorization systems will allow for a third classification, often called *spontaneously-fermented* because of the method; however, *wild or mixed fermentation* are perhaps more widely-used modern craft beer terms for these beers fermented with the addition of bacteria or with non-Saccharomyces yeast. The term wild in this context should not be interpreted to imply spontaneously-fermented; most are directly inoculated with the desired fermentation strains.

In Germany and other old-world brewing centers, the terminology most typically used to differentiate beers is to refer to them as top-fermented or bottom-fermented. Germans think of ale as a type of English beer, and lager as a method of conditioning beer. So, Germans would typically speak of Kölsch as a top-fermented lager beer, not an ale, for example.

English brewers, particularly when dealing in a historical context, might separate ales from porters and stouts as types of beer. They might go even further to describe ale as historically distinct from beer in that beer was hopped (or more highly hopped) than ale.

Coming back to the categorization of beer styles according to yeast type, ales are most associated with Britain, Ireland, and Scotland. However, the ale family also includes Belgian specialty beers, German specialty beers, and American ales. Ales tend to have a fruity aroma and palate, and often a complex flavor varying considerably among ales in bitterness, color, sweetness, and harshness.
Lagers are a whole family of beers ranging from the light delicate Pilsner beers to the dark, aromatic Munich types identified as "dunkels" and the strong lagers known as bocks.
Spontaneous or wild beers are produced, with different techniques, both in Europe and in America.

The following table shows some of the styles withing each of these categories:

Category	Style	
Ales	American Pale Ale	Porter
	India Pale Ale (IPA)	Stout
	Saison	Altbier
	Belgian Strong Golden Ale	Kölsch
	Barley Wine	Bière de Garde
	Scottish Ale	Irish Red Ale
	Bitter	Belgian Dubbel and Tripel
	Witbier	Weissbier
Lagers	Pilsner	Bock
	Munich Helles	Munich Dunkel
	Rauchbier	Vienna Lager
	Märzen	Pale Lager
	Amber Lager	Dark Lager
Spontaneously-fermented, wild or mixed-fermented beers	Berliner Weisse	Flanders Red Ale
	Oud Bruin	Lambic
	Gueuze	Gose
	Brett Beer	Straight Sour Beer

Table 2-4. Beer styles and categories according to yeast type

2.4.1 Elements of beer style

2.4.1.1 Flavor

Brewing is largely about flavor: getting the desired flavor, protecting the flavor, and verifying the flavor. But flavor can vary between individuals. In fact, different people may have different thresholds for perception of certain molecules. Flavor sensations are extremely prone to bias or external influence.
There are three components to flavor - taste, aroma, and mouthfeel - which are often processed together in the brain to generate a single composite flavor sensation. There are hundreds of distinct molecules that contribute to beer flavor. [11]

Taste is a chemical sense that responds to dissolved substances in the mouth. There are five currently recognized tastes: sweet, sour, salty, bitter, and umami (meaty or brothy taste like monosodium glutamate). [11]

- The sweet taste is evoked by sugars. Most sweet sugars normally present in beer wort are removed by fermentation. So, beer should only really taste sweet if there is any residual, or unfermented, sugar.
- The sour taste is evoked by acids. It is found in beers that are part of the mixed fermentation family, fermented by wild yeast and bacteria that produce acid.
- The bitter taste is evoked by many natural compounds with no evident chemical similarity. The most important bitter compounds in beer are the iso-alpha acids derived from hops.
- The salty taste is stimulated by sodium ions. Other alkali metal ions may taste salty, but the further away on the periodic table they are from sodium, the less they are perceived as salty.
- Umami tastes are seldom important in beer. This Japanese word actually translates as “deliciousness” in English. It can be found in some beers, particularly well-aged bottle-conditioned beers.

Aroma, or the olfactory sense, is a chemical sense that responds to molecules in the gas phase. The aroma in a beer may result from the malt and other fermentables, the strength and type of hops, the alcohol, esters, and various other aromatic components that can be contributed by the yeast strain, other elements that may derive from the water and any additional ingredients added during the brewing process.

Mouthfeel can be defined as the textural attributes of beer, those which produce a tactile sensation in the mouth. There are three key attributes recognized in the perception of mouthfeel: carbonation, fullness, and aftertaste. [25]

- *Carbonation* is often the first attribute perceived in the mouth. It is felt as a particular sting or tingle that is linked to the amount of carbon dioxide in a beer. Bubble size and foam volume, too, are related to carbon dioxide. Beers pressurized with large volumes

of nitrogen have a tight foam and tiny bubbles, which produce a creamy mouthfeel. [25]

- *Fullness* refers to the perceived weight and flow resistance of a beer while it is being consumed. Terms used to describe fullness are density and viscosity. These are sensations associated with the body of the beer. Beer often contains unfermentable dextrins, complex sugars developed during the mashing process, that can contribute to the mouthfeel of a beer without necessarily increasing perceived sweetness. Beers that seem to lack proper fullness might be described as "thin," whereas very full-bodied beers can range from "round" all the way up to "syrupy." [25]
- *Afterfeel* is associated with the lasting sensations recognized in the mouth. Such attributes as stickiness, astringency, dryness, bitterness, oiliness, or mouth-coating characteristics can leave a well-defined afterfeel that may linger. [25]

2.4.1.2 Appearance

The consumer's first impression of beer is by sight: color, foam, and haze.

Beers come in various **colors**, varying from pale to dark black to nearly colorless. This wonderful range is seldom achieved by the addition of coloring materials, although caramels have and continue to be used in some quarters for this purpose. The color of the beer is determined by different factors.

1) Generally the *malt and other solid grist materials* that are used in the brewhouse determine the color of beer. The color-forming materials in the grist are primarily the melanoidins, complex molecules that are produced when sugars and amino acids are heated. The more intense the heating regime in the production of malt, the darker the color produced. [1]
2) A second source of color in brewing is the *oxidation of polyphenol or tannin materials*. These tannin-type molecules originate from both malt and hops and are prone to oxidation if large amounts of oxygen are allowed to enter into the brewhouse operations. If this source of color is to be eliminated, it is essential that oxygen must be excluded in the mash mixer and, especially, the wort kettle. [1]
3) During the mashing process, malted barley is added to hot water. The mash color will depend on the *PH values of the water*. The higher the PH, the darker the beer will be. [26]
4) *Boiling* is another essential component that affects the color of the beer. The longer the beer is allowed to boil, the darker it becomes. [26]

There are a few different methods this beer color is measured: SRM, EBC, Lovibond.

- The most common value used in the US to measure beer's color is the Standard Reference Method, or *SRM* for short. It was developed by the American Society of Brewing Chemists in 1950 as the scientific standard for identifying beer color. SRM is

calculated in laboratories using specialized equipment by passing light through a small sample of beer and recording the drop in intensity due to absorption.

Beer Colors and SRM Value		
Color Swatch	SRM	Color
	2	Pale Straw
	3	Straw
	4	Pale Gold
	6	Deep Gold
	9	Pale Amber
	12	Medium Amber
	15	Deep Amber
	18	Amber-Brown
	20	Brown
	24	Ruby Brown
	30	Deep Brown
	40	Black

Beer Style SRM Color Ranges	
Style	SRM Range
Pilsner	2 - 7
Witbier, Berliner Weisse	2 - 4
Belgian Strong Ale	4 - 7
Maibock	4 - 10
Vienna Lager	7 - 14
Oktoberfest	4 - 12
American Pale Ale	6 - 14
Pale Ale	5 - 14
English Golden Ale	4 - 8
Bavarian Weizen	4 - 10
Bitter, ESB	8 - 14
Märzen	7 - 15
Imperial Pale Ale	5 - 11
Bière de Garde	6 - 13
Dunkel Weizen	9 - 13
Amber Ale	11 - 18
English Brown Ale	12 - 22
Bock	15 - 30
Porter	20 - 40
Oatmeal Stout	25 - 40
Baltic Porter	17 - 40
Foreign Stout	30 - 65
Imperial Stout	50 - 80

Source: Tasting Beer by Randy Mosher

Table 2-5. SRM scale to measure beer color and beer styles [27]

- The *EBC* method (European Beer Color) is the European equivalent standard to the SRM scale in Europe. Both SRM and EBC use very similar laboratory techniques to measure the beer color. Because of this similarity, SRM and EBC have an exact linear relationship to their values. In fact, the EBC value for a given grain is always a little less than double the SRM value.
  In practice the EBC color is approximately 1.97 times the SRM color:
  $$EBC = 1.97 \times SRM$$
- *Lovibond* (°L) is an older yet still common method for measuring the color of beer. It works by visually comparing a sample against a kit of reference colors with known values on the Lovibond scale. The Lovibond scale has mostly been replaced by the SRM and EBC methods in their respective countries for measuring beer color. However, it is still commonly used on packaging and online stores for reporting the color of malt and other brewing ingredients.

Foam, or head, on a glass of beer is the main attribute that visually separates beer from other sparkling drinks. It is produced by bubbles of gas, predominantly carbon dioxide, rising to the surface.
The carbon dioxide is produced during fermentation as a byproduct of the metabolism of yeast acting upon starches and sugars found in the wort. The carbonation can occur before or after bottling the beer. If the beer continues fermenting in the bottle, then it naturally carbonates, and the head is formed upon opening and/or pouring the beer. If the beer is pasteurized or filtered, then the beer must be force carbonated using pressurized gas.
While the actual foam activity of beer depends on the presence of carbon dioxide, it is the surface-active materials, like amphipathic polypeptides from malt, that determine size, shape and length of the foam. The main foam-stabilizing agents in beer are hydrophobic polypeptides derived from grain. In general, wheat tends to produce larger and longer-lasting heads than barley, being richer in proteins (that consist of one or more polypeptides arranged in a biologically functional way). In beer, a long-lasting head of foam is desirable, but the foam must not be so copious that the beer becomes difficult to serve or drink.
The creamy head on beers such as Guinness is created by a widget in cans or bottles using nitrogen, or by the process of drawing beer from a keg using nitrogen or mixed gas (carbon dioxide and nitrogen). The use of nitrogen, which was pioneered by Guinness, creates a firm head with small bubbles while reducing the excessively acidic taste often produced by using carbon dioxide alone.
Apart from being visually appealing, foam enhances the organoleptic quality of the beer, that is, it improves character perceived by the senses. It changes the texture of the beverage on the palate and provides effervescence and aromatic scents because volatile flavors are released as the foam bubbles break.

Haze is the broad term used for turbidity in beer; however, the term generally covers all forms of instability in beer in which insoluble material appears. As clarity is a desired trait in many types of beer, brewers of these beers work hard to avoid unwanted haze. Hazes are caused by suspended insoluble particles of colloidal or larger size that can be perceived visually or by instruments. From a technical point of view, there are several different types of haze.

- *Invisible haze* (“pseudo haze”), which is caused by very small particles that cannot be readily detected by the eye, but by haze meters that measure turbidity on the basis of the scatter of light at right angles to the incident. [28]
- *Visible haze* is differentiated into *chill haze*, which develops when beer is chilled to 0°C but disappears when the beer warms to 20°C, and *permanent haze*, which is present at all temperatures. It is also differentiated into *biological haze*, which arises from the growth of living microorganisms in the beer, and *non-biological haze*, which is caused by a diversity of colloidally unstable non-living materials in beer. [28] The biological

haze can be reduced or avoided, as it is caused by wild bacteria or yeast due to poor hygiene during beer processing and storage. In contrast, the non-biological haze is difficult to deal with, is caused by the large molecular substances in beer, such as dextrin, proteins, and polyphenols, etc. In the process of storage and transportation, due to the light irradiation and vibration, the large molecular substances undergo changes such as combination and agglutination, resulting in the formation of turbidity.

Among the factors causing non-biological haze formation, the interaction between haze-active proteins and polyphenols is the most well-known. [29] In the oxidation process of polyphenols, important for color, the individual tannin units associate to form larger molecules that, in turn, associate with protein to form insoluble particles that cause turbidity in beer. Other materials may cause cloudiness in beer. For instance, if the complex carbohydrates of barley are not sufficiently broken down during mashing, the long-chain dextrins cannot be used by yeast. After fermentation, dextrins will cause turbidity, as the solubility of dextrins is quite low in alcohol beverages. [29] Another natural component of malt is oxalic acid, which brewers should ensure is removed in the brewhouse operations by having enough calcium in the water to precipitate it out. If they fail in this task, then the oxalic acid will survive into beer. This is primarily a problem for draft beer because oxalate will precipitate out in the dispense lines and clog them. This is called “beer stone.” [1]

2.4.1.3 Strength

Alcoholic strength is the term used to denote the measure of the amount of ethyl alcohol (ethanol) in beer. It may be reported as percent by mass of beer or as percent by volume. Measurement of the specific gravity of the beer has been used to estimate the strength of beer by measuring its density. Several different scales have been used for the measurement of gravity, including the Plato, Baumé, Balling, and Brix scales, with the Plato scale being the most common modern measure.

This approach relies on the fact that dissolved sugars and alcohol affect the density of beer differently. Since sugars are converted to alcohol during the process of fermentation, gravity can be used to estimate the final alcohol. In beer brewing, a distinction is made between the original gravity, the gravity of the wort before fermentation has begun, and the final gravity of the product when fermentation has completed. Since the concentration of sugars is directly proportional to the gravity, the original gravity gives a brewer an idea of the potential alcoholic strength of the final product. After fermentation, the differences between the final and original gravities indicates the amount of sugar converted into alcohol, allowing the concentration of alcoholic strength to be calculated. Modern classification of the strength of alcoholic beverages for the purposes of taxation and regulation typically discriminates according to the percentage of alcohol by volume, generally abbreviated as ABV. The average strength of beer is between 4.8% and 5.2% alcohol by volume (ABV). However, there are many beers on the market with only 3.5%

ABV or below, whereas some beer styles, such as barley wine, commonly reach 12% ABV. [30]

Non and low-alcohol beers (NAB/LABs) also exist. Legislation concerning this kind of beers and the alcoholic content change from country to country.

- In the United States, beverages containing less than 0.5% alcohol by volume (ABV) are legally called “non-alcoholic”. Because of its very low alcohol content, non-alcoholic beer may be legally sold to people under age 21 in many American states. The terms “low alcohol” or “reduced alcohol” may be used only on malt beverages containing less than 2.5 percent alcohol by volume. The term “alcohol free” may be used only on malt beverages containing no alcohol. [31]
- In the United Kingdom, Government guidance recommends the following descriptions for "alcohol substitute" drinks including alcohol-free beer. The use of these descriptions is voluntary.
    - Alcohol free: not more than 0.05% ABV
    - Dealcoholized: over 0.05% but less than 0.5% ABV
    - Low-alcohol: not more than 1.2% ABV
- In some parts of the European Union, as Austria, Finland, Ireland and Hungary, beer must contain no more than 0.5% ABV if it is labelled "alcohol-free".

2.4.2 Glasses and their Importance

The shape of a beer glass affects the quality of the beer being served. Through the glass, it is possible to appreciate:

- Appearance. Color, turbidity, carbonation and foam are factors that can be perceived through the glass. Therefore, opaque glasses or ceramic jugs will not allow to appreciate these nuances.
- Foam. It is one of the most critical aspects in which glassware participates. The glass, cup or jug are often designed to accentuate or accommodate the head. Many other properties of the glass can also influence a beer head, such as a roughened surface at the base of glass known as a widget, providing for nucleation of carbon dioxide deep in the beverage rather than at the surface, resulting in a slower release of gas to the atmosphere. In addition, glasses for beer must be extraordinarily clean. Glass surfaces can retain oil from the skin, aerosolized oil from nearby cooking, and traces of fat from food. When these oils come in contact with beer there is a significant reduction in the amount of head, and the bubbles will tend to stick to the side of the glass rather than rising to the surface as normal. For proper foam formation, it is also important to dry the glass thoroughly after washing. Any water in the glass can prevent excitement of the gas by covering designs set in the bottom of the glass, thus making the beer flat. Conversely, some styles, such as Belgian witbier, benefit from being poured into a wet glass to control the often abundant head.

- Aroma. The opening of the glass, cup or jug will cause either the aromas of hops or malt to evaporate, or to be retained for longer.

Using the appropriate beer glassware enhances these traits. For this reason, different types of beer glasses exist.

Figure 2-15. Beer glassware

- **Shaker pint** (American pint). Probably the most recognizable beer glass available in the US, the standard American pint glass is heavy-bottomed with straight, tapered sides. This type of glass neither adds to nor detracts from the quality of the beer, making it a popular multipurpose glass. The pint glass can be used to serve any style of beer and is stocked in a lot of bars and restaurants because of its versatility and affordability. The traditional American pint glass can hold 16 ounces of beer.
- **Nonic pint** (British pint). It strongly resembles the American pint glass. However, the main distinction is that there are about two inches of bulge below the mouth of the glass. The pronounced curvature prevents the rim from chipping, and it allows for a firmer grip on the glass, making it easier for cleaning and stacking. Its large mouth provides a good layer of foam and facilitates drinking. Due to its capacity and shape, it is ideal for beers that do not drink very cold or carbonated. There are two measures: 16 and 20 ounces. This last variety is indicated for beers with abundant foam. It is excellent for drinking Double/imperial IPA, double/imperial stout, India pale ale, brown ale, or porter.
- **Tulip pint**. Its curved tulip-shaped design favors the capture of the aromatic qualities of beer, while its tight mouth allows the formation of a thick layer of foam. It is used for drinks with intense, hoppy flavors or with high degrees of alcohol such as Saisons,

Scotch ale, Belgian pale ale, Belgian strong ale, double/imperial stout or any drink with intense flavors and high degrees of alcohol.

- **Glass mug**. These are sturdy, made of thick glass, smooth or dimpled, for large capacity, and with a handle that prevents the heat of the hand from cooling the beer. Being the most universal drinking glassware ever made, the mug is versatile and accommodates all kinds of beer. They are designed to be able to collide at the time of toasting without breaking. The *dimpled mug* is the strongest of all the beer glasses.
- **Stein mug**. This iconic German mug is also sometimes referred to as a seidel but is most commonly known as beer stein in the US. Featuring intricate designs with references to Germany and Bavaria, the beer stein is largely a decorative piece. These collectible stein mugs are made from materials like porcelain, pewter, stoneware, and silver. A defining characteristic of the beer stein is the hinged pewter lid that covers the top of the mug and includes a thumb lever so that it can be opened with one hand. Its origins are from the fourteenth century in central Europe. They were used to prevent the entry of flies, since at that time they could contaminate the beer by existing pests (black plague). This jug is mainly used to serve Vienna, Munich or Bock style lagers.
- **Pilsner glass**. There are many variations on the shape of the pilsner glass, but traditionally it should be a tall, skinny, straight-sided glass that gets slightly wider towards the mouth. A true pilsner glass has no curvature. The long shape of the glass shows off the hue and effervescence of light, golden-colored beers, while the mouth maintains the head and forces aromatics towards the nose. This glass is used with beers that are light in color and have bubbly carbonation like pale lagers and pilsners. Typically, pilsner glasses hold between 12 to 14 ounces of beer, making them just a bit smaller than pint glasses.
- **Weizen glass**. Sometimes confused with the pilsner glass, the weizen glass is also tall and narrow but flares out into a subtle bulb shape near the top of the glass. The curvature traps and maintains a thick, fluffy head, holding the aromatics and directing them towards the nose while sipping. The tapered bottom is thought to prevent sediment or yeast from reaching the mouth of the glass. Weizen is the German word for wheat. As the name suggests, this glass is best suited for wheat beers like hefeweizen, dunkelweizen, American wheat ales, and even gose beers. It usually has a capacity of 500ml although in some countries like Belgium it can be 250 ml or 330 ml.
- **Stange glass**. The stange glass is a small, straight glass intended to be served on a round carrying tray called a kranz tray. Originating in Cologne, Germany, the standard stange glass has a small capacity of 6.5 ounces because it is meant to hold light, delicate beers that should be consumed quickly. Traditionally, as each stange glass on the tray is emptied, a server replenishes them one by one. Today, there are larger versions of the stange glass that are designed to hold 12 ounces, or a full bottle of

beer. The stange glass is perfect for light, crisp beers with low carbonation like kölsch beers and altbiers.

- **IPA glass**. Relatively new in the world of beer glasses, this glass was tested and chosen from over 100 different glass shapes as the one that most accentuated the fruity nose and flavor of an IPA. Deliberately designed, the IPA glass may look unusual, but the unique shape is very effective. This glass is characterized by its series of ridges at its base, which helps to aerate hoppy beers and release distinct aromas. Bell shape at the top of the glass pushes the aroma towards the nose. The IPA glass also preserves carbonation and keeps a frothy head longer than a standard pint glass. The typical IPA glass can hold 19 ounces of liquid, and it is best paired with IPAs of all varieties.
- **Stout glass**. This glass, as the IPA one, is relatively new to the market. Designed to complement the dark, roasted flavor and creamy mouthfeel of stout beers, this glass design was chosen from among several other glass prototypes. The glass design aims to elevate the experience of drinking a stout beer by accentuating the chocolate and coffee notes while still being functional. At first glance, it may look similar to the IPA glass, but there are some key differences. The bowl of the stout glass is slightly wider at the base with a sharper curvature to deliver the rich, toasted aromatics to the nose while sipping. A shelf-like shape encourages a cascade of sinking bubbles, and the hollow base helps retain carbonation and a frothy head. As the name suggests, it pairs well with all varieties of stout beers.
- **Snifter**. Ideal for beers with high alcohol content, the bowl-like shape of the snifter glass allows to swirl the beer and release its full aroma. Its full rounded bottom surface is designed to increase the heat transfer of the hand, therefore, to heat the beer. The upper part narrows inward to enhance and capture aromas. This glass is used to serve strong beers like barley wines, imperial IPAs, and imperial stouts.
- **Tulip**. Similar to a snifter glass, the tulip beer glass (also known as a Belgian glass) has a round shape that is perfect for swirling. The feature that makes the tulip glass unique is a flared lip that retains froth and carbonation, making it ideal for beers with big, foamy heads. Tulip glasses pair best with strong beers that have ample hops. These include Belgian ales, Belgian IPAs, Double/Imperial IPAs, Scotch ale, American wild ale, Saison, Fruit lambic and Gueuze.
- **Goblet and Chalice**. Traditionally, these glasses feature a long and thick stem that transitions into a wide bowl. While the words chalice and goblet are often used interchangeably, they are slightly different from one another. Chalices have thicker glass walls than goblets do, and they also weigh more. However, both types of glasses have wide mouths that are ideal for taking big gulps of beer. Chalices and goblets pair well with heavy malt beers, including German bocks and Belgian ales.
- **Flute**. Often confused with a glass of champagne, this type of glass is designed to retain some of the same properties found in champagne. These include active carbonation, an intense aroma and a visually attractive presentation. It is generally

tall, with a long, thin stem, made with thin glass walls. The long stem allows to enjoy the beverage without the hands coming into contact with the container and heating of the drink occurs. The narrow bowl creates excellent foam retention. It is used to serve fruity and carbonated beers, Vienna lager, lambic, Flanders red ale, gueuze, Saison, or even for the pilsner.

- **Thistle**. It is the glass that should be used to enjoy a Scotch Ale style beer. The crystal is shaped like a thistle flower, which is the national flower of Scotland. This glass looks like a stretched-out version of the tulip glass, but with smaller curvature at the lip.

2.5 Beer and Health

For millions worldwide, alcoholic beverages are condemned on religious grounds. Alcohol prohibition is enforced, for example, in many Muslim majority countries, such as Libya, Kuwait, Mauritania, Saudi Arabia, Somalia, Sudan and Yemen. Among cultures where alcohol is tolerated, it is recognized the social unacceptability of consuming alcohol to excess, with the terrible consequences it can have - road traffic accidents, family distress, development of conditions such as cirrhosis of the liver and certain types of cancer. Increasingly, however, it is becoming recognized that there may be some health benefits associated with the *consumption of alcoholic beverages in moderation*.

As far as nutrition information is concerned, 355 mL of a regular beer contain [32]:

- Calories: 153
- Protein: 1.6 grams
- Fat: 0 grams
- Carbohydrates: 13 grams

Though beer is often viewed as empty calories, it contains also some vitamins, notably some of those in the B group (pyridoxine, niacin, and riboflavin, and, above all, folic acid), and minerals, especially magnesium, potassium, and selenium. Beers generally have a low ratio of sodium to potassium, which is beneficial for blood pressure. There are usually quite high concentrations of calcium and phosphate in beer and also of silicic acid, which supposedly promotes the excretion of potentially harmful aluminum from the body (aluminum being one of the purported causative agents in Alzheimer's disease). [1] Depending on the color, some beers are also good sources of antioxidants. The darker the beer, the more antioxidants it tends to have. Antioxidants, in particular polyphenols, fight free radicals in the body, reducing the risk of chronic conditions and certain forms of cancer. [32]

In comparison with other alcoholic beverages, the content of alcohol is relatively low in the majority of beers. The alcohol strength of beers, which for the most part tends to be

around 5% by volume, is much lower than that of most other alcoholic drinks. Beer, then, is more suited to the quenching of thirst and counteraction of dehydration than wine, for instance. In some countries, such as Germany, beers at the lower alcohol end of the spectrum are favored as sports drinks [1]: beer has a high water content (but is relatively low in alcohol) and is rich in minerals (potassium, magnesium, etc.) as well as in vitamins. It is a practically isotonic beverage that replenishes the water reserves depleted by exercise and its readily available carbohydrates act as a valuable energy source.

There seems to be evidence for alcohol protecting against cardiovascular disease. [1] It has been found that beer dilates the coronary arteries and improves the blood levels of 'good cholesterol', inhibits fatty deposits in the internal artery walls (atherosclerosis), and thereby helps to ward off myocardial infarction. Alcohol also appears to reduce the "stickiness" of blood platelets, making them less likely to aggregate together as blood clots. [1]

Certain beer ingredients coming from its hops content, in particular xanthohumol, probably play a very major role in the inhibition of cancer growth. It has been shown in animal studies that a hops - rich diet resulted in the regression of a tumor within an extremely short timeframe. International studies have proven that individuals who regularly drink moderate amounts of beer are much less likely to suffer from carcinomas of the bladder, prostate, stomach and lungs. [3]

A person who consumes beer in a moderate but regular way has a lower risk of suffering from Helicobacter pylori infection. This bacterium is known to cause the majority of stomach ulcers and may be a risk factor for stomach cancer, and probably also contributes to the development of atherosclerosis. [3]

It has been claimed that beer stimulates milk production in nursing mothers [1] and may reduce the risk of kidney stones [3] and gallstones and promote bowel function [1]. Light to moderate alcohol intake may also improve blood sugar control, an issue for many people with diabetes. [32]

3 WORLD BEER MARKET

The beginning of the 20th century was one of the darkest periods for the world beer market. With the First and Second World Wars, the Great Depression, the Temperance Movement and the American Prohibition, beer consumption and production were significantly reduced. Many breweries were forced to shut down due to the scarcity of raw materials, the increase in the price of grain and because labor and machinery were mainly employed in war.

After the end of World War II, while the number of independent brewing companies across the world decreased steadily, concentration in national markets resulted in the rise of major corporate players. Traditional brewhouses or brewpubs disappeared almost completely, either purchased by larger breweries or ceasing activity. The effects of concentration in the market became significant during the 1970s and 1980s. A number of global conglomerates emerged following a series of mergers and acquisitions (M&A). In the US, the continued expansion of Anheuser-Busch, Miller Brewing Company, Coors Brewing Company and Pabst brought almost 75% of the US market into the hands of these four companies in the early 1980s [7]. In the UK, the market was dominated by six large national brewers which controlled the production and distribution of beer via their "tied-estates" [7]. In Europe, Heineken dominated the market together with Guinness (later Diageo) and Carlsberg. By 1999, four global leaders accounted for 60% of world beer production, with Anheuser-Busch having 25%, Interbrew 13%, Heineken 12% and AmBev 10% in volume terms [7].

The current situation, as shown by Figure 3-1, is not so different with respect to 1999. Also in 2020 there are few players accounted for most of the world beer production. ABInBev (formed through InBev, itself a merger between Interbrew from Belgium and AmBev from Brazil, acquiring Anheuser-Busch from the United States), Heineken, Carlsberg, Molson Coors and the two Chinese breweries, China Resources Snow Breweries and Tsingtao Brewery Group, together control about 60% of the global beer production.

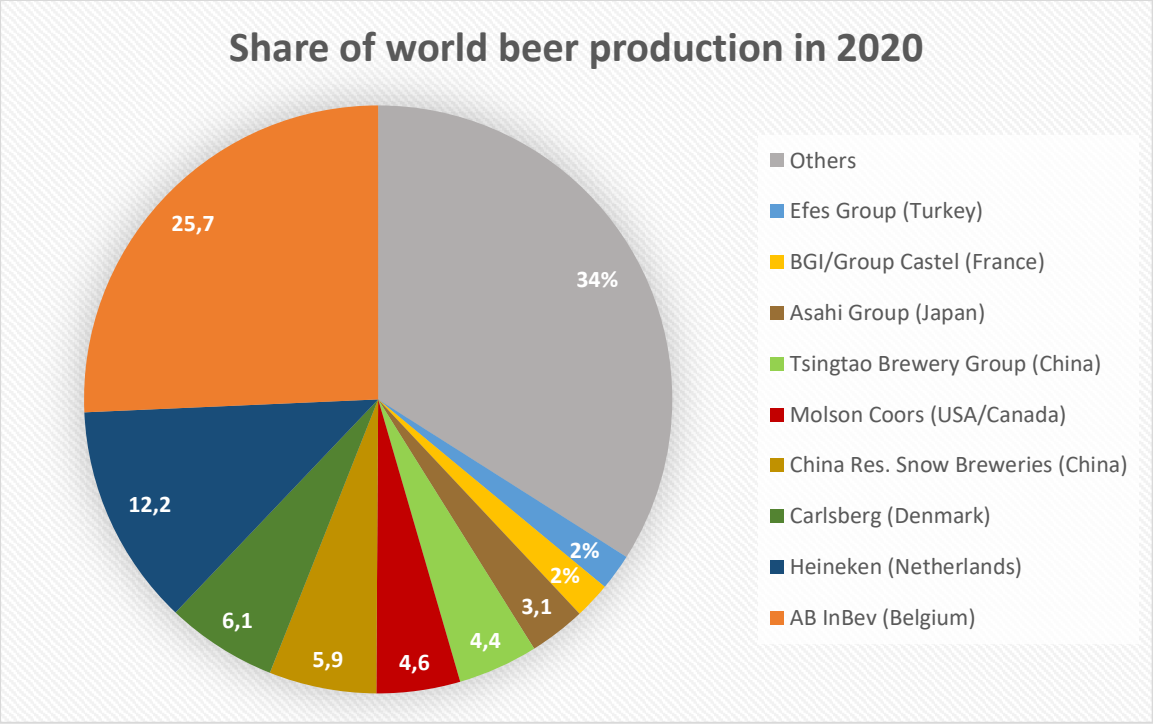

Figure 3-1. Global market share of beer production in 2020 [33]

Figure 3-2 shows the world beer production from 1998 to 2020. There was a continuous and uninterrupted growth until 2013 when, also due to the economic crisis, the global beer production hovered around 1.95 billion hectoliters/year. Starting from 2018, there was a decrease in production, accentuated in 2020, due to the spread of Coronavirus pandemic.

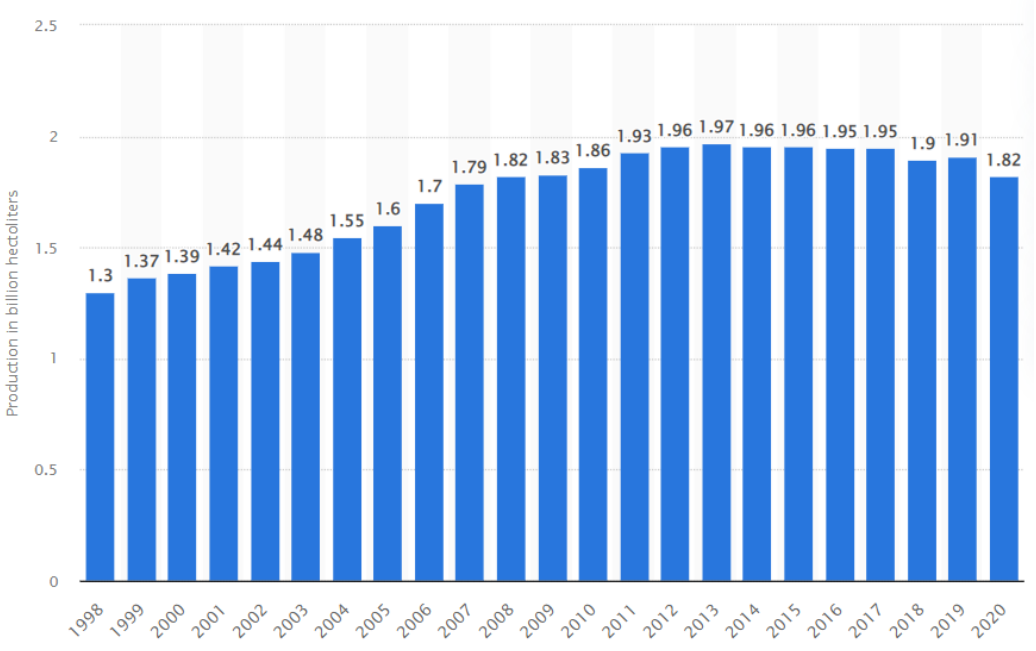

Figure 3-2. Beer production worldwide from 1998 to 2020 [34]

The outbreak of COVID-19 has been affecting the companies operating in the alcoholic beverage industry across the globe. Total beverage alcohol volume decreased by -6.2% globally in 2020, impacted by the near complete shutdown of bars and restaurants around the world. [35] In addition, Covid-19 greatly affected the world's distribution and production channels. Hobbled by the pandemic, shipping bottlenecks formed. Factories slowed or halted manufacturing. For alcohol, this caused prolonged, crippling shortages in aluminum and glass.

Beer was the most exposed category during lockdown. Beer markets in Italy, the UK and Colombia were amongst those particularly hard hit due to lockdown restrictions. Some brewers have also faced legislative challenges, including a complete ban on the sale of alcohol in India and South Africa, and a ban on home brewing in Mexico. However, by 2023, IWSR, a leading source of data and analysis on the beverage alcohol market, expects total beverage alcohol consumption to return to pre-Covid levels, with consumption steadily increasing through to 2025. [35]

The global beer market size reached USD 640.2 Billion in 2021 and it is expected to reach US$ 750.3 Billion by 2027, exhibiting a growth rate (CAGR) of 2.7% during 2022-2027. [36]

The analysis carried out at the level of production by individual countries points out that the major producers of beer during 2020 were China and USA. Together, with their 552m hl which represents 30.4 % of the global production, they exceeded the production of the whole Europe.

Region	*2019 production [1000 hl]*	*2020 production [1000 hl]*	*Growth rate 2019-2020 [%]*	*Share of world beer production in 2020 [%]*
Germany	91,610	87,027	-5.0	4.8
Russia	76,960	79,500	3.3	4.3
Rest of Europa	361,474	334,403	-7.5	18.4
Europe total	**530,044**	**500,930**	**-5.5**	**27.5**
USA	210,884	211,166	0.13	11.6
Brazil	144,772	151,900	4.9	8.3
Mexico	124,200	126,900	2.2	7.0
Rest of America	129,409	125,318	-3.2	6.9
America total	**609,265**	**615,284**	**1.0**	**33.8**
China	376,530	341,110	-9.4	17.7
Rest of Asia	235,383	209,767	-10.9	11.5
Asia total	**611,913**	**550,877**	**-10.0**	**30.3**
Africa	**140,663**	**131,506**	**-6.5**	**7.2**
Australia/Oceania	**20,607**	**20,988**	**1.8**	**1.2**
World total	**1,912,492**	**1,819,585**	**-4.9**	**100**

Table 3-1. World beer production 2019/2020 [33]

Asia and America are the regions that produce the largest amount of beer in the world. The beer market in the Americas was robust in 2019, even slightly growing by 6m hl in 2020. The figures for Asia, which saw a decline of 61m hl, were strongly influenced by decreasing output in China (-35.4m hl).

The five leading beer-producing countries are still China, USA, Brazil, Mexico and Germany. More than half of the beer produced worldwide in 2020 was brewed in those five countries (918m hl).

The same five countries, with the addition of Russia, lead also the statistic related to the global annual beer consumption.

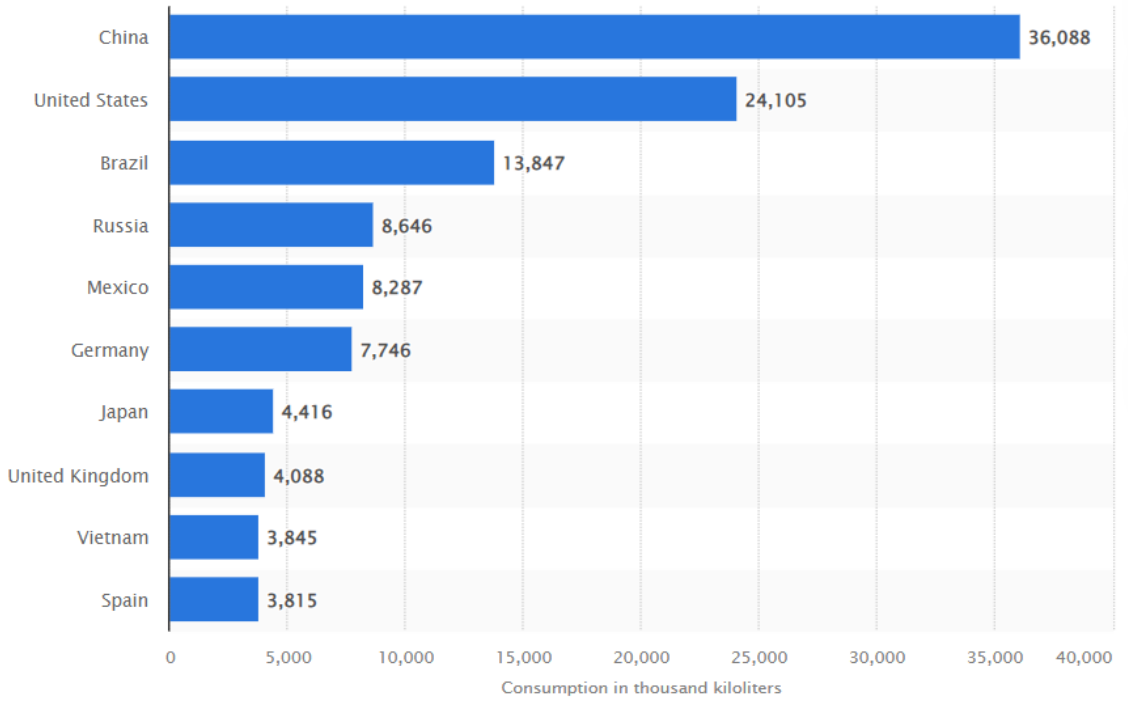

Figure 3-3. Annual consumption of beer worldwide in 2020, by country [37]

3.1 American Beer Market

As said in the introduction of this chapter and as shown in detail in the graph below, the major beer producer in North America is USA, whose production represents the 11.6% of the global beer production. It is the second world major producer after China. In South America, instead, Brazil and Mexico together produce more than USA, 279m hl against 211m hl produced by USA.

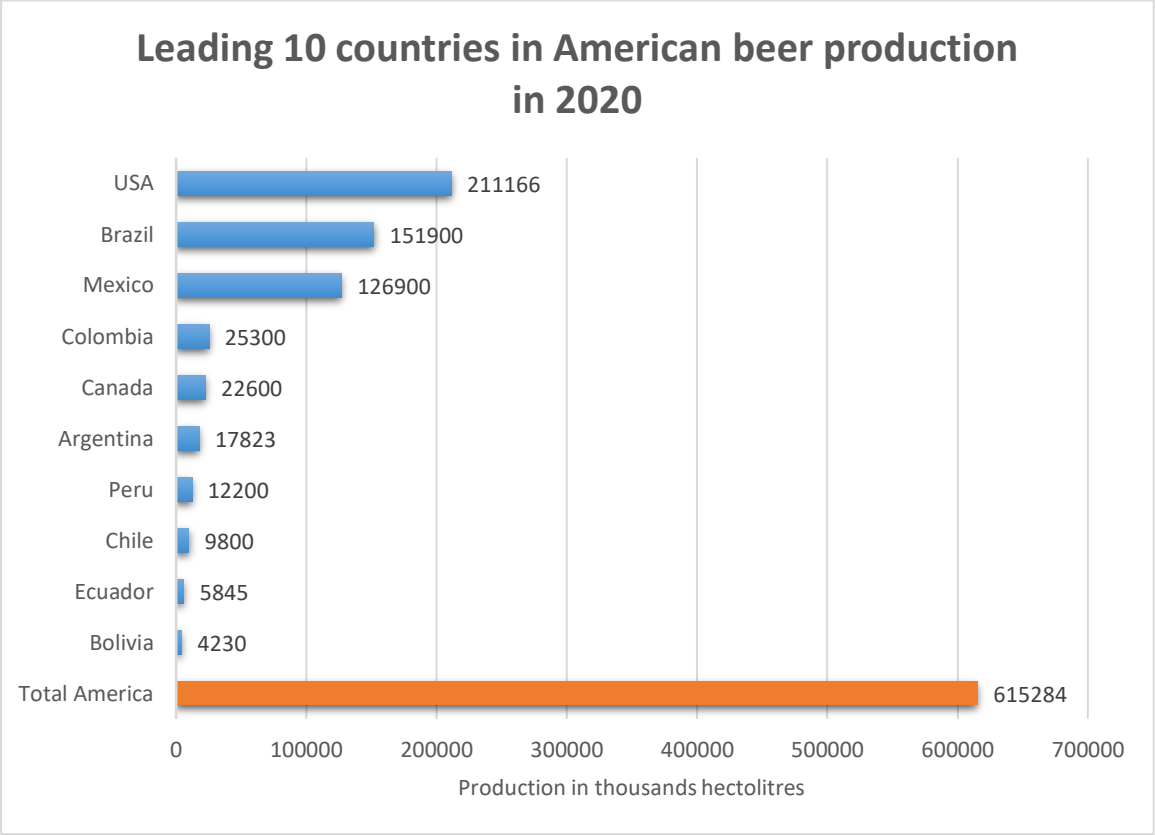

Figure 3-4. Leading 10 countries in American beer production in 2020 [33]

Historically, the U.S reached a peak of 4,131 breweries in 1873, a number that fell drastically by the middle of the 20th century. During the Prohibition era, in fact, the deadhead of the government brought the number of U.S. breweries down to zero - at least officially. Following the repeal of Prohibition, the beer industry quickly rebounded. Beginning in the early 1940s, however, brewing activity started to decline as the brewing industry consolidated and became dominated by Anheuser-Busch, Miller Brewing Company, Coors Brewing Company and Pabst. 1978 was particularly poor with the count falling to just 89. Beginning around 1980, the long decline in the number of breweries slowed and then was reversed. Judging solely by the number of breweries in operation, it appeared that a significant change had occurred: the number of firms began to increase, and by the late 1990s, hundreds of new breweries were operating in the U.S. However, this number is rather misleading: the overall industry remained very concentrated, with a three firm (Anheuser-Busch, Miller Brewing Company, Coors Brewing Company) concentration ratio in 2000 of 81 percent. [38]

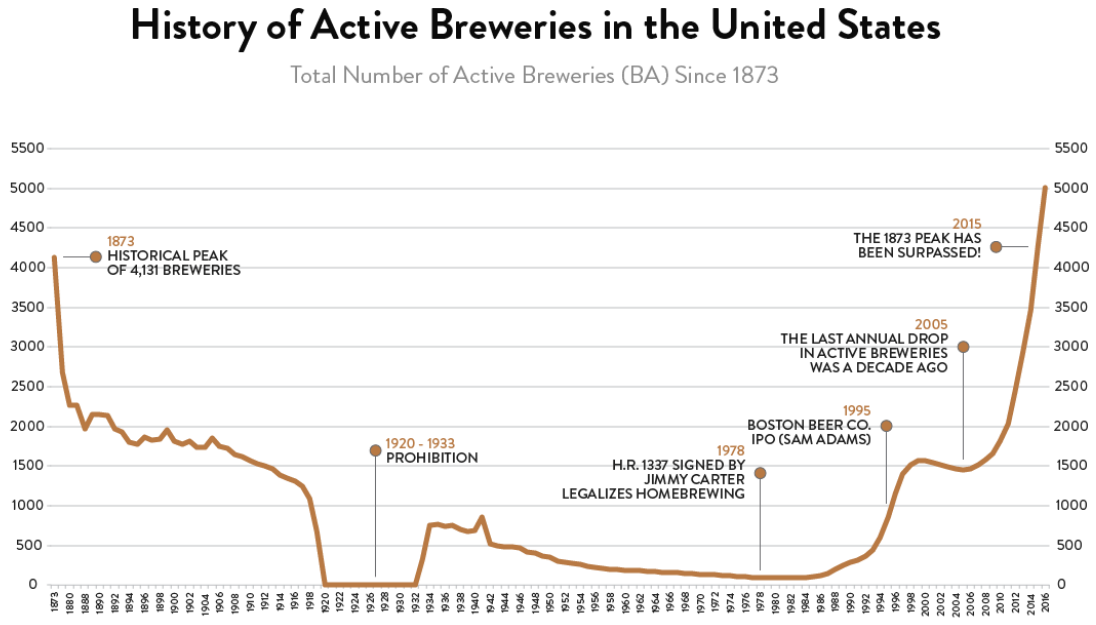

Figure 3-5. History of active breweries in the United States [39]

The beer market has been growing steadily in the U.S., with one of the reasons being the emergence of new brand labels and innovative flavors. It was valued at 120 billion U.S. dollars in 2019, declined to around 98 billion in 2020, but is projected to grow to 146 billion by 2025. Bud light, Coors, Miller Lite and Budweiser are some of the most popular domestic brands preferred by consumers. [40]

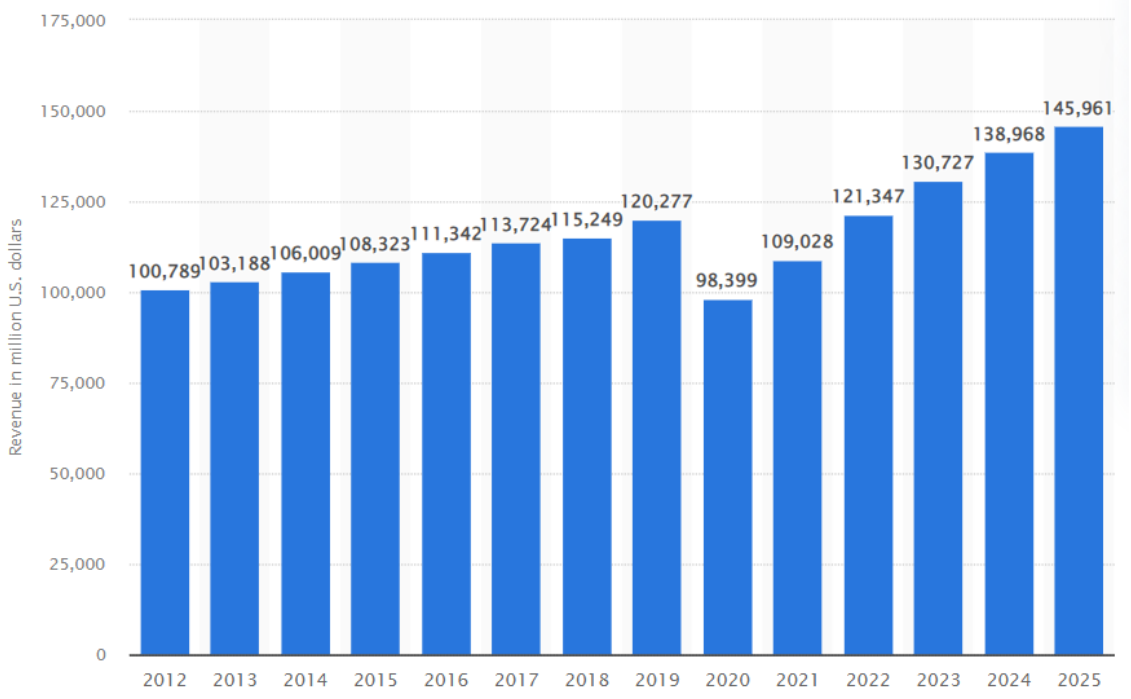

Figure 3-6. Revenue of the beer market in the United States from 2012 to 2025 [40]

In South America, the beer industry emerged as part of the Industrial Revolution which occurred in the late nineteenth century.

In Brazil, tastes for alcoholic beverages were influenced by Portuguese colonizers. Between the nineteenth and twentieth centuries, a liqueur obtained from sugar cane, called *cachaça*, became the biggest selling alcoholic beverage. Small regional breweries dominated the beer market until the 1930s, when the Brahma and the Antarctica breweries increased their production and acquired large sections of the Brazilian market. Brazil was the first country in South America to experience a merger between a national brewer and a multinational brewing company. In 1999, AmBev was formed through the merger of Companhia Antarctica and Cervejaria Brahma, which subsequently merged with the Belgian company Interbrew to form InBev in 2004. This company became AB-InBev in 2008. [7]

Between 1880 and the early 1900s the largest share of beer consumed in Mexico was imported from the United States, Great Britain and Germany. Beer was a very expensive beverage compared to traditional alcoholic drinks like *pulque* or *mezcal*. Being up to 30 times more expensive, beer was rarely accessible to the masses. The modern brewing industry in Mexico gained momentum after the 1910 revolution. Companies in the north and center of the country, with a privileged access to import of raw materials, dominated domestic production. In the 1940s, Mexico adopted import-substituting policies. However, the Mexican beer industry remained characterized by several medium-sized producers until the early 1980s, when three large companies, Grupo Modelo, Cervecería Cuahutemoc and Cervecería Moctezuma, started to progressively substitute locally produced for imported barley. The three companies began to act as brokers for barley farmers, supporting them with advanced technology to produce barley. The Mexican brewing industry remained vertically integrated and highly concentrated in the hands of a few national companies. The Mexican brewing industry changed significantly after Mexico signed the General Agreement Trade and Tariffs (GATT) in 1986 and the NAFTA (North America Free Trade Agreement) in 1994. In 1988, Cervecería Cuahutemoc acquired Cervecería Moctezuma and later became FEMSA Cerveza, establishing a duopoly with Grupo Modelo in the domestic market. While production by both brewing groups still targeted the domestic market, commercial alliances with large international breweries opened the way to export markets. As a result, Mexico became the first Latin American exporter of beer to the United States. [7]

3.1.1 Craft Beer in USA

The craft beer movement began in the USA when Fritz Maytag bought the Anchor Brewing Company of San Francisco in 1965. Anchor had begun in 1896 but had fallen on hard times.

Maytag revitalized the company by reverting to the traditional brewing practices found in Europe, where all-malt beers and ales were produced. This was a time when almost all other domestic brewers, such as Anheuser-Busch, Schlitz, Pabst, and Falstaff (the four leading producers in 1965), brewed light-bodied lager beers.
The characteristic pale color and mild flavor of traditional domestic lagers were created by replacing between 35 and 75% of the barley malt content typical of European beers with adjuncts such as corn or rice. Anheuser-Busch, Schlitz, Pabst, and Falstaff all brewed their beer in large breweries whose annual production capacities measured in the hundreds of thousands if not millions of barrels of beer.
In 1965, the Anchor Brewing Company had a capacity of 50,000 barrels but sold barely 1000 barrels of beer. It took a decade for sales to reach 7,500 barrels and the venture to become profitable. It was this eventual success and Maytag's willingness to share his experience that inspired other entrepreneurs to start their own craft breweries in Northern California, beginning in 1977 with the New Albion Brewing Company. Anchor Brewing Company's resurrection from the almost dead along with the entry from scratch by New Albion marked the start of the craft beer revolution in the USA.
Changes in both state and federal government regulations helped pave the way for new microbreweries in the USA. In 1977, federal excise tax reductions for smaller brewers went into effect. Federal legalization of homebrewing in 1979 and state legalization of brewpubs beginning in 1982 also facilitated entry. The expertise gained from homebrewing, and the resulting taste for craft beer that homebrewing caused, led many entrepreneurs to establish microbreweries that sold output off-premise (i.e. products are purchased at the location and consumed off site) and brewpubs that sold output on-premise (i.e. consumed on site). [41]
At the same time, the craft beer segment in the USA was being birthed, the macro sector of the industry also was going through a transformation, which ultimately aided the rise of craft brewing. Due to the high costs to run breweries of large size and the necessity to exploit scale economies in the production, the number of macrobrewers declined from 421 in 1947 to 10 by 2014, while the number of craft brewers increased from 1 in 1965 to 3464 in 2014. [41] Reflecting their small size, these new firms were nicknamed microbreweries.
US macrobrewers chose product characteristics that appealed to as many consumers as possible. The result was a more homogeneous and milder lager beer which was accomplished by using less hops and by replacing malt with adjuncts.
Craft brewers, instead, began to enter the market by filling up product niches left unfilled because of the homogenization of macro beer. The typical craft brewer produced darker lagers and ales similar to those being brewed in many European countries. In a sense, the craft beer segment in the USA represents the introduction of malt beverages that had been brewed outside the USA for many years.

In 1985, the number of craft brewers in the USA (37) exceeded the number of macrobrewers (34) for the first time. Entry was robust until the shakeout of the late 1990s, caused by distributional bottlenecks and the production of poor quality beer by some enthusiastic but ill-trained entrants. The number of craft brewers peaked at 1625 in 1998 and fell to 1469 by 2000. [41] Since then, the number of craft brewers in the USA grew slightly through 2010 when it reached 1758. After 2010, however, there was a resurgence in entry, with the number of craft brewers reaching 9,118 in 2021.

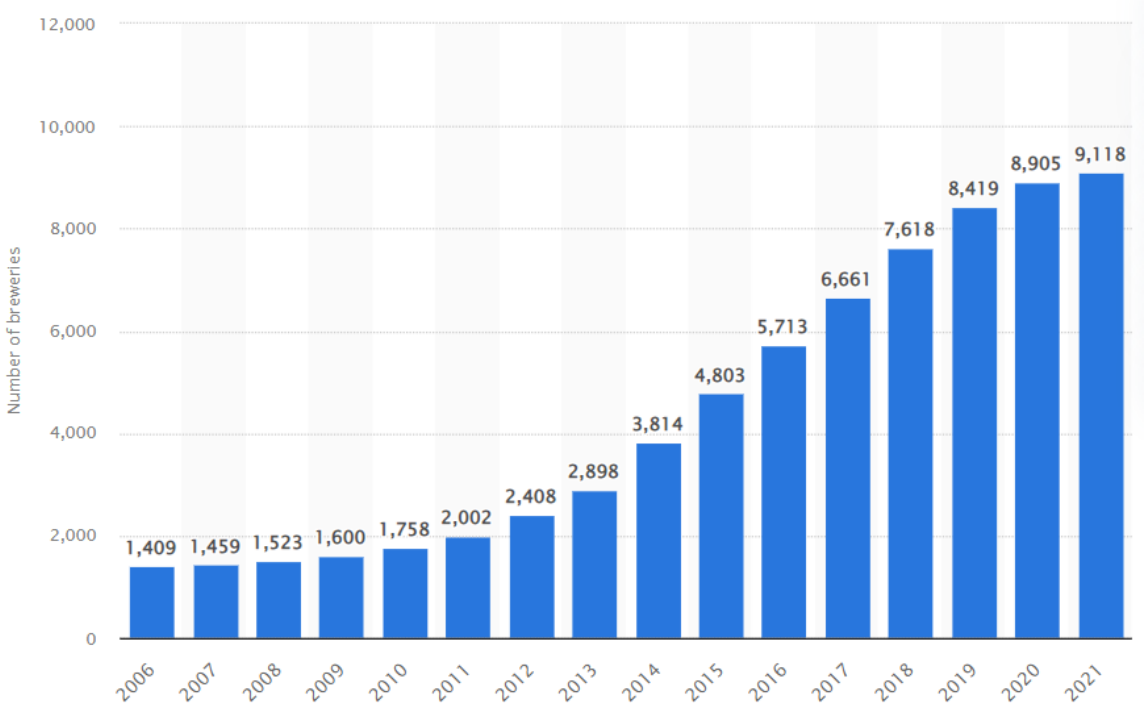

Figure 3-7. Number of operating craft breweries in the United States, from 2006 to 2021 [42]

Microbreweries have represented a new strategy in the brewing industry: rather than competing on the basis of price or advertising, they attempted to compete on the basis of inherent product characteristics. They emphasized the freshness of locally produced beer; they experimented with much stronger malt and hop flavors; they tried new and long-discarded brewing recipes, often reintroducing styles that had been popular in America decades earlier. Big breweries, such as Anheuser Busch, Miller, and Coors, have all tried to incorporate ideas from the microbrewery movement. They have introduced new marquee brands intended to compete for some of this market, and when this failed, they have bought shares in or outright control of some microbreweries.

In 2021, small and independent brewers' share was 13.1% of the U.S. beer market by volume and retail dollar sales of craft was $26.8 billion, accounting for 27% of the $100 billion U.S. beer market. [43]

3.1.2 Regulations in USA

An U.S. craft brewer, as defined by the Brewers Association (i.e. the national organization that represents the interests of small and independent craft brewers in America), is a small and independent brewer. It has an annual production of 6 million barrels of beer or less, and less than 25% of the craft brewery is owned or controlled by a beverage alcohol industry member that is not itself a craft brewer. [44]

The American craft beer industry comprises six different segments, whose definitions according to the Brewers Association are the following [45]:

1) Microbrewery. “A brewery that produces less than 15,000 barrels of beer per year and sells 75 percent or more of its beer off-site. Microbreweries sell to the public by one or more of the following methods: the traditional three-tier system (brewer to wholesaler to retailer to consumer); the two-tier system (brewer acting as wholesaler to retailer to consumer); and directly to the consumer through carry-outs and/or on-site taproom or restaurant sales.”
2) Regional Brewery. “A brewery with an annual beer production of between 15,000 and 6,000,000 barrels.” The large volume of beer produced means that the vast majority is sold off-site, in retail stores, bars and restaurants.
3) Brewpub. “A restaurant-brewery that sells 25 percent or more of its beer on-site and operates significant food services. The beer is brewed primarily for sale in the restaurant and bar and is often dispensed directly from the brewery’s storage tanks. Where allowed by law, brewpubs often sell beer to-go and/or distribute to off-site accounts.”
4) Taproom Brewery. “A professional brewery that sells 25 percent or more of its beer on-site and does not operate significant food services. The beer is brewed primarily for sale in the taproom and is often dispensed directly from the brewery’s storage tanks. Where allowed by law, taproom breweries often sell beer to-go and/or distribute to off-site accounts.”
5) Contract Brewing Company. “A business that hires another brewery to produce its beer. It can also be a brewery that hires another brewery to produce additional beer. The contract brewing company handles marketing, sales, and distribution of its beer, while generally leaving the brewing and packaging to its producer-brewery (which is also sometimes referred to as a contract brewery).”
6) Alternating Proprietor. “A licensed tenant brewery that physically takes possession of a shared brewery while brewing. In contrast to contract brewers, alternating proprietors are the brewery of record for all of the obligations of a licensed brewery, including record keeping, tax payments, and label or formula approval.”

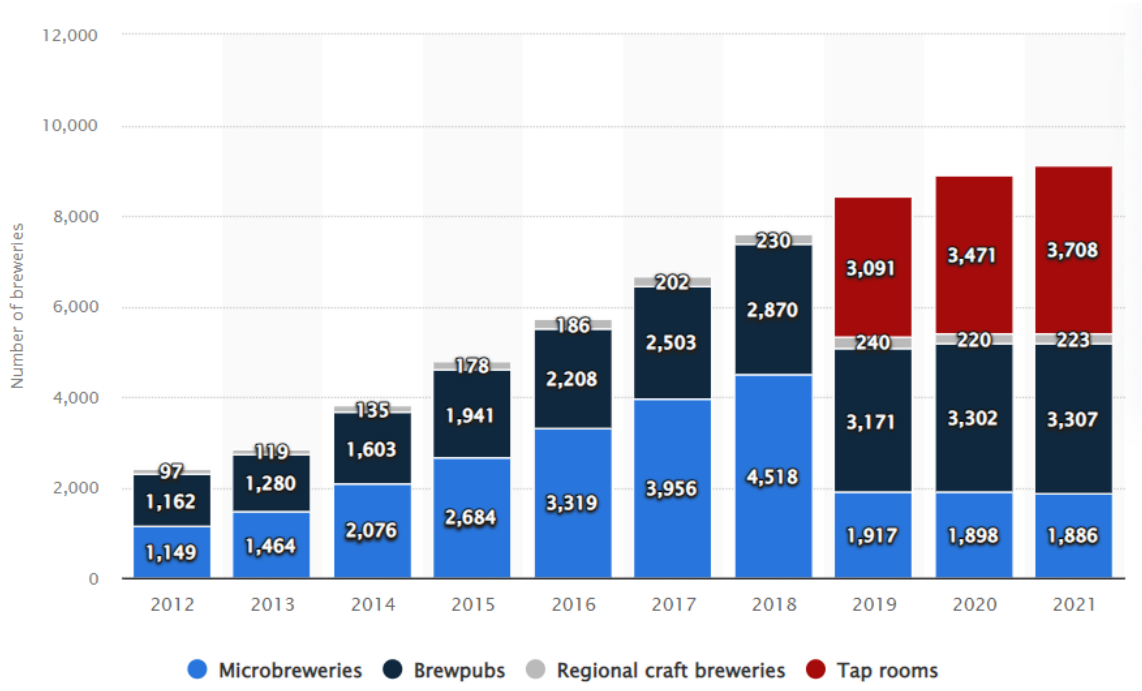

Figure 3-8. Number of operating craft breweries in the United States from 2012 to 2021, by type [46]

The brewing industry is subject to extensive government regulations at both the federal and state levels, as well as to regulation by a variety of local governments.

Prior to 1978, the federal excise tax on beer was $9.00 per barrel. In 1978, growth in the craft brewing sector was encouraged through federal tax credits offered to brewers which produce less than 2 million barrels, cutting their excise tax rate to $7 per barrel on the first 60,000 barrels and allowing them a far lower overall effective tax rate on all barrels up to 2 million. This was a windfall for craft brewers. [47] Starting from January 1, 1991, the federal excise tax on beer, was increased to $18 per barrel for 31 gallons. However, a reduced tax rate applied, at a rate of $7 per barrel, to the first 60,000 barrels of beer removed for consumption or sale by brewing companies that did not produce more than 2,000,000 barrels of beer per calendar year. [19]

The Tax Cuts and Jobs Act, passed by Congress in December 2017, provided a temporary reduction in federal excise taxes for all brewers and beer importers. Congress made these rates permanent at the end of 2020. The federal excise tax rates are now [48]:

- $3.50 per barrel on the first 60,000 barrels for domestic brewers producing fewer than two million barrels annually
- $16 per barrel on the first six million barrels for all other brewers and all beer importers
- $18 per barrel rate for barrelage over six million.

In addition to federal excise tax, which is applied to all states in the same way, state excise tax is also imposed, and it differs widely from state to state. The map below shows the

state beer excise tax rates in all 50 states and the District of Columbia. Rates vary widely: as low as $0.02 per gallon in Wyoming and as high as $1.29 per gallon in Tennessee. Missouri and Wisconsin tie for second lowest at $0.06 per gallon, and Alaska is second highest with its $1.07 per gallon tax. [49]

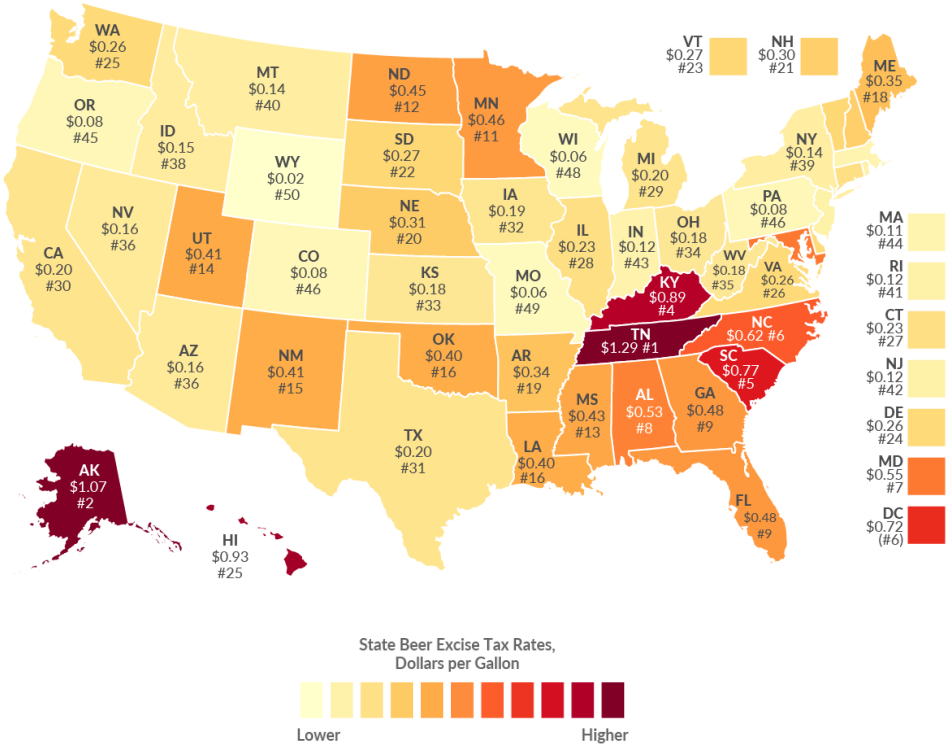

Figure 3-9. State Beer Excise Taxes (Dollars per Gallon), 2021 [49]

Many states permit local jurisdictions to regulate and separately tax beer sales, and even to prohibit the sale of beer within their jurisdiction. Jurisdictions in which the sale of alcoholic beverages is prohibited are called "dry" states. Many cities and counties that are not dry regulate operations and/or impose taxes on the sale of beer. Georgia, Illinois, Louisiana, Maryland, New York, and Ohio have cities or counties that impose local beer taxes. As might be expected, taxes can potentially represent the largest single-cost item in a glass of beer. [19]

As far as licenses are concerned, at the federal level, to qualify as a brewer you must complete and submit to TTB (Alcohol and Tobacco Tax and Trade Bureau), which manage all federal regulations involving alcohol, the appropriate forms along with any other required documentation. On the state and local level, the license process varies widely. In some areas, the state is the lead agency for all licenses (manufacturer's and retailer's licenses), and local approval is not necessary except to confirm proper zoning. Some states may control the number and type of beer retailers by issuing retail licenses and by determining to which retailer's credit can be extended. Some also determine permissible

locations for the sale of beer: on-premise, in restaurants and bars; and off-premise, in grocery stores, gas stations, liquor stores, and drug stores. [19]

3.2 Asian Beer Market

The consumption of beer has increased in Asia in recent years due to the rise in disposable income and an increase in consumer preferences for beer over other alcoholic beverages. Additionally, cultural changes and the adoption of western culture have influenced the perception of consumers toward alcoholic beverages, especially beer. [50]

The leading beer-producing country in Asia, as said, is China with its 341m hl of beer. 61.9% of the beer produced in Asia in 2020 was brewed in China.

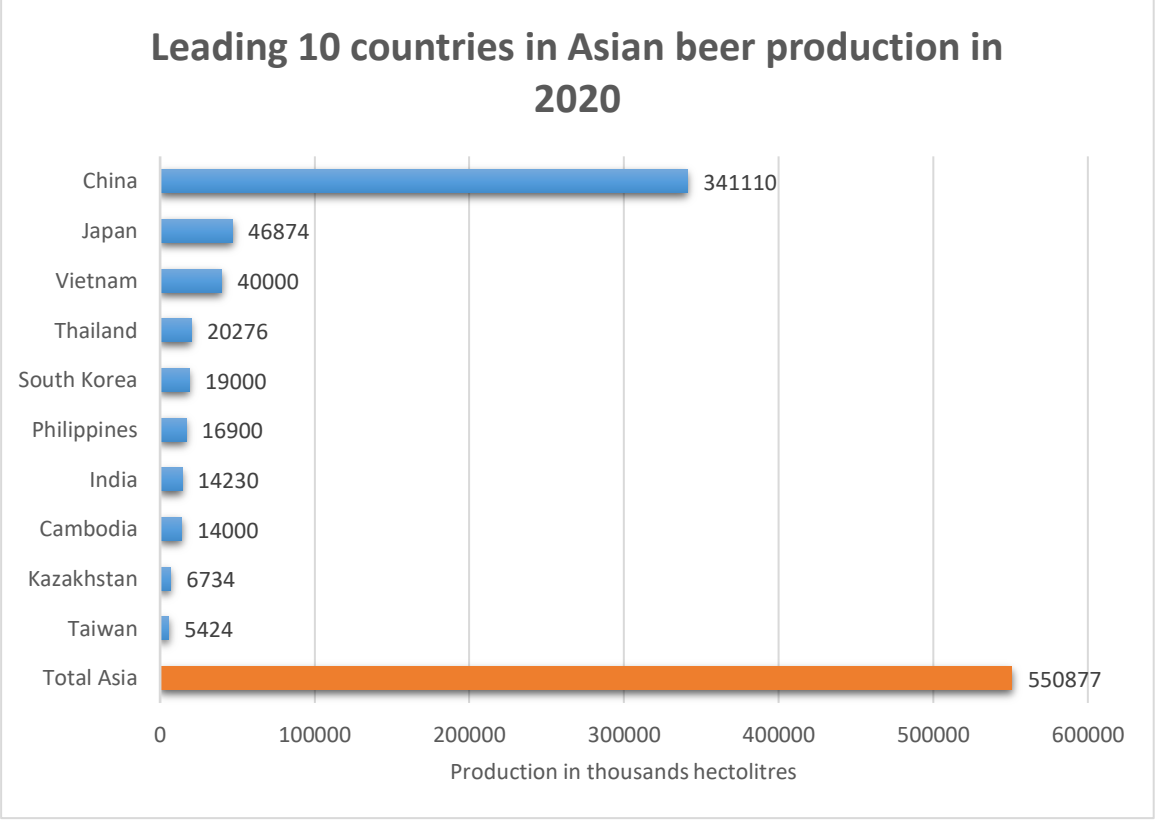

Figure 3-10. Leading 10 countries in Asian beer production in 2020 [33]

China has a long history of alcohol production and consumption, as mentioned in Chapter 1. Ancient Chinese people developed various alcoholic beverages using ingredients ranging from cereals and fruits to flowers. Both brewing techniques and drinking cultures spread with Confucian culture over the whole Asian continent. Although China had a long history of alcohol production, only recently has its alcohol industry become an important international player. This is particularly true with regard to beer. [41]

China's first breweries were established by Russians, Germans, and Czechs in the nineteenth century. Until recently, the Chinese, who traditionally preferred to drink *baijiu*, a type of highly distilled spirit with ingredients such as sorghum, rice, and even corn and wheat, did not consider beer an important national alcoholic drink. However, as the country implemented economic reforms and the disposable incomes of both urban and rural residents increased during the 1990s, China's beer industry began to catch up to its Western counterparts. [41]

The market has grown fast, although the initial production level was rather low. For example, during the early 1990s China's beer market was only about 7.64 billion liters in volume, or about 30 percent of US beer production during the same period. However, by 2001 China's beer market had surpassed the US beer market in volume, and by 2013 it had surpassed the US beer market in value and become the biggest beer market in the world. [41]

China has also taken the lead in terms of beer consumption. China beer sales remained stable from 2016 to 2020 at around 45 billion liters. In 2020, China's total volume of beer sold was 42.7 billion liters, representing a seven percent decline due to the COVID-19 pandemic. [51]

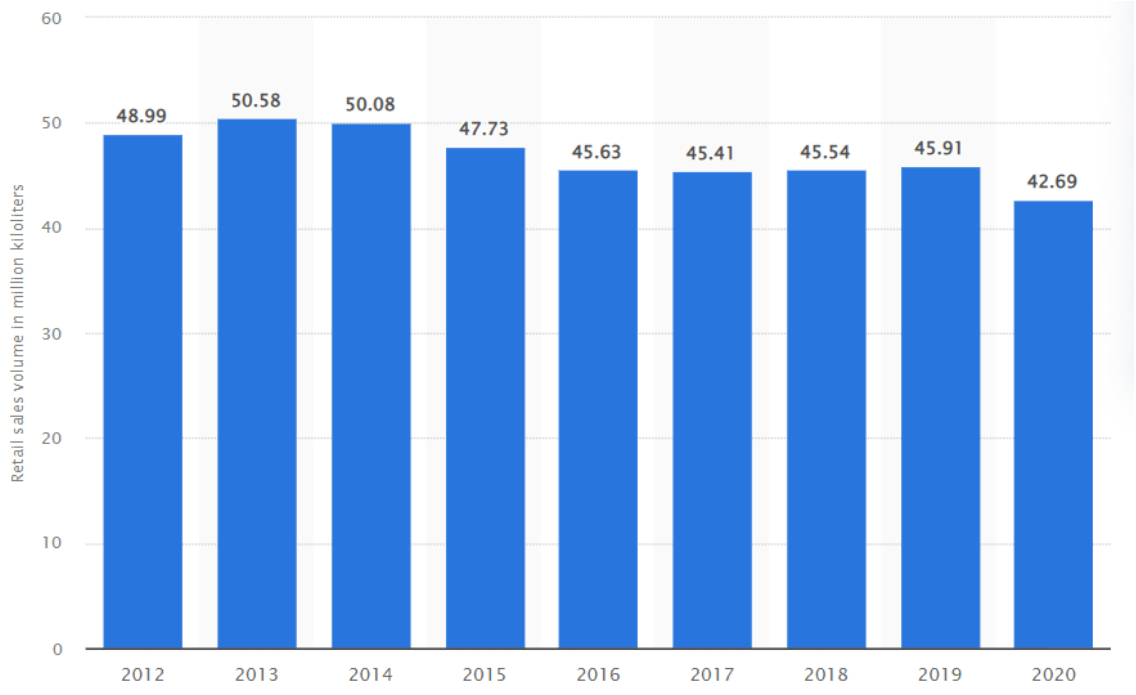

Figure 3-11. Retail sales volume of beer in China from 2012 to 2020 [52]

"China Resources Snow Breweries", "Tsingtao Brewery" and "Yanjing Beer" are the largest producers of beer in the country, which have a share of 5.9%, 4.4% and 1.9%, respectively, of the world beer production. [33] Mass-consumed beer or local brews account for more

than 90% of the market. There is a huge demand, however, for imported and premium brands, as well as for craft beers. [53] Foreign companies like Budweiser (AB InBev) and Carlsberg go toe to toe with China's biggest breweries in terms of sale.

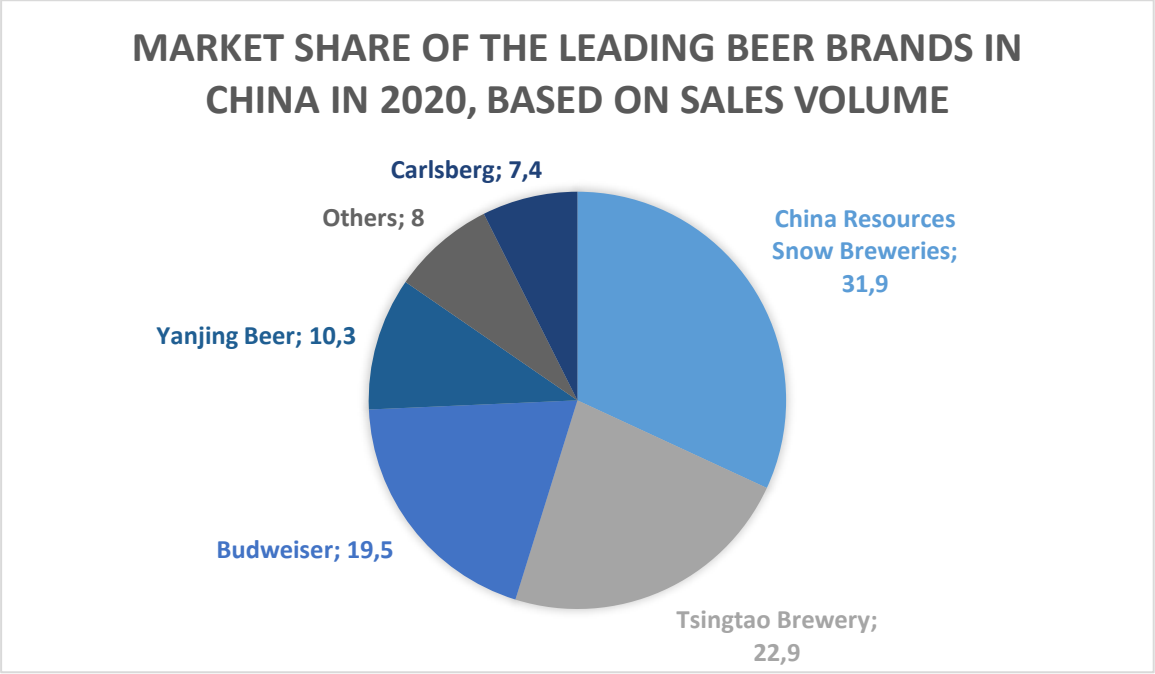

Figure 3-12. Market share of the leading beer brands in China in 2020, based on sales volume [54]

Germany and Belgium are the leading two sources of imported beer, followed by Mexico, France, and the Netherlands.

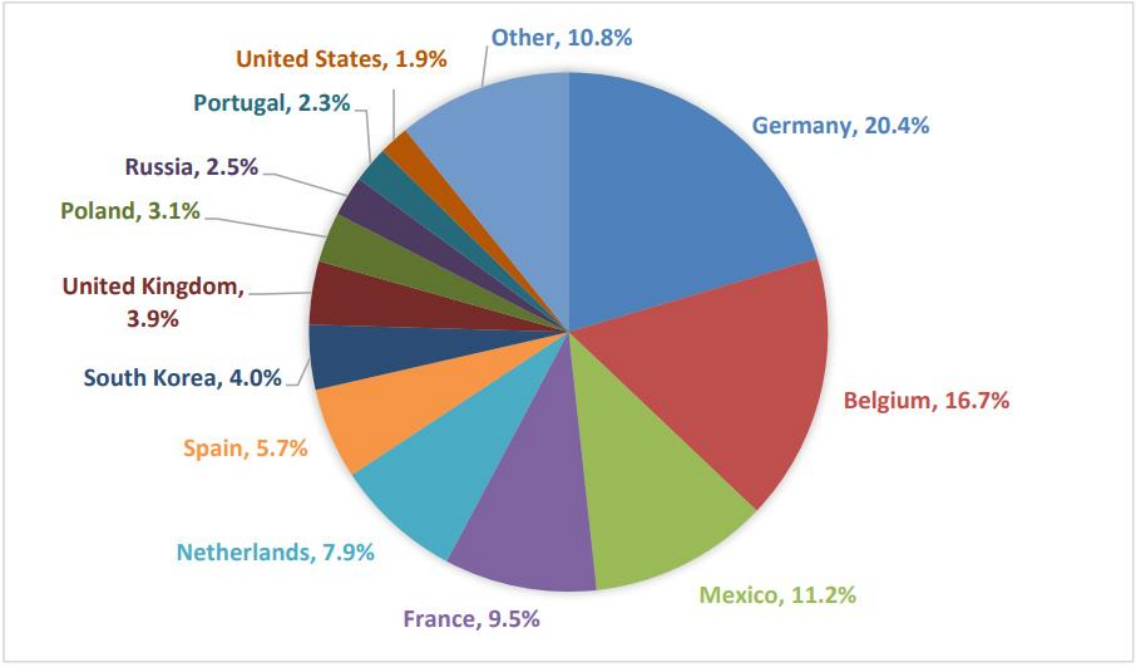

Figure 3-13. China imported beer market share in 2020 [51]

In 2020, China imported $695 million of beer, with decline of 15.2 percent with respect to 2019. [51] In 2021, the revenue of the beer market in China reached around 121.9 billion U.S. dollars. [55]

3.2.1 Craft Beer in China

While mass producers compete through consolidation and acquisition in China's beer market, a new entity has begun to emerge: the craft brewery. Craft breweries are still young but are becoming more important in China's beer market. Brewpubs (where beer is brewed with traditional European methods and served on-site) started growing and spreading out fast in the urban cities to serve their unique flavored beers after 2000. [41] Some unofficial reports claim that the first craft brewing pub was opened in Shanghai by a beer specialist from Texas in 2006. [41]

The rising number of the craft breweries in the UK and USA was much more a direct reaction against the homogenization of beers. To some extent, China's beer market performs a similar pattern. In fact, China's beer market became much more homogeneous after the country joined the WTO in 2001. Fierce competition among the mass producers over millions of people in an entire generation of new beer consumers led to marketing strategies focused on branding and advertising, instead of quality improvement. The beer industry in China has become a very capital-intensive industry where scale economies are the main driver of growth. [41]

As globalization and consolidation homogenized Chinese beer offerings, the cultivated urban beer drinker in China's first-tier cities (like Beijing, Shanghai, and Guangzhou) began to search for more diversified and higher value-added (more alcoholic) drinks. The same trend had been observed in the USA during the early 1990s. The increasing popularity of craft breweries in China directly reflects increased consumer demand for diverse, high-quality beers. Craft breweries in urban cities are generally serving this fast-growing trend. However, to succeed on this frontier is not easy. Craft breweries are characterized by smaller scales of production and local distribution (e.g., they serve on-site or in collaboration with restaurants and beer pubs). [41]

To summarize, several factors seem to have driven the growth of China's craft beer industry [41]:

1) Growing purchasing power and urbanization created demand for craft beers. Increased purchasing power enabled urban residents to afford such high-quality products as craft beer, and fast urbanization provided them with more opportunities to get access to such a diverse array of products.
2) The adventurous spirt of Chinese beer drinkers and craft brewers helped shape the craft brewing industry. The long isolation of the Chinese economy before the 1990s

blocked almost every connection in people's life forgetting to know about the outside world. The opening-up reform, for the first time, brought people back to the world with numerous exotic things. Being adventurous became necessary for people to adapt their life to fit into this new society. Chinese consumers are searching for new products all over the world. Beer drinkers and craft brewers are especially curious about experimenting with new flavors. The adventurous spirit among Chinese craft brewers, meanwhile, is reflected in the development of unique Chinese craft beer recipes and marketing techniques. To meet consumers' demand for unusual new beers, local craft brewers develop their recipes with ingredients such as jasmine flowers, oolong tea, and sweet yam. The unique flavors attract those beer drinkers consistently looking for new brews. At the same time, to market their beers in a local cultural way, craft brewers often name their beers with some historical hero's name (or some local well-known ingredients) to illustrate the beer's special characteristics.

3) On the supply side, entrepreneurship and increasing investments stimulated craft breweries. Most early craft breweries in China were started by foreigners. Nowadays, Chinese entrepreneurs know that the country's craft brewing industry lags far behind the USA or the UK and expect that it has great potential for growth. In addition, other investors have focused on increasing the production of brewing equipment. The fact that such equipment is now easily available will undoubtedly boost the growth of craft brewing in China.
4) China's food safety concerns promoted the growing trend of craft brewing. In 2005, after several media reports that mass producers (like Tsingtao, Yanjing, and Snow) were adding formaldehyde to beer, demand for "organic beer" rose dramatically. Craft breweries that emphasize authenticity have an advantage over mass producers in fulfilling consumers' desire for a real, safe beer.

There are important challenges for craft beers in the country. First, regulations continue to ignore the development of the craft breweries and need to be adjusted (more details in the next Paragraph). Second, competition with both international craft beers and national industrial beer brands has increased. Lastly, Chinese craft breweries have difficulty in accessing high-quality ingredients locally. Ideally, craft brewers typically use better-quality barley (lower in protein and other minerals, but rich in starch) than large-scale, mass brewers and better ingredients in general. Importing all the ingredients is necessary and possible, but it has substantially increased craft brewers' variable costs. [41]

In 2020, the consumption volume of craft beer in China totaled 830 million liters and was yet expected to triple by 2025. [56]

3.2.2 Regulations in China

In China, there are two categories of regulations and laws that all brewers have to comply with: beer production regulations, which are mainly implemented through the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ); and general food safety laws, which are mainly implemented through regulations and laws from the Ministry of Health. To protect consumers against health risks, AQSIQ imposed various standards for brewers and brewing procedures. The regulations affect almost every aspect of the brewing industry, from sourcing to labeling, from brewing to bottling. The Standardization Administration of China (SAC) has compiled comprehensive national standards for the brewing industry to comply with, accompanied by detailed implementation procedures from AQSIQ. [41]

However, under China's current regulatory system, there is no official definition of "craft brewery," nor is there a general guide for craft brewers to follow. The regulations and laws are all designed for mass beer producers. This gap in regulation significantly inhibits the growth of craft breweries in China. Without official regulations for craft breweries, both craft and industrial brewers have to comply by default with the same regulations, which are generally designed for mass producers. An example of a regulation that is appropriate for mass producers but not for craft brewers is that bottled and canned beer produced in China will not meet the quality control standards for distribution if it tests positive for yeast or any other microbiological bacteria. Bottled and canned beer must be filtered and pasteurized, thus removing yeast. However, these procedures will destabilize or remove flavors that the craft brewer intended for the finished beer. As a result, craft brewers choose to supply their craft beers to restaurants and brewpubs, where they need to comply with less strict food safety regulations. In the short run, serving new beers in restaurants might be a good strategy for craft brewers to increase customer familiarity with their brands, without violating the regulations. However, the lack of a specific and clear regulation for craft breweries in food safety law might cause an increase in misbehavior in the craft brewing industry. Since the concern over food safety in general is already pretty tense, this failure of regulation might cause the government to crack down on the whole craft brewing industry just as it begins commercializing. For example, after the milk scandal in China, the government tightened food safety standards across all food industries, including the beer industry. The country's fledgling craft brewing community suffered as it tried to adhere to an even stricter structure and management code, which are in fact designed for mass beer producers. Many craft breweries are in fact incapable of complying with these requirements simply because they are smaller scale, and the new management code is too costly for them. [41]

A national craft brewing association could interact with the government in setting up negotiations to improve the regulations. However, China does not yet have such a nationwide association of craft breweries, as the Craft Brewers Association (CBA) in the

USA. Several regional craft brewing associations have been established, such as the Beijing Homebrewing Society (BHS), to promote brewing knowledge and to co-organize beer festivals. These societies are in their infancy, and it is still difficult for these fragmented, volunteer, non-profit organizations to be strong actors in regulatory discussions and guiding China's craft brewery development. [41]

Another major limitation in China is that the National Development and Reform Commission requires a brewery to have a production capacity of 12,000 bottles per hour to receive a commercial license. It can be considered as a significant barrier to entry considering that usually a craft brewery starts as a microbrewery with a significantly lower production. [57]

3.3 European Beer Market

Following America and Asia, Europe is the third continent for beer production in the world.

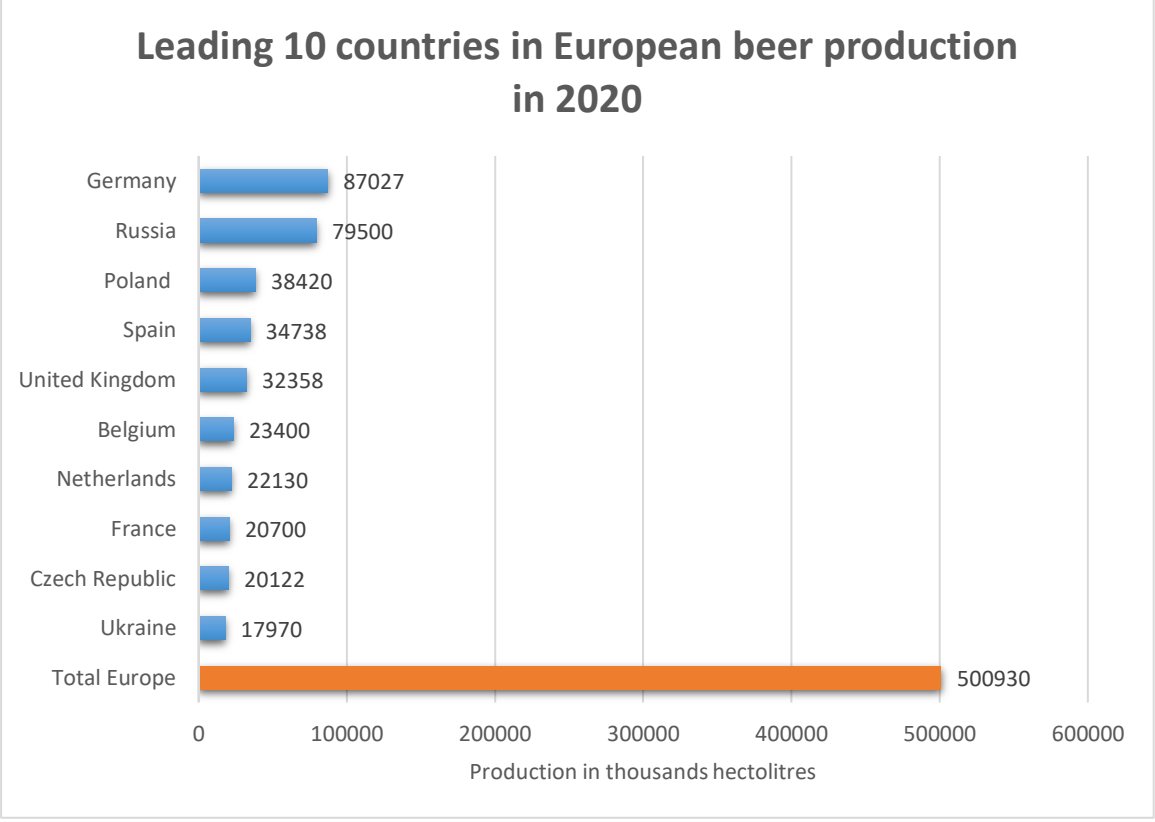

Figure 3-14. Leading 10 countries in European beer production in 2020 [33]

Some countries of the old continent, where beer has always represented the largest share of alcohol consumed, have seen in the last ten years a consistent reduction in the

production of beer. For example, in 2010 Germany and United Kingdom produced 95,683 and 44,997 thousands hectoliters, respectively. This means that, with respect to 2020, there was a decrease in production of about 9% in Germany and of about 28% in United Kingdom. [58] Belgium, a country very famous for its brewing traditions, differently from Germany and United Kingdom, has increased its production of about 29% with respect to 2010. [58] Also France has had a strong growth progression with a plus of about 5 million hectoliters compared to 2010. [58] Very significant is the case of Ukraine: its production has reduced of about 42% with respect to 2010. Part of the explanation for the steep decline in production is that Ukraine's brewers lost a big chunk of their market after Russia's annexation of the Crimean Peninsula in March 2014 and the subsequent war in Donbas. [59]

Even if France is not the country with the highest production in Europe, it shows a very interesting figure: it is the country with the highest number of active breweries in 2020 (2,300), followed by the UK (1,870) and Germany (1,528). This trend is significantly changed in the last years. In 2014, in fact, the UK with its 1,430 active breweries was the first in Europe, followed by Germany (1,359) and France (663). [60] However, in terms of consumption habits, France is still lagging behind its neighbors when it comes to beer. They may have the most breweries, but the French drink less beer than most of the other European countries, according to Brewers of Europe. The French came in last in 2020 with 33 liters per capita, far behind the Czechs who drank 135 liters each, Austrians who consumed 100 liters and Germans with 95 liters per capita. [60]

3.3.1 Germany's Reinheitsgebot and Beer Regulations

The medieval Reinheitsgebot, or "Purity Law", is a decree mandating that all beer be made from four ingredients: barley, water, hops, and yeast. It is the oldest food law still in effect. Duke Wilhelm IV signed the Reinheitsgebot into law for Munich in 1487 and for all of Bavaria in 1516.

It is argued that the Reinheitsgebot served first and foremost as a consumer protection policy, regulating the production of beer during earlier times to ensure the health and safety of the beer. Prior to the introduction of this decree, there were many incidents of brewers using additives that turned out to be toxic. During the Middle Ages, brewers experimented with rushes, roots, mushrooms, and animal products as beer additives. They were not always forthcoming about which ingredients they used. In reality, the original law was mainly written because of rising prices in wheat and rye, which was causing bread prices to spike. Limiting brewers to barley reduced the demand on wheat and rye, and as a result the price of bread dropped.

The integration of Germany into the EU led to a challenge against the oldest existing beer regulation in the world. In 1987, exactly five centuries after Duke Wilhelm IV signed the

initial Reinheitsgebot, the European Court of Justice ruled that it conflicted with European trade laws and ordered it to be removed for foreign beers. In fact, the Reinheitsgebot constituted a non-tariff barrier to trade within the EU. Nevertheless, it remained in effect for beers brewed within Germany. German brewers that fail to adhere to the Purity Law may sell their beverages but may not call them “beer.” Non-German brewers, instead, are allowed to sell even non-Reinheitsgebot brews into Germany and call them “beer”.

Critics argue that while it may at some point have served to protect beer consumers against the use of unhealthy ingredients in the production of beer or against rising bread prices, more recently the effect has been to protect German brewers from competition (they try to distinguish their “pure” beer from the foreign “chemical beer”) and stifle innovation in brewing (hindering the worldwide trend toward craft beer).

German brewers who are adopting craft beer styles cannot market these products as beer. Instead, they must call them by the name of the specific style (IPA or stout, for example) and market them as Biermischgetränke, “mixed beer drinks.”

3.3.2 Craft Beer and Beer Regulations in the UK

The United Kingdom is, together with France, the European country with the highest number of microbreweries: 1852 for UK and 2000 for France. However, its beer consumption per capita is significantly higher than the French one: 61 liters against 33.

In the UK, the origin of the craft beer movement is typically associated with the emergence, in the 1970s, of CAMRA (Campaign for Real Ale), an organization with the main objective of campaigning for the revival of “real ale,” cask-conditioned beers brewed with traditional methods, for instance non-pasteurized and non-filtered, and served without gas-driven dispensing but rather hand pumped. The work of CAMRA in promoting traditional ales created a potential customer base for the rise of new breweries, increasingly perceived by the public as an alternative to mass producers. The introduction of Progressive Beer Duty (PBD) in 2002, which granted small and micro-breweries a lower tax levy than large brewers, boosted the growth of these businesses throughout the country. [61] Such a decision came after years of active campaigning from industry organizations such as the Society of Independent Brewers (SIBA), established in 1980 to represent the interests of the growing number of British independent breweries. It also aligned the UK system with those applied by other EU members for small businesses operating in the brewing industry. Prior to the introduction of PBD, all breweries paid a flat rate of excise duty per hectoliter of beer produced according to its alcoholic strength. With the PBD, brewers benefits from a 50% reduction in duty on the first 5,000 hl of annual production, and a progressive tax remission system up to an output level of 30,000 hl (raised to 60,000 hl in 2004), after which the full duty is paid. [41] The system has been

hugely successful and led to a significant growth in the number of independent craft breweries in the UK.

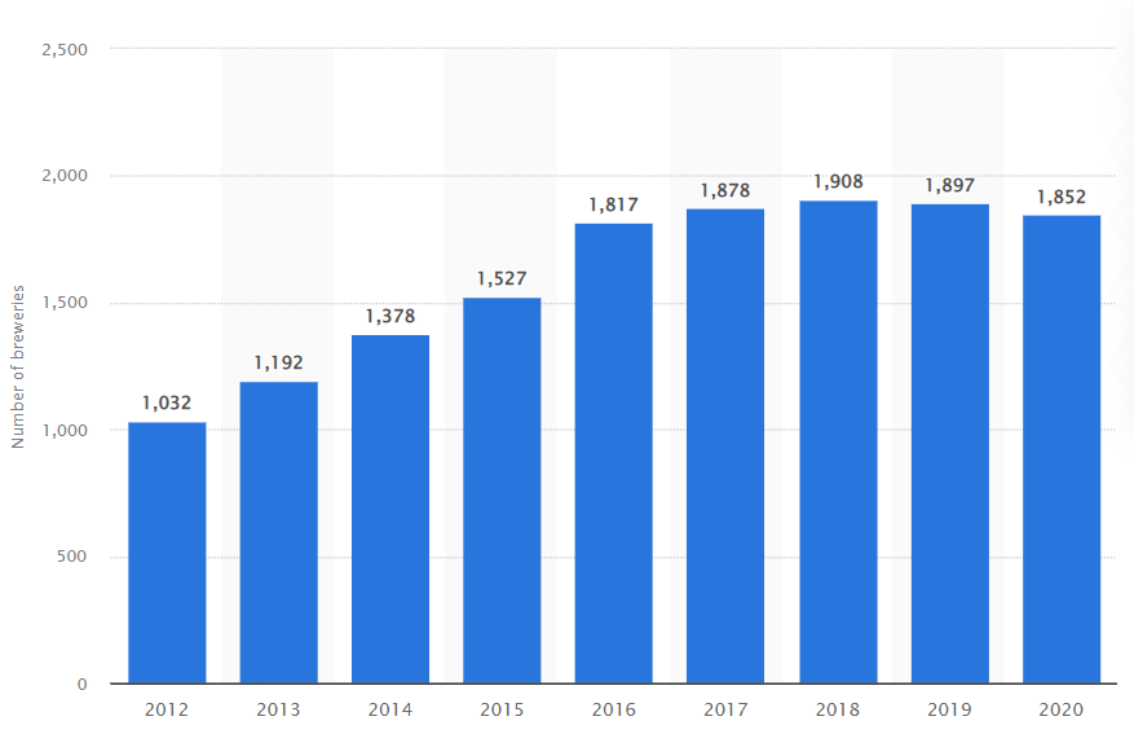

Figure 3-15. Number of active beer microbreweries in the United Kingdom (UK) from 2012 to 2020 [62]

There is no universal definition of craft beer in UK.

However, in order to use SIBA's Assured Independent British Craft Brewer logo in the UK, the beer must be brewed by a British brewer who abides by the SIBA Manual of Good Brewing Practice; is truly independent of any larger controlling brewing interest; and brews less than 200,000 hl annually. SIBA currently represents around 830 independent craft breweries. [63]

3.4 African Beer Market

Beer market in Africa cannot be compared with the ones of Europe, Asia and America (see Table 3-1). In terms of production, in 2020 Africa contributed for only 7.2% to the global beer production.

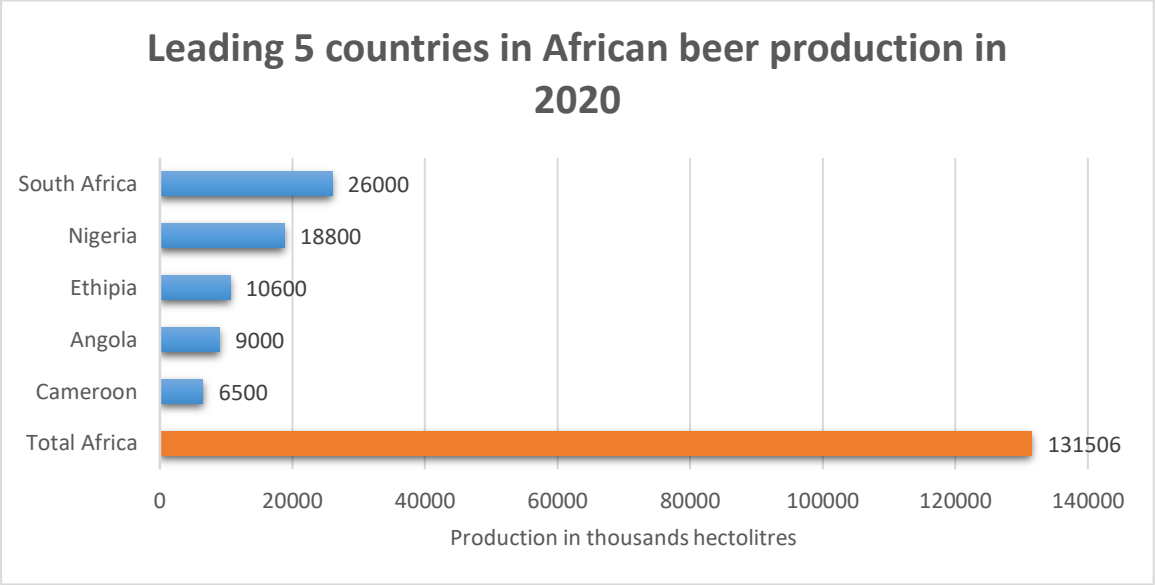

Figure 3-16. Leading 5 countries in African beer production in 2020 [33]

However, African beer market is very attractive and companies such as Heineken, Diageo and units of Anheuser-Busch InBev, such as SABMiller, are investing heavily in building new breweries, expanding to other countries and advertising their products. The reasons are different. First of all, according to a study by Kirin Holdings Co., in Africa beer consumption rose by 33% between 2010 and 2019, making it a rare growth region in a world whose thirst for beer is generally decreasing. Second, there is an increase in population in Africa which could eventually lead to high levels of consumption. By 2050, it is forecasted that its nations will have a larger combined population than either China or India. [64] Lastly, the sustained positive economic growth rates of many African countries signal an increasing level of disposable incomes and purchasing power of people and hence a favorable market potential. [7]

The fragmented nature of the African market, coupled with infrastructural problems, particularly in the rural areas, is however posing a challenge to the effective promotion and distribution of beer. Additionally, the increasing attention on both the economic and health burden of beer drinking is triggering the development of policies by countries in the region to regulate beer drinking as well as its marketing. Many countries are using increasing taxation and excise duties in controlling the marketing of beer and alcohol in general. In some countries, such as Gambia, advertising beer on television, radio or through sport sponsorship is prohibited. In other countries, such as Ghana, Uganda and Nigeria, the brewing- and beer-related policies and regulations developed so far are not very strict. In fact, Uganda and Ghana both rely on self-regulation by the brewing and beer industry. Madagascar, on the other hand, has legislation that prevents beer advertising as well as sale anywhere near public institutions such as religious buildings, hospitals and

schools. Because of religious reasons, countries in North Africa also have restrictive policies on beer drinking and marketing. [7]

Even though a growing movement of craft breweries is trying to get the African drinkers to broaden their tastes, the total number across Africa remains relatively low. In South Africa, where the craft beer started to become popular in 1983 with the opening of a craft brewery in the Western Cape [65], there were 225 craft breweries in 2019 [66].

3.5 Australian/Oceanian Beer Market

Australia's overall beer production in 2020 was the highest in the Australia/Oceania region, with the country producing a total of 16.58 million hectoliters (out of a total of 20.99m hl – 79%), compared to the around three million produced by New Zealand in the same year. [33]

The Australian craft beer industry has become an ever-expanding section of an Australian beer market that has long been dominated by the country's big beer brands and major breweries. Imported beers and popular brands like VB, Carlton, Tooheys, and XXXX remain as some of the most consumed beers in the country, but Australians are also developing a taste for locally owned and brewed beers. Over the past decade, the number of independent and craft breweries in Australia have multiplied to almost 300 brands. The craft beer industry in Australia is valued at more than 150 million Australian dollars and is estimated to be increasing by five to ten percent each year. [67]

The beer industry is highly taxed in Australia. In fact, the single biggest cost in the price of an Australian-made beer is tax. According to the Brewers Association of Australia, Australians pay the 4th highest beer tax in the industrialized world, only after Norway, Japan and Finland. [68]

4 ITALIAN BEER MARKET

Law No. 1354 of 16/08/1962 establishes the hygienic regulation of beer production and trade. Throughout the years from 1962 to now, this law, consisting of 32 Articles, has undergone numerous amendments. [69]

According to the first article, replaced by D.P.R. 30/06/1998 No. 272, the beer denomination is reserved to a product obtained from alcoholic fermentation with *Saccharomyces cerevisiae* or *Saccharomyces carlsbergensis* strains of a must prepared with barley malt (also roasted), or wheat or their mixtures, and water, with the addition of hops, or its derivatives, or both.

The second article, replaced by D.P.R. 30/06/1998 No. 272 as Art.1, provides some further definitions:

1. the name "non-alcoholic beer" is reserved for a product with a Plato degree not lower than 3 and not higher than 8 and with an alcoholic strength by volume not exceeding 1.2%
2. the name "light beer" is reserved for a product with a Plato degree not lower than 5 and not higher than 10.5 and with an alcoholic strength by volume higher than 1.2% but lower than 3.5%
3. the name "beer" is reserved for a product with a Plato degree higher than 10.5 and with an alcoholic strength by volume higher than 3.5%; this product can be named "special beer" if the Plato degree is not lower than 12.5 and "double malt beer" if the Plato degree is not lower than 14.5
4. when fruit, fruit juices, flavorings, or other characteristic food ingredients are added to the beer, the sales denomination is completed with the name of the characterizing substance.

A legislative change that took place in 2010 then revolutionized the Italian brewing system. Ministerial Decree 212/2010 recognized beer as an agricultural product for all intents and purposes and the agricultural brewery as a company employed in the production and direct sale of agricultural beer, marking an important turning point in the regulatory framework and, consequently, in the market for the production and marketing of the beer in Italy. The concept of agricultural beer is based on a similarity to what has long existed for wineries: a farmer who grows grapes for wine production in his vineyards can also produce and market his own wine. The Decree states that farmers must produce agricultural beer with at least 51% of self-produced barley. [70]

With the aim of protecting, promoting and enhancing the activity carried out by agricultural breweries, COBI - Consorzio Italiano di Produttori dell'Orzo e della Birra (Italian Consortium of Barley and Beer Producers) was founded in 2003 in the Marche region. It is the only Italian consortium that brings together more than 130 farmers [71] who, in addition to being barley producers, are at the same time producers of agricultural beer. The farmers adhering to the consortium grow and harvest barley for brewing and then give it to the consortium, which processes it into malt. The malt is taken back by the farmers to brew their own beer, using artisanal methods.
COBI has also registered the collective trademark "Birragricola". To join it, its members must produce their beer with at least 70 percent of the raw material produced within the consortium, instead of the 51 percent required by the Decree: the use of this mark activates mechanisms of territorial recognition that favor the promotion of the finished product. [70]

Six years later, through Art. 35 of Law No. 154 of 28/7/2016, it has been added, for the first time in Italy, a definition for craft beer: beer produced by small independent breweries, and not subjected, during the production phase, to pasteurization and microfiltration processes. A small independent brewery is a brewery that is legally and economically independent of any other brewery, which uses plants that are physically distinct from those of any other brewery, which does not operate under a license to use the immaterial property rights of others and whose annual production does not exceed 200,000 hectoliters, including the quantity of beer produced on behalf of third parties.

As it is possible to notice, the definition of craft beer is built on that of craft brewery; it means that a beer can be defined as craft only when it is produced by a company that bases its principles on the craftsmanship of work. Summing up, a craft brewery is characterized by:

- absence of certain industrial solutions (microfiltration and pasteurization)
- maximum annual production of 200,000 hectoliters/year
- legal and economic independence.

4.1 Production and Consumption

In recent years, up to 2019, Italy has recorded a long series of successes in the beer world with history-making increases in production, consumption and exports, proving that it plays a leading role foremost in the landscape of the beverage industry and thus in the national economy. A trend that has consolidated the sector's added value for the country, which has translated into a positive impact on both employment and tax revenues.
These results have been achieved thanks to the growing appreciation of Italians for beer, which is increasingly present on our tables and of an industry that has invested in innovation, research and development, but also dissemination of the beer culture.

Due to Covid-19 pandemic, 2020 depicted a completely different scenario. The national beer production decreased by 8.4%, from 17,288 thousand hectoliters in 2019 to 15,829, after the last 10 years had seen production increase volumes by 35%. These results are the mirror of a crisis that has involved the entire supply chain of beer and in particular the consumption of the out of home that, with the restrictions imposed, have marked a drop in consumption of 11.4% (18,784,000 hectoliters vs. a 2019 that had exceeded 21 million hectoliters).

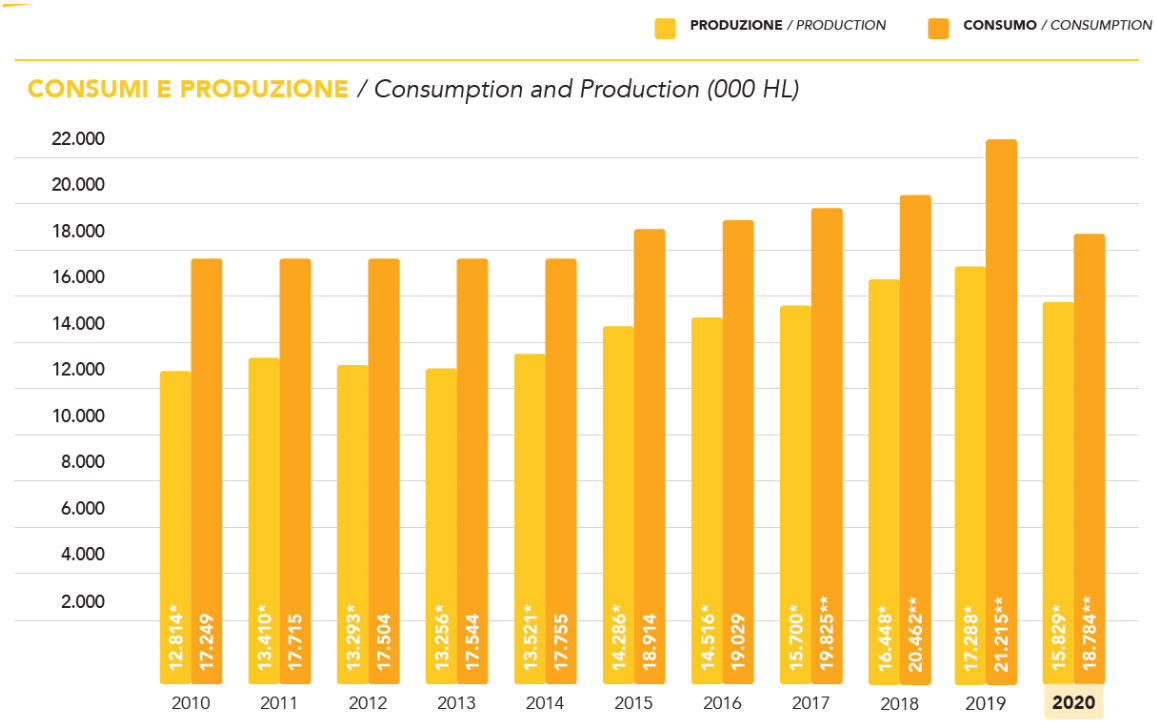

Figure 4-1. Volume of beer produced and consumed annually in Italy from 2010 to 2020 [72]

This all fits into a European context where the same measures to counteract Covid-19 imposed by governments on bars, pubs, restaurants have reduced by 42% the beer sales volumes in the out-of-home sector (from 126 million hectoliters in 2019 to 73 million hectoliters in 2020), reducing the significant and positive contribution made by the beer value chain to the overall economy. [72]

The added value of the beer sector in Europe has been reduced by more than 15 billion, or 25%, from 60 billion euros in 2019 to 45 billion in 2020. And once again it is the out-of-home channel sector that accounts for the highest percentage with 45% less value in 2020 than in 2019, representing a loss of 13 billion euros. In addition, there was 23 percent drop in tax revenue of 11 billion euros (36 billion in 2020 toward 47 billion in 2019), of which 7 billion corresponds to the loss of VAT usually collected through the on-trade. Another 4 billion euros were lost in governments' revenues due to the income and social security contributions usually paid by the hundreds of thousands of people who lost their jobs. In fact, it is estimated that about 860,000 jobs were lost, a 25 percent drop in the total value added by beer to the European economy. [72]

The same situation is evident also in the data regarding the annual per capita consumption. After a peak in 2019 with 35 liters per capita, year 2020 has recorded a decrease of 4 liters per capita.

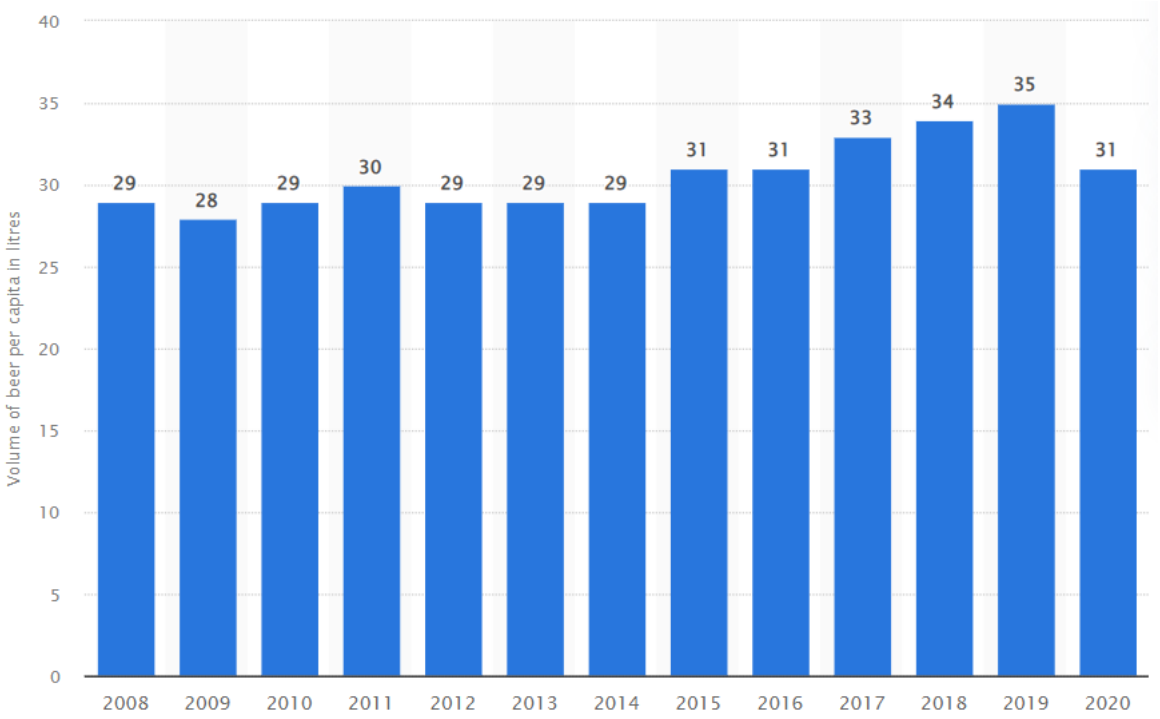

Figure 4-2. Annual volume of beer consumed per capita in Italy from 2008 to 2020 [73]

It is worth to mention that the level of consumption per capita in Italy is considerably below the European average. In 2020, Italy ranks second from last on the list of volumes of beer consumed per capita in Europe by country. Only Greeks drink less than Italians, with 28 liters as per capita annual consumption. As mentioned before, the leading country is Czech Republic, with 135 liters. [60]

It is also interesting to explore the dynamics of consumption linked to the seasonal trend. In 2020, beer is still confirmed as all-year drink for Italians, demonstrating an ever decreasing seasonality in consumption, due to an increased knowledge of the product. The period between May and August still remains the one with the highest percentage of consumption, which amounts to 48%. A small increase in the first two months of the year should also be noted, growing by 13.6% with respect to 2019. [72]

Analyzing the consumption trend per capita with respect to other alcoholic beverages, wine remains the most drunk alcoholic beverage. But it must be noticed that beer is shortening the distance. While in 1980, wine consumption per capita was 5.56 times the beer consumption, in 2020 there is a difference of only 2.5 liters.
Italy has never been a country known for beer production; on the other hand, it is probably the country with the largest and most diverse wine production in the world. The reasons can be found in its history, culture and climate: in particular the geological characteristics and the conformation of the territory make Italy the ideal place for the production of quality wines with much diversified characteristics.

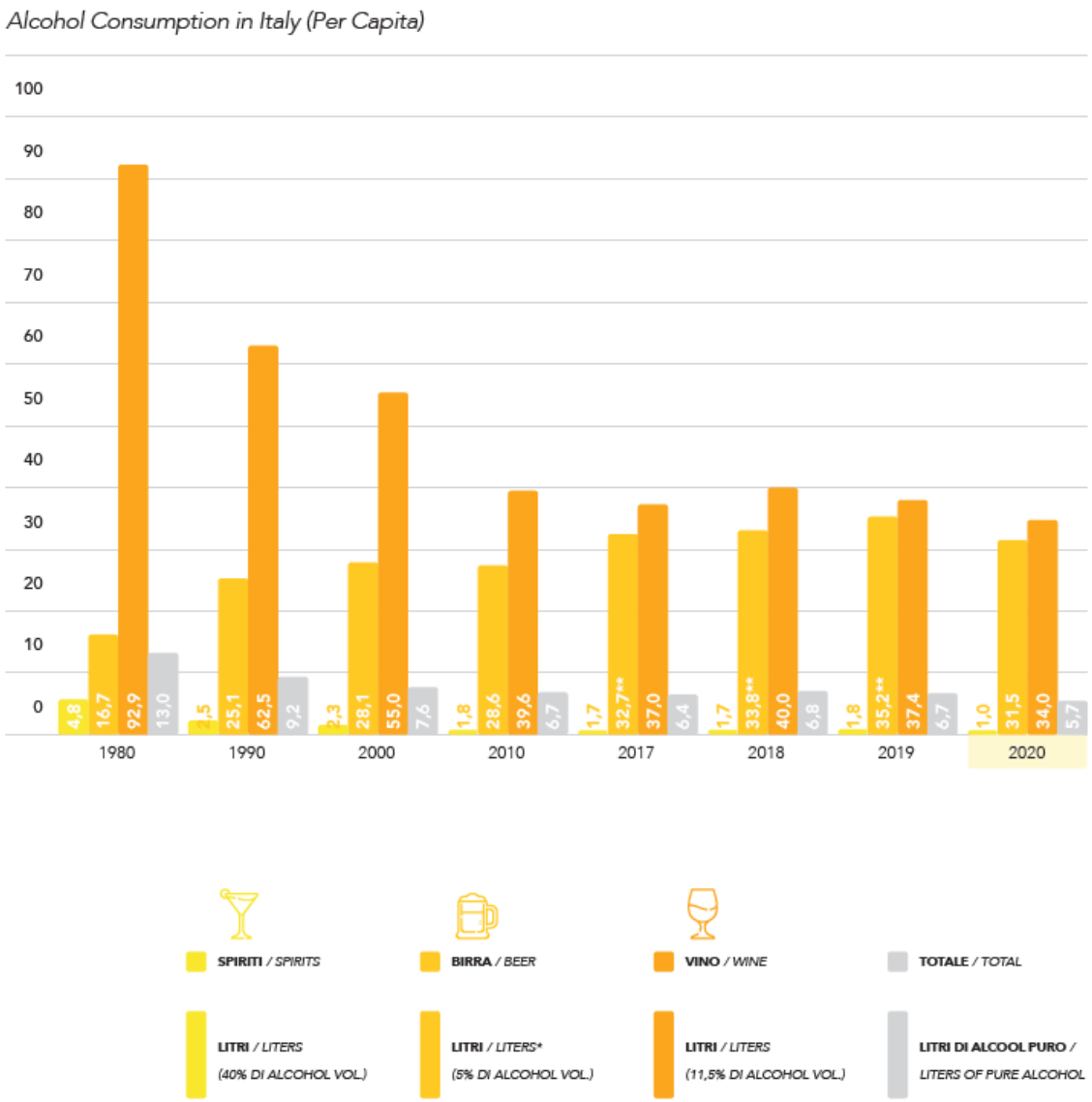

Figure 4-3. Alcohol consumption per capita in Italy [72]

4.2 Tax and Excise Duty

Excise duties are indirect taxes on the sale or use of specific products, such as alcohol, tobacco and energy. The revenue from these excise duties goes entirely to the country to which they are paid. [74]

EU countries agreed on common EU rules to make sure that excise duties are applied in the same way and to the same products everywhere in the Union. For example, by applying at least a minimum rate of excise duty. This helps prevent trade distortions in the Single Market, ensures fair competition between businesses, and reduces administrative burdens for companies. [74]

EU legislation only sets harmonized minimum rates, so EU countries are free to apply excise duty rates above these minima, according to their own national needs. In particular, for beer the minimum rate is 0.748€ per Hectoliter per degree Plato or 1.87€ per Hectoliter per degree alcohol. [74]

Over the last few years the brewing sector has been subjected to particular attention by the Italian legislator. From October 2013 to January 2015, in fact, the Government had increased excise duty on beer from 2.35 € to 3.04 € per Hectoliter/degree Plato. This factor, combined with the continuing economic crisis, has kept the brewing sector in stagnation. However, starting from 2017, an important reversal trend has partially corrected what happened, contributing to the recovery of market growth of beer in Italy. The 2017 Budget Law (Article 1, Paragraph 48 of Law No. 232 of 2016) had lowered the excise tax amount from 3.04 to 3.02 €. The 2018 Budget Law (Article 1, Paragraph 514 of Law No. 205 of 2017) had further reduced this amount from 3.02 to 3 €. In the 2019 Budget Law (Article 1, paragraphs 689-691 of Law No. 145 of 2018), the measure of excise duty on beer was lowered, which thus dropped from 3 to 2.99 euros per hectoliter and degree-plate as of January 1, 2019. For the year 2022 only, the relevant Budget Law (Law No. 234 of 2021, paragraphs 985-987) provides that the general excise tax on beer is reduced to 2.94 euros. The tax reverts to 2.99 euros per hectoliter and degree-Plato as of 2023. [75]

On 4 June 2019, the Ministerial Decree provided for by the Budget Law established the reduction in excise duties on craft beer. This was an important step, the same that was happening in the great majority of European countries, to support and protect small Italian craft breweries and to incentive the growth of this sector. It provided a 40% reduction in excise duties for craft breweries that did not produce more than 10 thousand hectoliters a year, which were independent at company level and did not carry out pasteurization and microfiltration. For the year 2022 only, the relevant budget law (Law No. 234 of 2021, paragraphs 985-987) provides that:

- the measure of beer excise duty reduction for craft microbreweries (annual production up to 10,000 hectoliters) be raised from 40 to 50 % for the year 2022 [75]
- specific excise duty reduction measures be introduced for craft breweries with annual production up to 60,000 hectoliters. In particular, a 30 % reduction for breweries with annual production between 10,000 hectoliters and 30,000 hectoliters; a 20 % reduction for breweries with annual production between 30,000 hectoliters and 60,000 hectoliters. [75]

Another important tax is the Value-Added Tax (VAT). The VAT rate is applied to the value of a product/service and, therefore, also to the excise duty applied to that product/service. In Italy, VAT on beer is at 10 % on serving (draft beer), and at 22 % on selling (e.g., take-out, or on beer sold in bottles/cans).

Figure 4-4 shows the trend of excise duty and VAT from 2004 to 2022. The VAT, computed on excise duty, has been calculated considering the VAT on selling: at 20% until 2011, at 21% in 2012 and 2013, and at 22% from 2014 onwards.

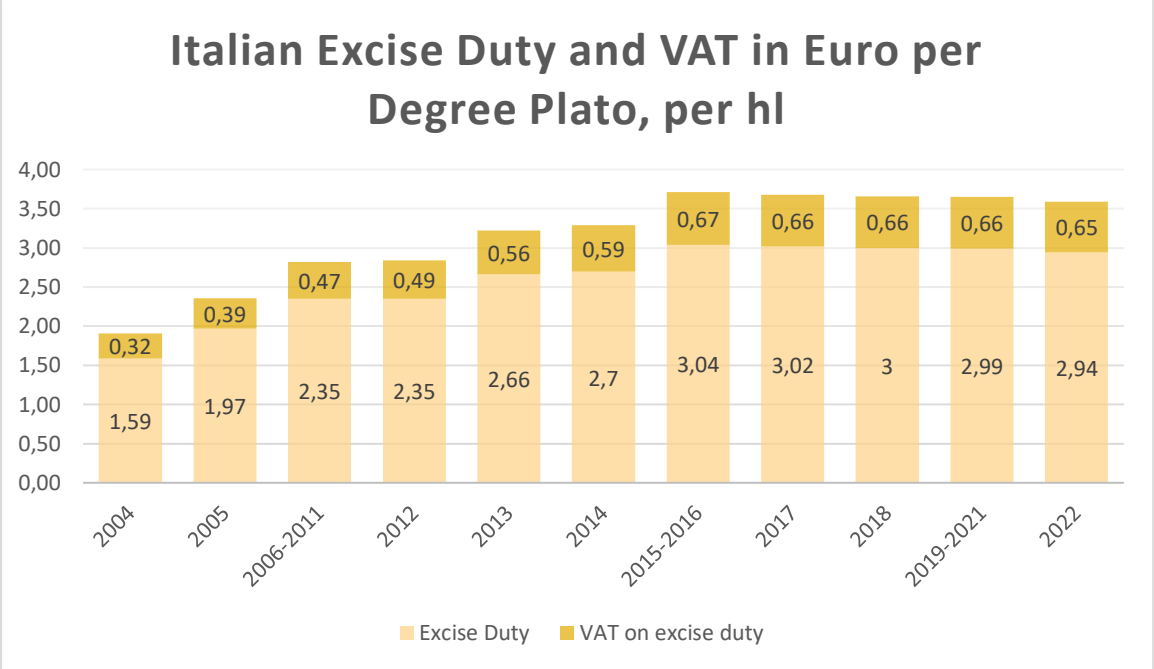

Figure 4-4. Italian excise duty and VAT computed on excise duty in euro per degree Plato, per hl

The Figure below shows the European situation in terms of excise duty and VAT on beer applied in 2021. Excise duties can be levied per alcohol content (ABV), per degree Plato (°P) or as a fixed amount for defined ABV/°P brackets. To make these excise duties comparable, a hectoliter of beer of 5% ABV (about 12°P) has been considered.

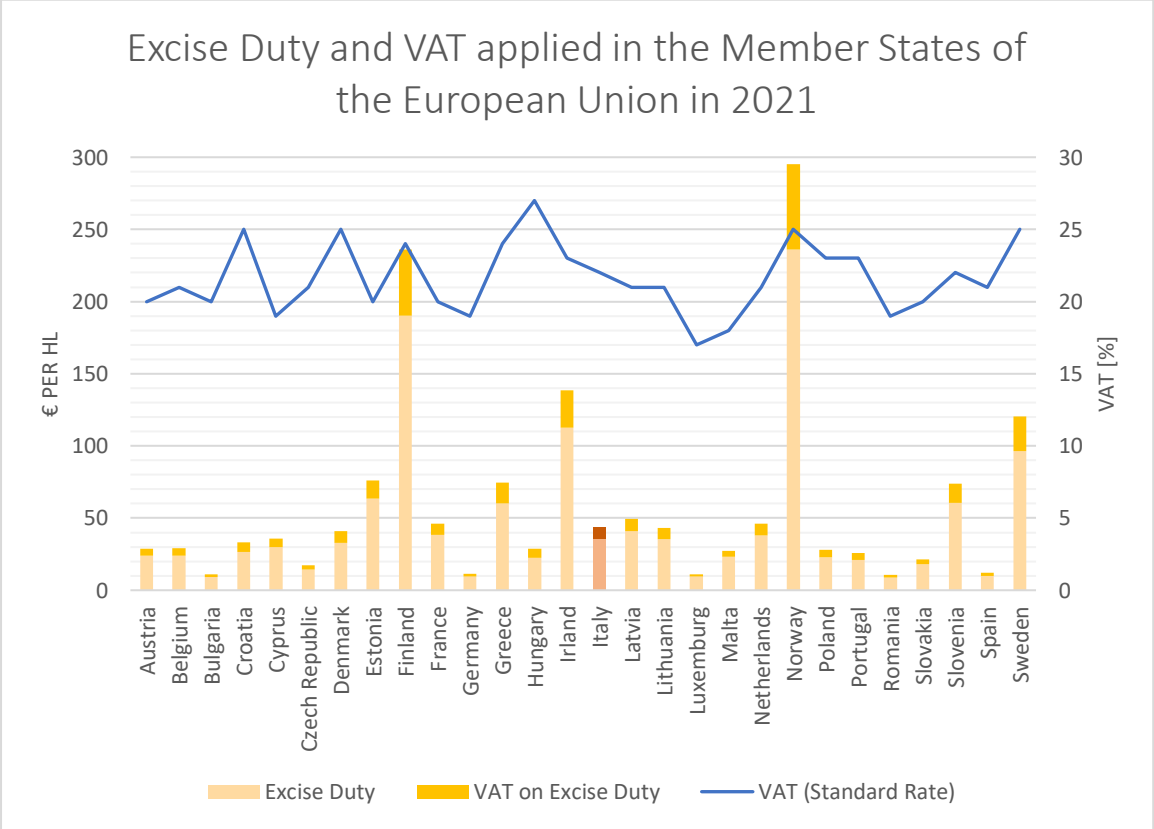

Figure 4-5. Excise duty and VAT per hectoliter of beer at 5% ABV (12 °P) in the member states of the European Union in 2021 [76] [77]

While Germany, Bulgaria, Luxembourg, Romania, and Spain are the countries levying approximately the EU's minimum excise duty, Norwegian and Finnish tax rates on beer are the highest in Europe.

It is possible to notice from the figure above that Italy adopts a lower VAT standard rate than other European countries and that the total taxation (excise duty + VAT computed on excise duty) is lower than in other Member States of the European Union, as well. In particular, the tax burden in Norway, Finland, Ireland, Sweden, Estonia, Greece, Slovenia, Latvia, France and Netherlands is higher than the one applied in Italy.

Nonetheless, Italy is one of the European countries with the highest tax revenue on beer consumption. Even if Ireland, Sweden, Estonia, Greece, Slovenia, Latvia and Netherlands have a tax burden higher than Italy, their consumption is significantly lower than the Italian one. Norway, Finland, France and Poland have revenue higher than Italy. Even if the beer consumption is about one fifth in Finland and one sixth in Norway with respect to Italy, their taxes are so high (more than 5 and 6 times, respectively, higher than the Italian ones) that their revenues are more or less equal to the ones of the Italian government (652 m€ for Finland and 647m€ for Norway vs. 644m€ for Italy). In France, both tax burden and consumption are higher than the Italian ones, and so its revenue is higher. Poland, while adopting lower taxes, has an annual consumption almost twice as much as the Italian on (34,689 for Poland vs. 18,784 for Italy).

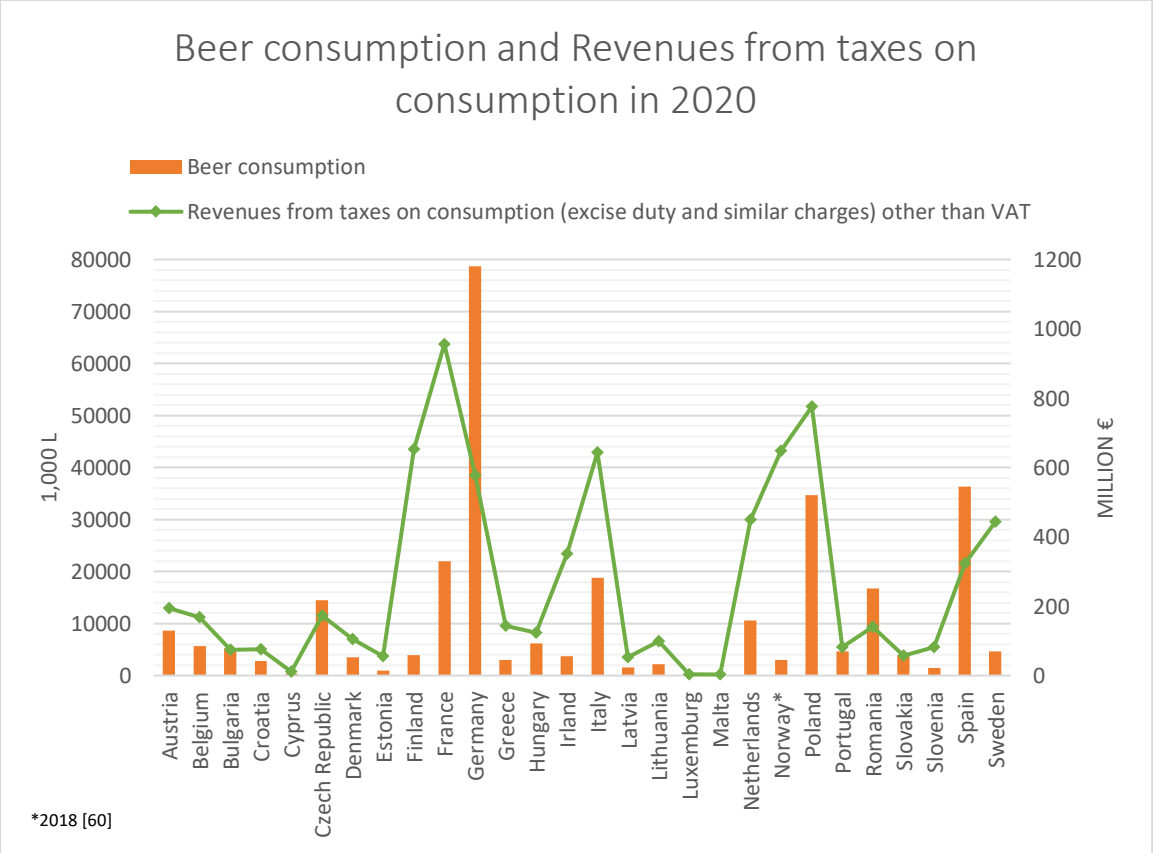

Figure 4-6. Beer consumption [60] and revenues from taxes on consumption [78] in 2020

4.3 Import and Export

Exports, too, similarly to production and consumption, after years of growth suffered a 4.8% drop in 2020. Nevertheless, the export of Italian beer has increased by 74% from 2010 to 2020. Furthermore, a 15% drop in imports was also recorded.

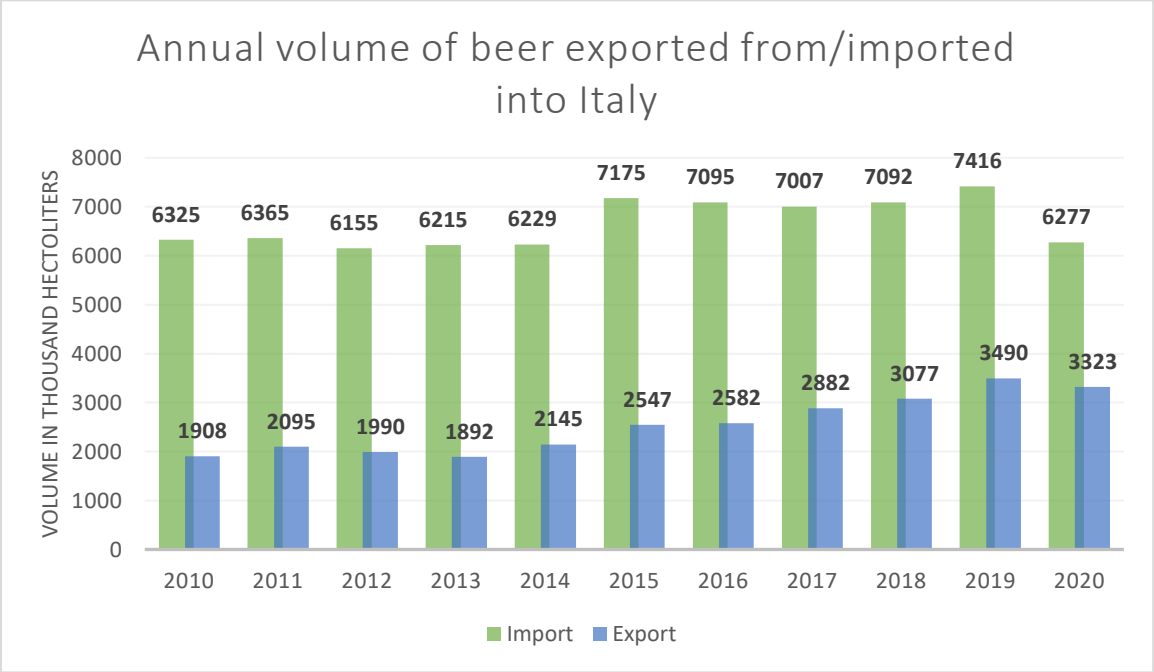

Figure 4-7. Annual volume of beer exported from/imported into Italy from 2010 to 2010 [79] [80]

The EU is the largest export market: during 2020, it covered almost 73% of Italian beer exports.

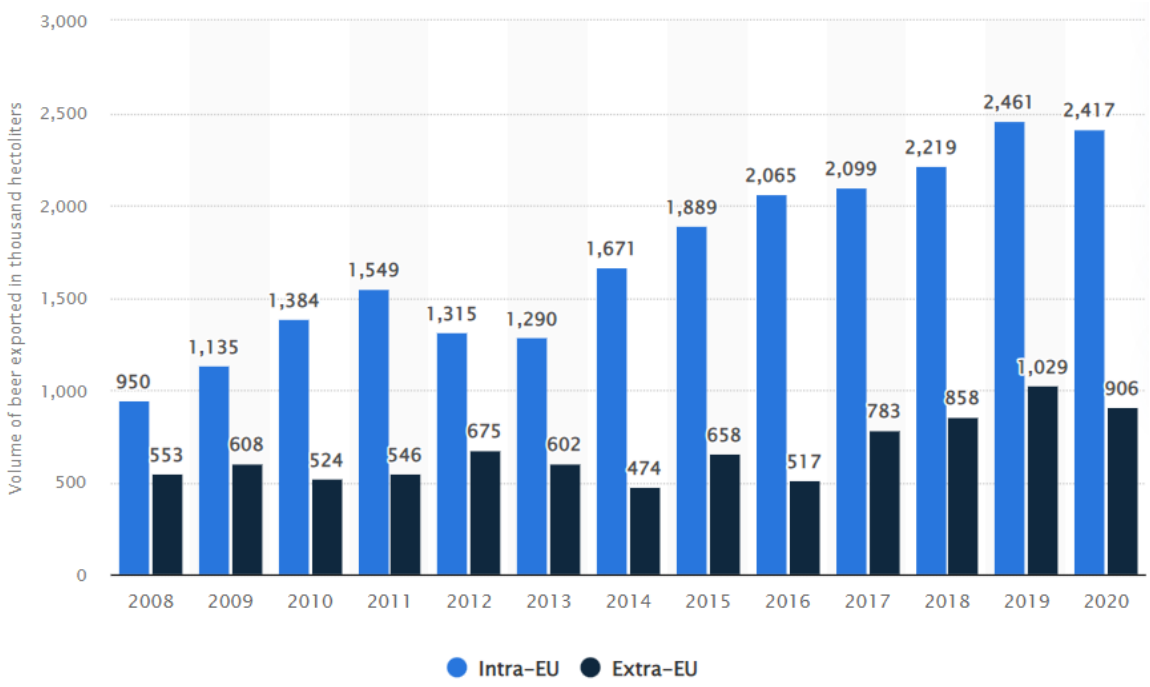

Figure 4-8. Annual volume of beer exported from Italy from 2008 to 2020, split by intra-EU and Extra-EU trade [80]

The export of Italian beer continues to be confirmed in 2020 in countries with strong brewing traditions, demonstrating the high quality of Italian beer. The countries mainly interested in Italian beer are Great Britain, which is confirmed in the first place with 47.3% of the total exports, followed by the United States (7.3%), Australia (7%) and France (3.2%).

Italian Exports of Beer 2015-2020 (HL)

	2015	2016	2017	2018	2019	2020	% TOT
Regno Unito / *United Kingdom* - UK	1.126.386,54	1.287.366,52	1.495.755,68	1.487.036,24	1.591.495,85*	1.572.419,16	47,3
Francia / *France* - FR	99.552,96	123.949,08	132.932,84	156.135,31	159.265,48*	107.812,66	3,2
Paesi Bassi / *Netherlands* - NL	200.639,24	56.284,80	69.109,45	113.826,18	184.888,06*	127.682,09	3,8
Romania / *Romania* - RO	30.761,11	54.017,88	31.208,29	97.367,64	37.476,69*	25.749,22	0,8
Malta / *Malta* - MT	20.708,91	20.421,37	21.795,80	22.918,01	18.610,47*	19.232,51	0,6
Germania / *Germany* - D	40.852,34	69.533,22	15.641,21	13.144,75	25.562,36*	23.769,96	0,7
Altri Paesi / *Other countries* - UE	370.408,42	454.040,39	333.359,22	328.931,98	443.876,52*	540.532,21	16,3
Tot. U.E. / EU	1.889.309,52	2.065.613,26	2.098.640,47	2.219.360,11	2.461.175,43*	2.417.197,81	72,8
Stati Uniti / *United States* - USA	196.453,69	196.208,05	217.985,71	236.156,52	334.369,77	241.795,18	7,3
Australia / *Australia* - AU	45.803,74	46.964,53	206.490,14	231.599,72	275.652,04	232.187,67	7,0
Albania / *Albania* - AL	45.796,53	42.290,66	50.428,80	59.556,89	76.304,49	76.298,78	2,3
SudAfrica / *South Africa* - RSA	227,97	499,22	5.629,61	9.443,57	6.273,45	4.831,52	0,1
Altri Paesi e punti franchi / *Other Third Countries*	369.672,11	230.389,63	303.368,09	321.430,45	336.153,53*	350.290,89	10,5
TOTALE / TOTAL	2.547.263,56	2.581.965,35	2.882.542,82 °	3.077.547,26 °	3.489.928,71 */°	3.322.601,85 **/°	100,0

Table 4-1. Italian exports of beer 2015-2020 by destination country [72]

The volume of beer imports has grown by 17.2% between 2010 and 2019. However, in 2020, imports suffered a setback with a drop of 15% with respect to the previous year. In 2020, domestic production only covered 84.3% of domestic demand.
Overall, almost all imports (95.4% in 2020) come from Europe; Mexico dominates among the extra - Europeans countries with approximately 248 thousand hectoliters.

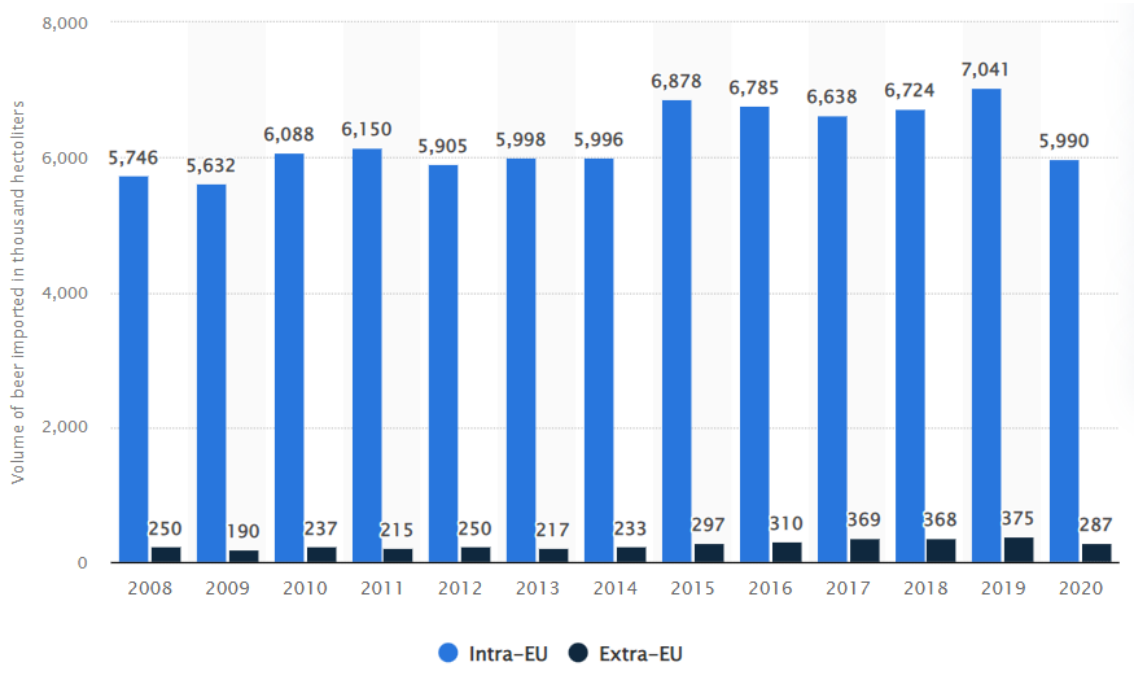

Figure 4-9. Annual volume of beer imported into Italy from 2008 to 2020, split by intra-EU and extra-EU import [79]

Almost a third of imports come from Belgium with 1.9 million hectoliters imported during 2020. Taking into consideration the period 2015-2020, it can be seen that there has been a collapse of imports from Germany which has fallen from 3.4 in 2018 to 1.5 million hectoliters in 2020.

Italian Imports of Beer 2015-2020 (HL)

	2015	2016	2017	2018	2019	2020	% TOT
Germania / *Germany* - D	3.400.794,87	2.958.521,42	2.095.904,52	1.862.880,93	1.625.319,72*	1.487.709,41	23,70
Belgio/Lux / *Belgium/Lux* - B	614.448,73	930.126,87	1.942.997,42	2.024.383,26	2.404.418,83*	1.900.890,35	30,28
Paesi Bassi / *Netherlands* - NL	688.250,26	773.492,82	756.982,89	913.648,04	782.241,98*	680.173,27	10,84
Polonia / *Poland*- PL	367.912,68	400.967,60	492.747,62	551.036,49	506.635,30*	596.335,86	
Danimarca / *Denmark* - DK	394.775,47	396.651,45	409.731,67	425.658,78	386.975,91*	389.574,14	
Francia / *France* - F	245.007,53	279.075,02	263.580,80	302.945,34	287.490,77*	312.131,93	
Austria / *Austria* - A	157.373,28	175.572,03	166.397,17	114.004,71	187.120,44*	125.683,49	
Slovenia / *Slovenia* - SL	292.846,31	218.436,43	157.072,03	179.143,88	189.150,19*	252.985,00	
Regno Unito / *United Kingdom* - UK	441.297,28	414.480,79	94.324,40	100.029,35	77.620,79*	60.939,36	
Rep. Ceca / *Czech Rep.* - CZ	61.430,99	66.226,30	59.125,30	73.498,58	78.360,75*	50.005,89	
Irlanda / *Ireland* - IRL	62.075,26	59.357,21	58.043,83	57.035,28	58.969,08*	48.664,70	
Grecia / *Greece* - GR	63.463,15	10.155,00	54.017,09	6.334,78	19.188,48*	18.164,30	
Spagna / *Spain* - E	40.068,96	43.452,76	42.525,52	48.068,67	85.820,34*	40.355,01	
Romania / *Romania* - RO	32.819,58	29.279,08	22.453,86	47.316,65	30.823,19*	14.281,39	30,60
Svezia / *Sweden* - S	2.973,21	8.481,87	10.084,54	12.095,51	13.395,17*	6.146,81	
Portogallo / *Portugal* - P	30,24	1.710,49	9.120,05	1.095,57	1.434,94*	2.746,16	
Malta / *Malta* - MT	6.753,20	3.288,52	2.428,41	2.261,71	938,40*	79,70	
Estonia / *Estonia* - EE	3.174,88	152,52	293,81	195,94	502,45*	1.027,18	
Finlandia / *Finland* - FI		21,76	211,54	96,08	175,75*		
Cipro / *Cyprus* - CY	79,24		158,48	1.773,18	2.431,12*	1.000,50	
Bulgaria / *Bulgaria* - BG			86,25	633,64	269.928,62*	715,88	
Lettonia / *Latvia* - LV	16,90		68,43	24,40	1.109,42*	23,10	
Slovacchia / *Slovakia* - SLOV	1.100,57		22,53		26.910,12 *		
Ungheria / *Hungary* - HU	1.745,28	15.788,70	1,16	251,25	3.379,23*		
Lituania / *Lithuania* - LT	3,20				430,06*	7,00	
Tot. U.E. / EU	6.878.437,87	6.785.238,64	6.638.379,32	6.724.412,02	7.040.771,05*	5.989.640,43	
Messico / *Mexico* - MEX	227.391,48	243.740,58	272.768,09	270.301,18	266.139,93	247.569,07	
Cina / *China* - RC	31.874,46	29.981,03	31.773,54	33.763,74	35.453,16	15.696,69	
Svizzera / *Switzerland* - CH	9.938,33	11.619,67	29.413,66	22.912,17	5.066,18 *	1.926,42	
Giappone / *Japan* - J	840,90	117,81	112,30	2.725,16	2.225,51	1.768,62	4,58
Egitto / *Egypt*			3.388,70	446,28			
Altri Paesi Terzi / *Other Third Countries*	27.301,93	24.493,25	31.639,12	37.375,41	66.676,93 *	20.443,16	
Totale Paesi Terzi / *Total Third Countries*	297.347,10	309.952,34	369.095,41	367.523,94	375.561,71*	287.403,96	
TOTALE / TOTAL	7.175.784,97	7.095.190,98	7.007.474,73 °	7.091.935,96 °	7.416.332,76 °/*	6.277.044,39 **/°	

Table 4-2. Italian imports of beer 2015-2020 by country of origin [72]

4.4 Competitors and Market Share

On the Italian beer market, there are mainly five brewing companies with industrial production in our area: Heineken Italia Spa, Birra Peroni Srl, Anheuser-Busch In.Bev Spa, Carlsberg Italia Spa and Birra Castello Spa. They have approximately 70% of the Italian

market share. Craft production units, such as microbreweries and brewpubs, and third-party imports must be added to the total computation of brewing companies in Italy.

	2016		2017		2018		2019		2020	
Aziende Birrarie Brewing Companies	000 hl	%	000 hl	%	000 hl	%	000 hl	%	000 hl	%
HEINEKEN Italia Spa	5.336,0	28,0	5.771,0	29,1	6.254,0	30,6	6.674,0	31,5	6.253,0	33,3
Birra Peroni Srl	3.473,0	18,3	3.699,0	18,7	3.827,0	18,7	3.822,0	18,0	3.377,0	18,30
Anheuser-Busch In.Bev Spa	1.736,0	9,1	1.852,0	9,3	1.911,0	9,3	1.954,0	9,2	1.611,0	8,6
Carlsberg Italia Spa	1.166,0	6,1	1.249,0	6,3	1.225,0	6,0	1.058,0	5,0	991,0	5,3
Birra Castello Spa*	1.034,0	5,4	1.125,0	5,7	1.059,0	5,2	1.068,0	5,0	1.103,0	5,8
Birra Lucana Srl**	35,0	0,2	30,0	0,1	34,0	0,2	35,0	0,2	31,0	0,2
Hausbrandt Trieste 1892 Spa	35,0	0,2	35,0	0,2	33,0	0,1	33,0	0,2	19,0	0,1
Altri (Aziende non associate ivi comprese le microbirrerie) Others (Microbreweries and non-member breweries)	1.261,00	6,6	1.393,00	7,0	1.405,0	6,9	1.450,0	6,8	1.041,0	5,5
Importazioni di terzi non associati Non-member third-parties imports	4.953,0	26,0	4.671,0***	23,6	4.714,0***	23,0	5.121,0***	24,1	4.358,0	23,2
TOTALE / Total	19.029,0	100,0	19.825,0***	100,0	20.462,0***	100,0	21.215,0***	100,0	18.784,0	100,0

Table 4-3. Beer marketed for consumption: Italian supply 2016-2020 [72]

In particular, Heineken Italia Spa and Birra Peroni Srl are the leader in sales and together they control more than 50% of the total market.

4.4.1 Story of the Italian brewing industry

The story of the Italian brewing industry is similar to that of many other industrialized regions. After World War II, the bigger national firms emerged and dominated the market. Even if some attempts at entering the beer industry on a small scale were made, the prevalent organizational form in the industry was the multi-plant national group.

In the 1960s, the four largest national groups, Peroni, Wuhrer, the Luciani Group (Pedavena-Dreher), and Birra Poretti, pursued external growth strategies through mergers and acquisitions of the plants and brands of smaller companies. The biggest four groups held a market share of more than 60% in the 1960s. In addition to mergers and acquisitions, the reasons for the increase in the degree of concentration were mainly linked to the exploitation of economies of scale in production and marketing.

The 1980s and 1990s marked a further step toward increased concentration. These are the years in which foreign groups began entering the Italian market: United Breweries (Carlsberg and Tuborg), Heineken, and SABMiller. The structure of the industry in 1990 was two large groups (Peroni and Heineken) which dominated the market, together with four other medium-sized producers (Poretti, Moretti, Wunster, and Forst). At the same time as the concentration increased, the number of firms, as well as the number of production units located around the country, gradually and steadily declined, passing from about 40 at the end of 1960s to about 20 at the end on 1990s [41].

The largest firms are multi-plant and multi-brand companies. However, even if firms sell several brands in the marketplace, the main product of the major brewers is lager beer, which is pale yellow in color, pasteurized, and contains more or less 5% alcohol. This is the most diffused type of beer among consumers. Lager has historically become “the beer” in Italy, following a tradition with origins which are close to German culture. This tradition has been continuously consolidated through the decades up to recently, such that the diffusion of beer in Italy has always meant the diffusion of the standardized and homogeneous lager beer.

At the beginning of the 1990s, beer in Italy was still considered a refreshing product to consume principally during summer, in competition with non-alcoholic soft drinks. Almost half of the consumption of beer in Italy has traditionally been concentrated only during the four-month period from May to August, when the temperature is higher. There was still little emphasis on the attributes of the beer product, which was basically considered a drink for satisfying the physiological need of thirst, without evidence of the affection of the Italian consumers toward the product.

Something started to change between the late 1980s and the early 1990s, when the first group of entrepreneurs engaged in the first attempts at craft brewing in Italy, which represented an innovation in the beer industry, in terms of production process, products produced, and advertising strategies.
As regards production, what substantially differentiates the product of craft enterprises from the lager of large firms is the manufacturing process that does not require pasteurization or, generally, micro-filtration. Due to the absence of these stages of production, the ingredients are combined in order to create a product with more aroma, flavor, and distinctive characteristics. Many of the first craft beer producers in Italy produced a non-pasteurized, non-filtered lager beer, thus supplying a “new” product to Italian consumers which was distinct from the large firms’ standard beers.
In addition, craft breweries were new also because they pursued strategies of product differentiation. New varieties were constantly introduced into the market, having been traditionally disregarded by the national producers.
Finally, the advertising strategies of craft breweries are different from those pursued by the large producers. In their advertising campaigns of the leading brewing groups, beer has often been associated with a famous person or advertised as the appropriate drink in particular situations, such as concerts and sport events. In contrast, craft breweries focus

advertising on intrinsic product attributes, mainly based on local advertising, the internet, social networks, and local festivals and events.

The first craft beer producer (a brewpub) entered the market in 1988. The initial spread of increasing numbers of new entrants was initially rather slow, but there was an exponential increase after 2000.

C. Garavaglia highlights the key factors that affected and shaped consumers' patterns of behavior in 1980s-1990s [41].

- Increasing revenue. Per capita income in Italy had an upward trend from the 1970s to the 1990s. This factor led consumers to a slow but significant change in their attitudes and consumption choices: consumer demand became more sophisticated, more refined, and inclined to greater variety. Referring to Maslow's hierarchy of needs, there was an identifiable change designed to satisfy the needs of a higher order than the basic physiological needs.
- Food scandals and environmental concerns. The methanol scandal in the wine industry in 1986 is a prime example of how consumers can suffer serious health consequences, including death, due to the consumption of unhealthy and uncontrolled food. This created significant consequences for consumers, generating skepticism and concern, which led to growing attention to signs and information attesting to the safety of consumer goods.
- Mass consumption. Fast food experienced immediate success in the country; however, the model of mass consumption and increasingly globalized products that dominated the 1980s began to show its weaknesses shortly thereafter, in the 1990s, when consumers started to develop an attitude in favor of local production. The Slow Food movement was initiated in Italy in 1986, and it became an international association in 1989. Local food, artisanal producers, traditional cuisine, and traditional modes of production are part of the community culture which Slow Food aims to preserve.
- International integration. The 1980s and 1990s were crucial decades in terms of the international integration of people and economic relationships, thanks to the Schengen agreement, signed by Italy in 1990, to remove controls at the common borders of the states in the agreement and to introduce freedom of movement for all citizens, and the beginning of the process of liberalization of European air transport. It happened that during the 1980s and 1990s the internationalization of people and communication contributed to increasing consumers' knowledge about the existence of a great variety of food products which had previously been unknown or less known.

Around 2007, there was also the advent of the organizational form called "contract brewing." In this type of arrangement, the contracting brewery gives production control of their product to the host brewery. In these situations, the host brewery is often responsible for the production itself in addition to record keeping, labeling, getting appropriate certificates, and even paying taxes as the beer leaves their premises. These responsibilities may vary a little but will always be spelled out in the legal agreement.

Italian creativity contributed to the international success of Italian craft beer. The re-interpretation of traditional beer styles, the experimentation with new recipes, the strategy to characterize beer with the addition of traditional local ingredients (for example, chestnuts, fruit, spelt, wine) contributed to the acknowledgment of Italian producers in the international beer panorama. The inclusion of the first Italian beer style, IGA (Italian Grape Ale – a style of beer flavored with grape must), in the Beer Judge Certification Program-2015 Style Guidelines represents a clear confirmation of the increasing role played by the Italian craft beer producers in the world.

4.4.2 Microbreweries and Brew pubs

The proliferation of made-in-Italy beers has been accompanied by a surprising growth in microbreweries and brew pubs: in the last 10 years microbreweries have recorded a percentage increase of 235% (from 186 to 624 units), while brew pubs increased by an amount equal to 22% (passing from 108 to 132 pubs).

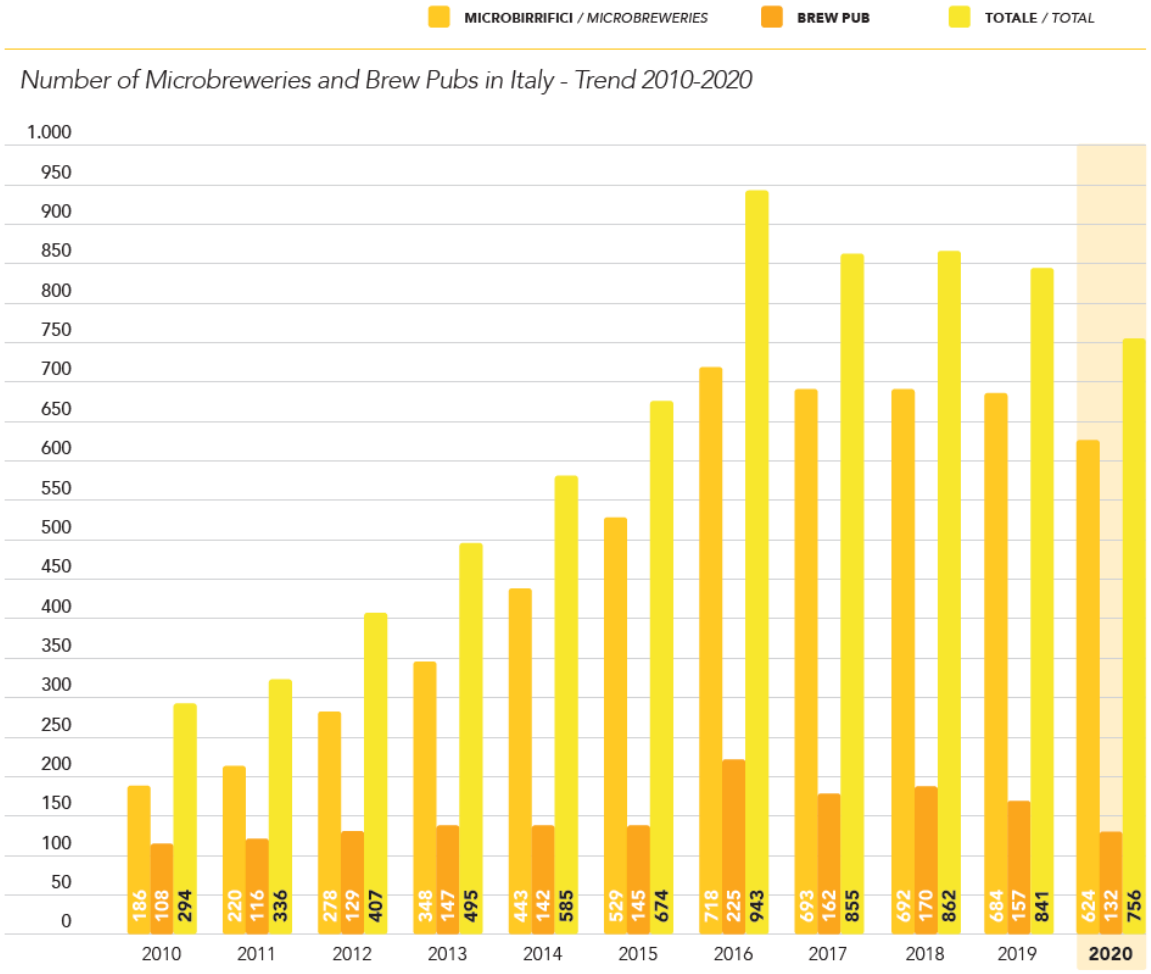

Figure 4-10. Number of Microbreweries and Brew Pubs in Italy from 2010 to 2020 [72]

Microbreweries are real breweries that produce significant quantities of craft beers that they then sell to third parties. The brew-pubs are premises that present both the

production unit and areas reserved for the supply and sale of the products they produce. Within them, therefore, both production and catering/selling activities are performed.

Analyzing the geographical distribution of microbreweries and brew pubs, reported in Figure 4-11, it emerges that the largest number of activities is in northern Italy. Lombardy, the first region per number of activities, accounts for 16.9% of them, followed by Piedmont (9.5%) and Veneto (8.6%). In central and south Italy, Tuscany and Campania, respectively, lead in the number of microbreweries and brew pubs.

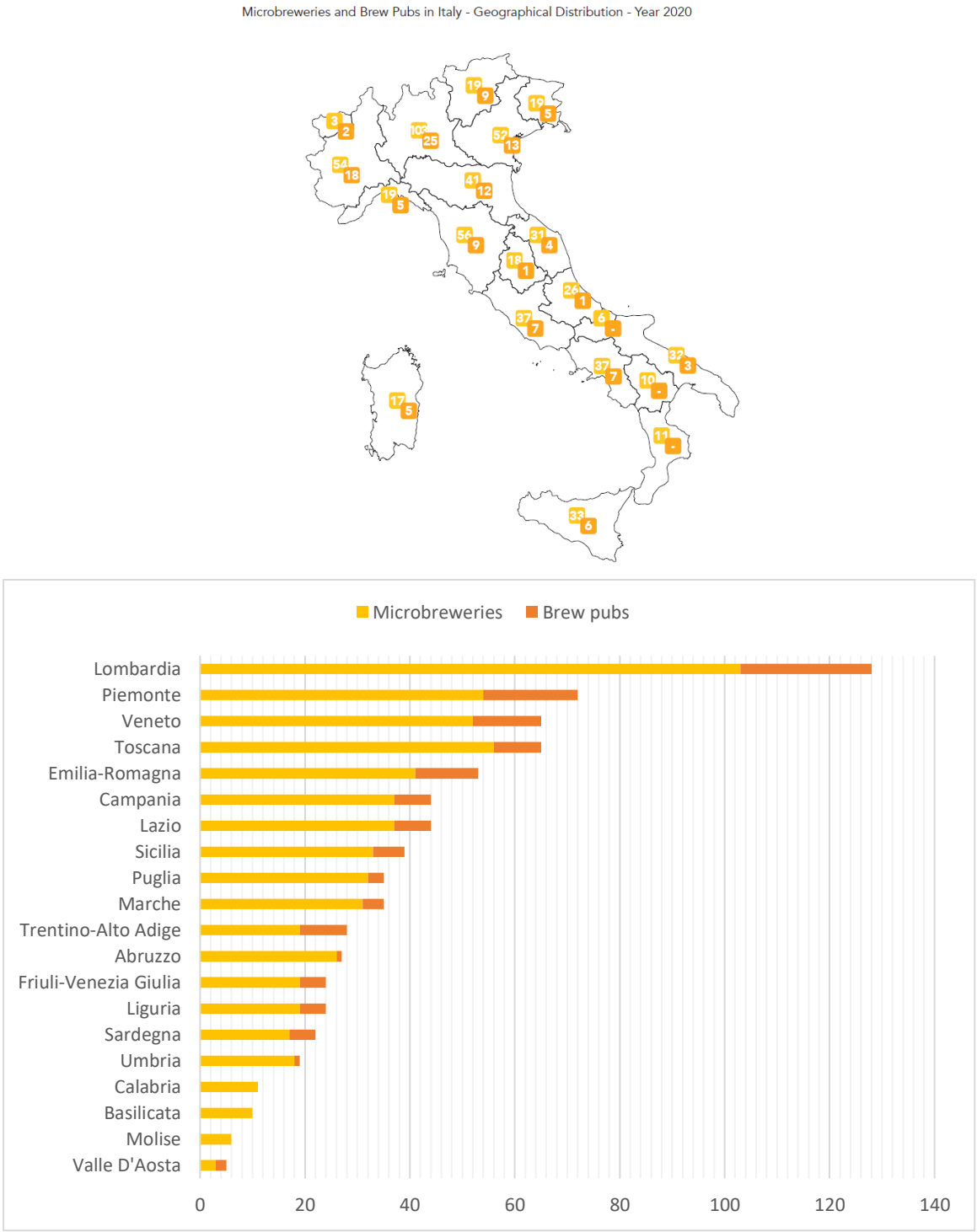

Figure 4-11. Geographical distribution of microbreweries and brew pubs in Italy – 2020 [72]

In Europe, Italy is the fifth country for number of microbreweries in 2020 (624), only preceded by France (2,000), UK (1,815), Switzerland (1,159) and Germany (901). [60]

In 2020, Italian microbreweries and brew pubs produced 361,000 hectoliters of beer [72], equal to 2.3 % of the national production. Year 2020 marked a drop of 31% compared to 2019. Their production fell below 400 thousand hectoliters, after many years above this level and even two years (2018 and 2019) above 500, which have witnessed a real boom of the craft movement in Italy.

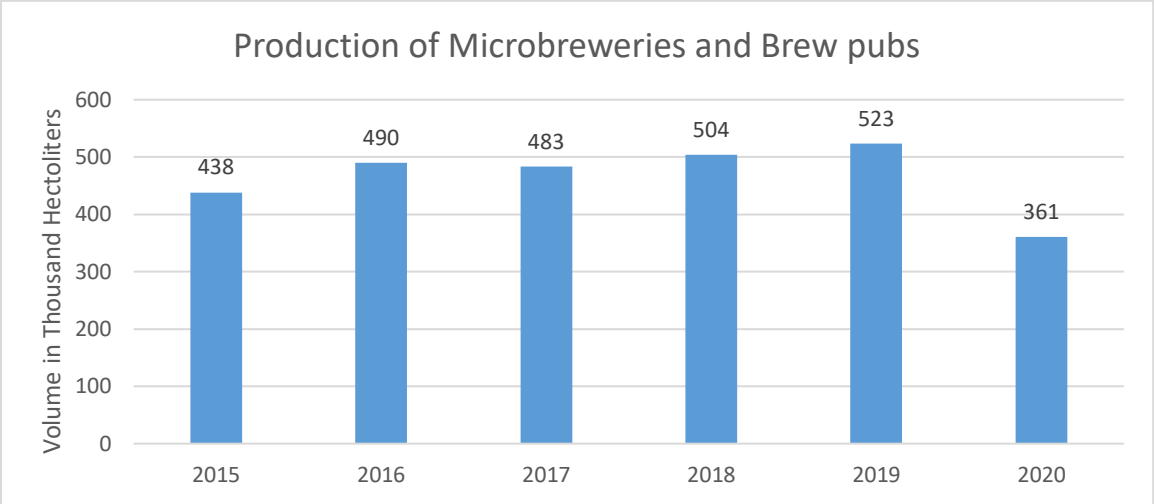

Figure 4-12. Production of microbreweries and brew pubs in Italy, 2015-2020 [81]

4.5 Consumer Preferences

Italians' favorite beers remain lagers, with 84.18% share in 2020. However, consumer preference for this type of beer has declined in recent years, with a 7.7% decrease since 2014. Light and non-alcoholic beers always remain a residual category in Italian consumption (less than 2% of volumes). Similarly to lagers, these beers have also witnessed a decline over the years. Compared to 2014, they have experienced a 50% decline. Specialty beers, benefiting from those declines, show an opposite trend. In fact,

consumers tend to choose these beers more and more and, compared to 2014, they exhibit a growth of 132%.

Market Segmentation 2014-2020

Tipi di birra *Kinds of beer*	2014	2015	2016	2017	2018	2019	2020
Low - non Alcoholic	2,58	2,63	2,03	1,86	1,75	1,60	1,30
Lager	91,16	89,95	89,59	88,15	86,56	85,21	84,18
Speciali / *Specials*	6,26	7,42	8,38	9,99	11,69	13,19	14,52
TOTALE / *Total*	100	100	100	100	100	100	100

Table 4-4. Market segmentation in Italy, 2014-2020 [72]

A paper of 2020 by A. Carbone and L. Quinci [82] has explored the Italian beer market as it has been portrayed by a consumer survey. The consumers' survey is based on a questionnaire conducted via web. The sample used for the purpose of the analysis is of 356 people. The questionnaire explores knowledge, preferences and consumption habits related to drinking beer. At the end of the interview the following choice experiment was proposed: there were five rounds of simulations; in each round one craft and one industrial beer were offered at different prices and the interviewee was asked to choose, the no-choice option was always possible.

The results have depicted five different consumers' profiles:

1) *Craft beer enthusiast experts* (30% of the sample). These are frequent consumers, definitely preferring beers to any other alcoholics. Furthermore, they find craft beers much better than the industrial ones and, coherently, they usually drink the first. Their WTB (Willingness To Buy) and WTP (Willingness To Pay) are both higher than the ones of any other group in the sample. These consumers have a better knowledge of craft beer brands compared to the other interviewees and often go to pubs and to beer shops while they tend not to go to beer events as compared to people in all the other groups. This result suggests that beer events are more attractive for less expert people who wish to increase their knowledge and awareness about beers.
2) *Curious/Eclectic consumers* (23.0% of the sample). These are consumers' that drink beer and are curious to try different types of beer even if they usually drink also other alcoholic beverages. These consumers do share some features with the previous ones, however, their positive bias toward beer in general – and craft beer in particular – is by far less strong and their consumption, in terms of frequency and quantity, is reduced. Coherently, they tend not to drink crafts, they go less frequently to pubs and do not buy beer in beer shops. At last, their knowledge about artisanal beers is more limited.
3) *Sophisticated consumers* (12.6% of the sample). It gathers consumers who prefer alcoholic beverages different than beer. Coherently, they tend to drink smaller quantities of beer. However, when drinking it, they appreciate more the crafts even if

they do not think this is a priori superior to industrial one. Even if they are not beer lovers, these persons enjoy some expertise in the field and go to pubs and beer shops even more than people in the "Curious/Eclectic consumers" group. People in this group are the eldest in the sample. Furthermore, the cluster has the relatively highest share of people living in the South.

4) *Craft beer sceptic consumers* (16.0% of the sample). They are only moderately interested in craft beer, despite the fact that, more in general, they do drink and appreciate beers even if their alcohol consumption patterns significantly include other kind of beverages. They show the lowest levels of WTB and WTP for craft beers, respectively. In the survey, only few of them were able to recall only at least one brand of craft beer; they go less to pubs and very seldom buy at beer shops (5.3 percent buy beer to the beer shops).
5) *Beers? No, thanks* (18.3% of the sample). They are poorly attracted by beers and rather prefer other alcoholic beverages; they drink smaller quantities each time and in fewer occasions as compared to all the other interviewees. Furthermore, they are not inclined to crafts nor they are interested in them: on average, they are not able to recall any brand of crafts. When they happen to drink beer, it is usually industrial. This profile is also confirmed by the results of the buying simulation where their choice of the craft alternative is quite low even if not as low as for the skeptic group of consumers. These people do not usually to go to pub or to beer shops, just as the "Craft beer sceptic consumers." Surprisingly, people in the group enjoy fairs and other public events linked to drinking beers much more than any other group in the sample. This may be explained by the social nature of these events and by the possibility to find also other products, thus confirming the high potential of such events as ways for enlarging beer knowledge and experience to the wider public.

The DOXA research sponsored by AssoBirra in 2020 [72] analyzed what factors influence consumers in their choice of beer. Taste remains the main driver of choice (38%), particularly for half of young people aged 25 to 34 years old (48%), followed by beer's connection to tradition (22%) and the connection it has with the territory (16%).

4.6 Market Distribution

The off-trade market includes all retail outlets like hypermarkets, supermarkets, convenience stores, mini markets, kiosks, spirits shops, etc. The on-trade market (also called horeca: Hotel-Restaurant-Catering), instead, includes outlets like bars, restaurants, coffee shops, clubs, hotels, etc.

Also in 2020, a trend that has been going on for several years was confirmed: the supremacy of consumption at home compared to that outside the home. And Covid-19 pandemic and its restrictions (at first closure of bars, restaurants and hotels and then early closing time for hospitality venues, restrictions on the number of patrons in total, per table or per square meter, etc.) has even widened the gap between the two markets. The

stop of the restaurant sector, a priority channel for microbreweries that rely on their relationship with direct distributors, has halted beer consumption. Nevertheless, craft beer has continued to attract enthusiasts with home consumption through new solutions made possible by e-commerce and delivery, which have allowed the sector to try and reinvent itself. Many microbreweries have expanded their offer by focusing their presence on the e-commerce channel, no longer seen as an 'emergency' channel but as a 'preferred' one.

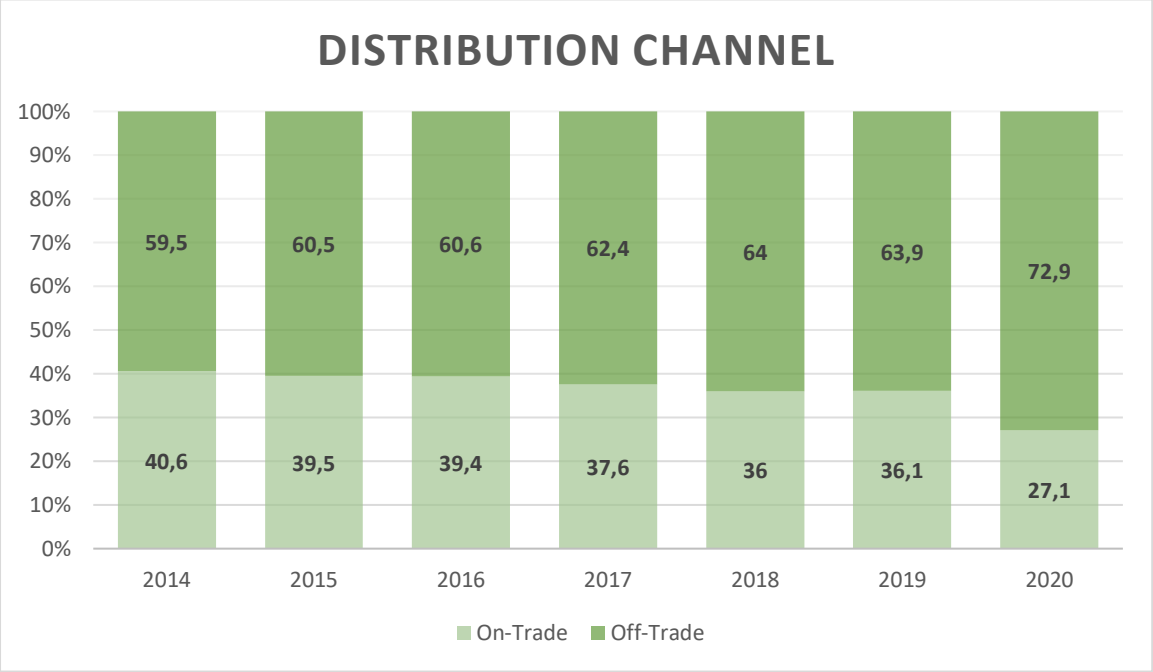

Figure 4-13. Distribution channel in Italy: on-trade vs. off-trade, 2014-2020 [72]

4.7 Packaging

Beer comes in a wide variety of packages of different sizes, shapes and materials.

Whilst bottles historically were by far the favored container for beers, from some years, American breweries are increasingly turning to the use of cans instead of glass bottles. The new trend in the United States is not just about craft breweries but also large industries, which have never stopped producing canned beer. According to a report by Beer Institute, in 2017, aluminum cans made up 62% of beer volume produced and sold in the United States. [83]

This trend is also spreading in Europe. Also Italy, after the adoption of cans by various craft breweries (such as Baladin and Lambrate) is showing an increasing embrace of cans, as reported in the Table below, fighting against the prejudice toward canned beers as products of poor quality.

Packaging 2014-2020

Tipi di contenitori *Kinds of Packaging*	2014	2015	2016	2017	2018	2019	2020
Fusti / *Kegs*	11,65	11,74	11,59	11,57	11,63	11,71	6,25
Bottiglie di vetro *Glass bottles*							
• a rendere *returnable*	7,03	6,41	5,78	5,09	4,73	7,78	7,74
• a perdere *non-returnable*	75,54	76,59	77,60	78,36	78,79	73,05	78,28
Lattine / *Cans*	5,78	5,26	5,03	4,98	4,85	7,46	7,73
TOTALE / *Total*	100	100	100	100	100	100	100

Table 4-5. Beer packaging in Italy, 2014-2020 [72]

It is possible to notice that the Italian market is characterized by a clear prevalence of non-returnable packages, while in the main European countries with a high brewing tradition, such as Germany, return packaging prevails, which are reused several times in the production process. Deposit return schemes, also called deposit-refund systems, are a key way of reducing the production of single-use packaging waste, especially in the food and drinks sector. The mechanism is simple: a container, once emptied, must be returned to the supplier so that it can be reused, after a sterilization process. Generally, those who buy the product in deposit-refund system pay a deposit which is given back upon return. This system guarantees the circularity of the life cycle of the materials (plastic, glass and aluminum) that constitute the beverage containers, avoiding them to ending up wasted in landfills, incinerators, or even worse abandoned in the environment. In addition, it allows to save the energy required for the creation of new packages.

Europe's first Deposit Return Scheme was introduced in Sweden in 1984. The system launched in Lithuania in 2016 is considered one of the best in the world, leading to the recovery of 70% of drinks containers in its first year, and 90% in the second year. Deposit Return Systems are already active in 10 European countries, and 12 additional countries have voted in favor of legislation to introduce similar schemes by 2022 or 2023. Nine countries are discussing what type of deposit system to adopt, and how it should be organized. Only the Czech Republic, Bulgaria, and Italy have not yet started a debate regarding the introduction of DRS on their territory. [84]

4.8 Labeling

The labeling legislation has the objective of guaranteeing the consumer a complete, truthful and transparent communication and to avoid false advertising about the product he purchases. For this reason, some rules have been defined regarding the information that must or can be included on the label.

Article 12 of the aforementioned Law No. 1354/1962, which has undergone many changes over the years, essentially concerns labeling and capacity of containers. The regulation of labeling is then contained and regulated more extensively in Legislative Decree 27.01.1992 No. 109 (as amended) implementing two EEC directives (No. 89/395/EEC and No. 89/396/EEC) concerning the labeling, the presentation of advertising on foodstuffs. On 8 February 2018, the Legislative Decree 15 December 2017 (n.231) was published in the Official Gazette, n. 32. This decree adapts national legislation to the provisions of the Regulation (EU) No. 1169/2011 about food information to consumers.

The following information must be indicated on the label [85]:

- sales denomination - in the case of beer, it is the legal designation provided for in Law No. 1354/1962
- trademark or business name of the producer, importer or distributor
- alcohol content expressed as a percentage by volume, if the alcohol content is higher than 1.2% by volume
- list of the ingredients in descending order by weight as recorded at the time of their use in the production of the beer. For beverages with alcohol content above 1.2% by volume such a list is not required, even if more and more brewers are indicating it
- net volume, expressed in liters or sub-multiples
- production batch and bottling date
- minimum shelf life or expiration date
- location of the production plant or, if different, of the packaging plant
- any presence of allergens or substances that cause intolerance (sulfites > 10 mg/kg) - the way in which the allergen is highlighted is not specified, but usually boldface or another font is used with respect to the other ingredients. In case there is no ingredient list, then the allergen must be specified (for example, "it contains gluten").
- the conditions of storage or use, if necessary for the characteristics of the product, to avoid alterations and changes to the product in terms of sanitation and organoleptic characteristics

In addition to these mandatory indications, the producer has the option of reporting optional information, such as nutritional labeling, advice on food pairings, color, and information regarding the production method.

The distinctive element of any communication is that it must be truthful, verifiable, and such that it does not mislead the consumer. Errors can arise on voluntary statements or graphic images that, if not carefully evaluated, can expose to sanctions.

Labels are used to attract drinkers' attention and imagination. This is why many breweries, especially craft breweries, rely heavily on labels and their graphics. For example, at Lucca Comics & Games, Della Granda Brewery from Lagnasco (Cuneo, Italy) turned labels into vignettes of a graphic novel. Another example is provided by Claterna Brewery from Castel San Pietro Terme (Bologna, Italy) that has represented on its labels different characters of different personalities, each one associated to a specific beer.

Figure 4-14. Examples of creative labels for craft beers: Della Granda Brewery on the left [86]; Claterna Brewery on the right [87]

4.9 Malt and hop supply

In 2020, Italian beer production used 190,364 tons of barley malt and 4,152 tons of hop [72].

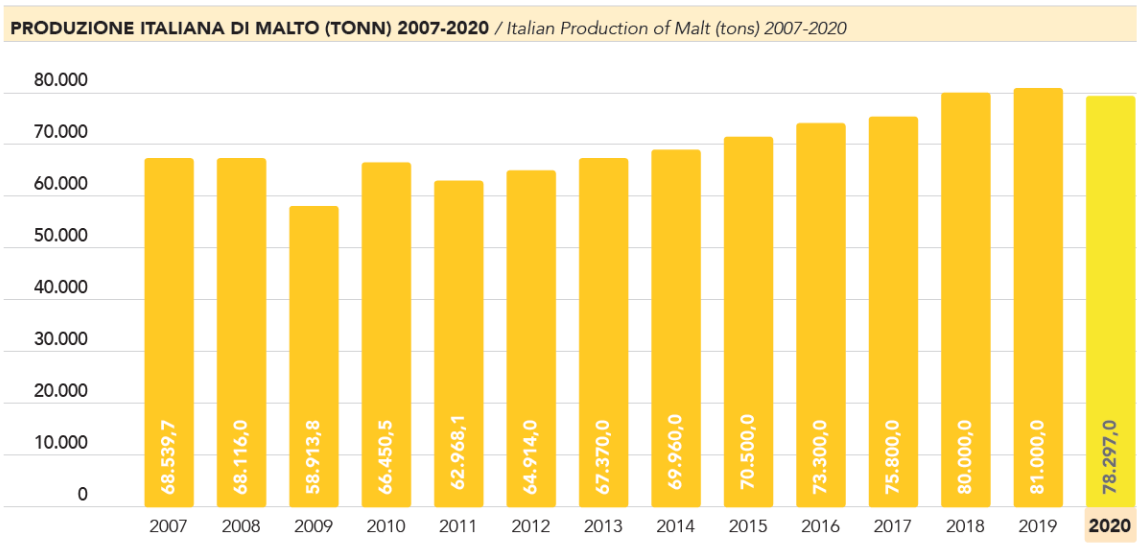

Figure 4-15. Production of malt in Italy, 2007-2020 [72]

Italian producers brought around 80,000 tons of malt in 2020, covering about half of Italy's needs. Currently, there are only two large malt houses in Italy: Saplo Spa in Pomezia (Rome) and Adriatica Spa in Melfi (Potenza). Alongside these two industrial realities, there is also COBI - Consorzio italiano produttori dell' orzo e della birra (already mentioned in the introduction of this Chapter), a consortium of farmers who grow and harvest barley for brewing and then give it to the consortium, which processes it into malt. The malt is

taken back by the farmers to brew their own beer, using artisanal methods. Finally, there are micro-malt houses in Tuscany, Friuli Venezia Giulia, Emilia Romagna and Piedmont, with a malting capacity between 5 and 20 tons. [71]

However, most of the necessary malt is still imported from abroad. About 58% of imported roasted malt comes from Germany. Major suppliers of unroasted malt are, instead, France (48%), Germany (36%) and Austria (8%).

IMPORTAZIONI DI MALTO IN ITALIA 2015-2020 / *Italian Imports of Malt 2015-2020*

TORREFATTO (TONN) / *Roasted (tons)*	2015	2016	2017	2018	2019	2020
Francia / *France* - FR	1.131,032	98,785	95,545	657,058	1.096,722 *	748,222
Paesi Bassi / *Netherlands* - NL	32,200	45,700	38,320	55,933	57,549	39,370
Germania / *Germany* - D	517,651	1.508,912	1.700,076	1.397,498	2.125,615 *	2.076,234
Regno Unito / *United Kingdom* - UK	98,761	99,225	267,200	89,950	399,090 *	234,930
Belgio/Lux / *Belgium/Lux* - B	237,916	281,236	278,565	169,819	585,122	126,799
Spagna / *Spain* - E	-	-	-	-	-	-
Svezia / *Sweden* - SE	-	-	-	-	-	-
Austria / *Austria* - A	169,463	172,744	202,774	195,237	195,271	148,551
Finlandia / *Finland* - FI	0,400	25,454	4,705	-	-	-
Ungheria / *Hungary* - HU	50,800	33,200	38,400	30,800	44,000	43,200
Rep. Ceca / *Czech Rep.* - CZ	10,561	-	-	-	-	-
Polonia / *Poland* - PL	-	-	507,000	581,000	-	152,038
Stati Uniti / *United States* - USA	-	-	-	-	2,041	-
Sri Lanka / *Sri Lanka* - LKA	-	-	-	1,280	-	-
Altri Paesi / *Other Countries* - UE	1,092	-	0,020	-	0,400	-
TOTALE / TOTAL	2.249,876	2.265,256	3.132,605	3.178,575	4.505,810 *	3.569,344

NON TORREFATTO (TONN) / *Unroasted (tons)*	2015	2016	2017	2018	2019	2020
Francia / *France* - FR	37.726,435	37.884,981	45.328,427	53.414,683	54.923,504*	74.806,163
Paesi Bassi / *Netherlands* - NL	4,733	76,660	50,000	445,243	455,285*	329,465
Germania / *Germany* - D	51.209,288	51.891,335	56.202,445	59.683,986	57.656,068*	57.361,258
Regno Unito / *United Kingdom* - UK	581,668	747,228	969,699	1.201,290	1.280,293*	686,163
Belgio/Lux / *Belgium/Lux* - B	866,957	961,625	4.318,446	1.154,600	2.906,438*	2.709,076
Spagna / *Spain* - E	-	-	27,560	78,631	21,480*	196,505
Portogallo / *Portugal* - P	4,032	-	-	-	-	-
Danimarca / *Denmark* - DK	-	-	-	3,300	13,033*	-
Finlandia / *Finland* - FI	10,600	67,510	75,870	-	-	-
Polonia / *Poland*- PL	33,424	434,780	1.470,570	1.078,591	5.294,517*	1.093,348
Austria / *Austria* - A	16.622,580	15.356,221	18.503,274	22.877,058	22.179,466*	13.304,996
Slovacchia / *Slovakia* - SLOV	400,600	149,385	282,590	-	-	-
Rep. Ceca / *Czech Rep.* - CZ	145,942	225,268	2.776,220	3.485,000	1.037,771*	13,770
Ungheria / *Hungary* - HU	180,965	4,819	-	726,540	1.943,680	1.781,400
Grecia / *Greece* - GR	-	-	-	-	-	5.374,760
Bulgaria / *Bulgaria* - BG	-	-	0,007	-	-	-
Croazia / *Croatia* - HR	-	-	-	499,600	-	55,402
Svizzera / *Swisse* - CH	-	-	-	-	-	4,650
Estonia / *Estonia* - EE	-	-	-	-	0,600	-
Romania / *Romania* - RO	-	-	-	-	66,761*	-
Stati Uniti / *United States* - USA	-	-	-	-	4,082	-
Sri Lanka / *Sri Lanka* - LKA	-	-	-	0,336	0,768	1,248
TOTALE / TOTAL	107.787,224	107.799,812	130.005,108	144.648,858	147.783,746 *	157.718,204

Table 4-6. Imports of roasted and unroasted malt in Italy, 2014-2018 [72]

As far as hops are concerned, in Italy, most brewers rely on foreign countries, as Humulus lupulus production is almost absent. However, the development of many craft breweries has prompted a few brewers and some research centers to start experimental plants, although we are only at the beginning: in 2020, there were about 100 hectares planted

with hops [88]. However, in-depth studies and field experiments are still needed to identify the varieties that are best adapted to Italian micro-climates and the development of cultivation and pest management intervention systems.

Europe is the world's largest producer of hops, has the oldest cultivation tradition, and each country is characterized by very specific varietal and quality peculiarities [89]. Germany, in particular, produces just slightly less than half of the entire world's brewing hops [89]. It is not surprising that Germany is the largest supplier of hops to Italy. In 2020, about 97 percent of Italy's imported hops came from Germany.

IMPORTAZIONI DI LUPPOLO IN ITALIA ANNO 2020 (TONN)
Imports of Hops in Italy - Year 2020 (tons)

	Luppolo in polvere *Hops Powder*	Estratto di luppolo *Hops Extract*	TOTALE *Total*
Germania / *Germany* - D	2.883,093	105,570	2.988,663
Paesi Bassi / *Netherlands* - NL	-	3,642	3,642
Danimarca / *Denmark* - DK	-	0,001	0,001
Slovenia / *Slovenia* - SL	0,300	-	0,300
Serbia / *Serbia* - RS	3,000	-	3,000
Regno Unito / *United Kingdom* - UK	0,110	6,149	6,259
Belgio/Lux / *Belgium/Lux* - B	30,716	49,490	80,206
Spagna / *Spain* - E	0,020	-	0,020
Francia / *France* - F	-	0,030	0,030
Austria / *Austria* - A	-	-	0,000
Estonia / *Estonia* - EE	-	.	0,000
Polonia / *Poland* - PL	.	.	0,000
Svezia / *Sweden* - SWE	-	0,900	0,900
Tot. U.E. / EU	2.917,239	165,782	3.083,021
Cina / *China* - RC	-	.	0,000
Corea del Sud / *South Korea* - KOR	-	.	0,000
Nuova Zelanda / *New Zeland* -	1,100	.	1,100
Stati Uniti / *United States* - USA	0,700	0,022	0,722
Altri / *Other*	-	-	0,000
TOTALE / TOTAL	2.919,039	165,804	3.084,843

Table 4-7. Imports of hops in Italy, 2020 [72]

4.10 Italian Beer Associations

4.10.1 AssoBirra

AssoBirra, Association of Brewers and Maltsters, was founded in 1907 and brings together the major companies that produce and market beer in Italy, which, in total, cover more than 90 percent of national beer production and produce more than 71 percent

of the beer consumed, employing, directly and through their associated industries, more than 144,000 people. [90]

AssoBirra performs institutional, promotional and technological development functions for the brewing sector. The institutional tasks of the Association are mainly related to the representation of member companies, both in Italy and abroad, with regard to legislative, legal and trade union aspects. In these areas, AssoBirra plays an important role of control and information, with the aim of protecting the interests of members and providing them with opinions, general guidelines and assistance.

In addition, the Association of Brewers and Maltsters is the body responsible for monitoring the consumption of beer in Italy: for this purpose, it promotes annual qualitative-quantitative research on the consumption habits of Italians, as well as studies and research on the quality of beer and the production technology.

AssoBirra has also long promoted collective advertising campaigns, with the aim of educating on responsible consumption and developing the beer culture.

AssoBirra is a member of Confindustria and Federalimentare and is a member of BoE (The Brewers of Europe), Euromalt (Comité de Travail des Malteries) and EBC (European Brewery Convention).

4.10.2 Unionbirrai

The trade association Unionbirrai, dedicated to the craft brewing sector, was founded in 2000 with the intent of promoting the culture of craft beer in Italy and connect producers, tasters, retailers and end consumers. It protects brewing producers in front of institutions and is a member of the European Beer Consumers' Union (EBCU).

Unionbirrai's main goals are:

- to become a solid point of reference for those who produce, sell and consume craft beer
- increasingly confirm itself as a representative contact with institutions
- enable producers to constantly improve the quality of their products and, in parallel, allow consumers to demand beers that are well produced, well stored and properly served
- increase the spread of craft beer in Italy.

Unionbirrai organizes and promotes different types of initiatives, such as:

- courses for the opening of microbreweries or beer shops
- tasting courses
- technical training courses and on legislative aspects for producers
- cultural trips to traditional brewing countries
- events and fairs.

It also annually holds the “Birra dell’Anno” contest, a competition that rewards the best Italian craft beers and the brewery of the year.

Unionbirrai has also registered the collective trademark "INDIPENDENTE ARTIGIANALE - UNA GARANZIA UNIONBIRRAI", registered in both Italy and Europe, which identifies the independent craft breweries recognized by the Association. The logo, visible on the labels and in the communication of the breweries that have obtained it, makes it possible to protect the consumer with correct information and, at the same time, offers the brewery itself a tool to qualify in an increasingly competitive market.

5 HEDONIC PRICE MODEL FOR ITALIAN CRAFT BEER

The so-called hedonic price technique relates the price of a differentiated product to its specific attributes. In other words, it decomposes explicit market prices into implicit prices of individual product characteristics.

Since the seminal contributions by Lancaster (1966) [91], Griliches (1971) [92], and Rosen (1974) [93], the hedonic price technique has been used to analyze durable goods, such as housing (for example, the study published by Can in 1992 [94]), automobiles (for example, the paper by Murray and Sarantis of 1999 [95]) and personal computers (for example, the work done by Berndt and Griliches in 1990 [96]) which lend themselves to this kind of analysis being highly differentiated and with easy-to-identify characteristics. However, in the last decade hedonic price analyses have been performed also for some nondurable goods, in particular wine.

Unlike wine, which appears in the economics literature with many studies (e.g., Nerlove, 1995 [97]; Lima, 2006 [98]; Benfratello et al., 2009 [99]; Michis and Markidou, 2013 [100]), beer has been object of relatively little research using hedonic methods to evaluate its price.

Hedonic regression models for wine frequently include variables associated with the sensory (e.g., firmness), objective (e.g., grape variety), and chemical (e.g., alcohol content) attributes of wine products and have been used to study reputation effects on prices. Similar considerations can be applied also to brewing products. For example, the objective characteristics of beers can include style and country of origin, the sensory characteristics can be color and serving temperature and the chemical attributes can be alcohol content and calories. Similarly, consumer ratings also exist in the beer industry; examples include specialized ratings published by beer community websites like RateBeer and Untappd.

5.1 Literature Review

Ruttanajarounsub in her master thesis of 2007 [101] examines factors that influence the price of beer in the US market. The model presented in this paper includes, as variable, advertising expenditures, beer type (ice beer/stout beer/mass-produced beer), imported beer, non-neighboring countries (German, Netherlands, Ireland and UK) and neighboring countries (Canada and Mexico). According to this study, the market price is positively

influenced by countries not neighboring the United States and negatively influenced by neighboring countries. Moreover, the results indicate that stout beer and ice beer receive a positive premium, while mass produced beer receives a negative premium. Advertising does not impact beer prices significantly.

Javier Cerpa and Oscar Melo in 2011 [102] have studied which variables are significant for beer prices in the Chilean market. The attributes taken into account are packaging (bottle/can), alcoholic strength, rating, beer category (ale/lager), beer type (industrial/foreign/craft), and four dummy variables for amber lager, amber ale, European beer and Easter Island beer. The results of the hedonic price estimation show that the variable that contributes the most in the explanation of the price of beer is “Easter Island”, followed by handmade beers.

Smith, McKinney, Caudill and Mixon in 2016 [103] analyzed the impact of consumer ratings, calorie content, alcohol content and beer style on beer prices. Consumer ratings and alcohol volume were both found to be positively related to beer prices. More specifically, a 10-point increase in consumer ratings leads to about a $0.50 increase in the price of a beer per unit.

Wieczorek and Czupryna in 2021 [104], in their hedonic regression analysis of the Polish beer market, show that the price of a beer is not only related to its main ingredient (malt) but to the fermentation type and quality aspects as well – beer rating, beer reviews, and quantity of beer awards.

Antonis Michis in 2022 [105] proposes regression models for both consumer ratings and prices that account for all the main beer attributes, namely the sensory, objective, and chemical characteristics of beers. First, it provides estimates of the determinants of consumer ratings using detailed information on the sensory, objective and chemical characteristics of beers. Second, since consumer ratings are frequently measured with error, this study proposes the use of the sensory and chemical characteristics of beers as instrumental variables in the estimation of hedonic regression models for beer prices. The findings suggest that beer prices tend to be influenced by consumer ratings and the objective characteristics of beers (e.g., style and country of origin), while consumer ratings tend to be influenced by the sensory (body, color, serving temperature) and chemical (alcohol, calories) characteristics of beers.

The following analysis intends to provide evidence on the factors driving Italian craft beer price, which has been so far the object of any empirical analyses. Following an approach similar to the one adopted by A. Michis in his study, this analysis proposes regression models for both consumer ratings and prices, in order to address the endogeneity problem associated with the impact of consumer ratings on beer prices (i.e. the rating is high because of the price).

5.2 Data Description

To develop a hedonic regression framework for Italian craft beer prices, the information used has been collected by inspecting several published sources.

The starting point for the construction of the database has been *Guida alle Birre d'Italia 2021* by SlowFood, in which 387 craft breweries and 1866 beers are presented. This guide, published every two years, is the most important publication in Italy for craft beer enthusiasts.

The first thing that has been done was looking for those breweries in the guide with own and independent online shop and selling bottles, cans or mini-kegs singularly and not in packs. This has been done in order to have beer prices as homogeneous as possible.

This step has led to the introduction in the database of 1575 different beers from 128 different breweries.

The prices reported in the online shops of each craft breweries have been added in the database for 33 cl bottles and cans (the most common size), specifying the packaging type (bottle or can) since this can affect also the consumer rating or the price.

From prices, VAT and excise duty were computed and subtracted from the original price. Excise duties are computed starting from the Plato degree, which, in turn, is proportional to the alcoholic content that is one of the attributes that will be inserted in the regression model. VAT at 22% (since the prices are meant for online sales) is applied also to excise duties, as provided in Italy. Plato degree is reported for many beers and breweries on their website. The missing values have been computed starting from ABV (always present on the websites) since ABV generally is 0.4 the Plato degree. Excise duties have been computed considering a tax of 2.94 euros per hectoliter and degree-Plato, as stated for 2022. Being microbreweries, it has been considered also the excise duty reduction provided for craft microbreweries (annual production up to 10,000 hectoliters) of 50 % for the year 2022. Only one brewery, Birra Salento, has a production between 10,000 hectoliters and 30,000 hectoliters and so a 30 % reduction for it has been accounted for.

Size	Variable Name	Observations	Mean	Standard Deviation	Min	Max
33 cl	*PriceWithVATandExcise33*	1249	4.13	1.05	1.92	14
	Excise33		0.072	0.021	0.036	0.16
	VAT33		0.75	0.19	0.35	2.52
	PriceWithoutVATandExcise33		3.32	0.86	1.51	11.39

Table 5-1. Descriptive statistics: price, excise and VAT for 33 cl bottles and cans

Prices are not the only information obtained from online shops and breweries' websites: also alcohol content, service temperature, fermentation type, bitterness, packaging types, "gluten-free, organic and session" characteristics, and beer styles are reported.

- Alcohol content is reported in the database as percent by volume and is used as a numerical variable in the econometric analysis (*ABV*).

Variable	Mean	Standard Deviation	Min	Max
ABV	6.36	1.9	3	18

Table 5-2. Descriptive statistics: ABV

- Service temperature is expressed as intervals: "4-6", "6-8", "8-10", "10-12", "12-14", "14-16", "16-18". For beers and breweries without this information, other two websites has been used: www.microbirrifici.org and www.fermentobirra.com. Dummy variables, also known as indicator variables, have been constructed for each temperature interval (*Tservice_dum*) to be included in the hedonic regression analysis.

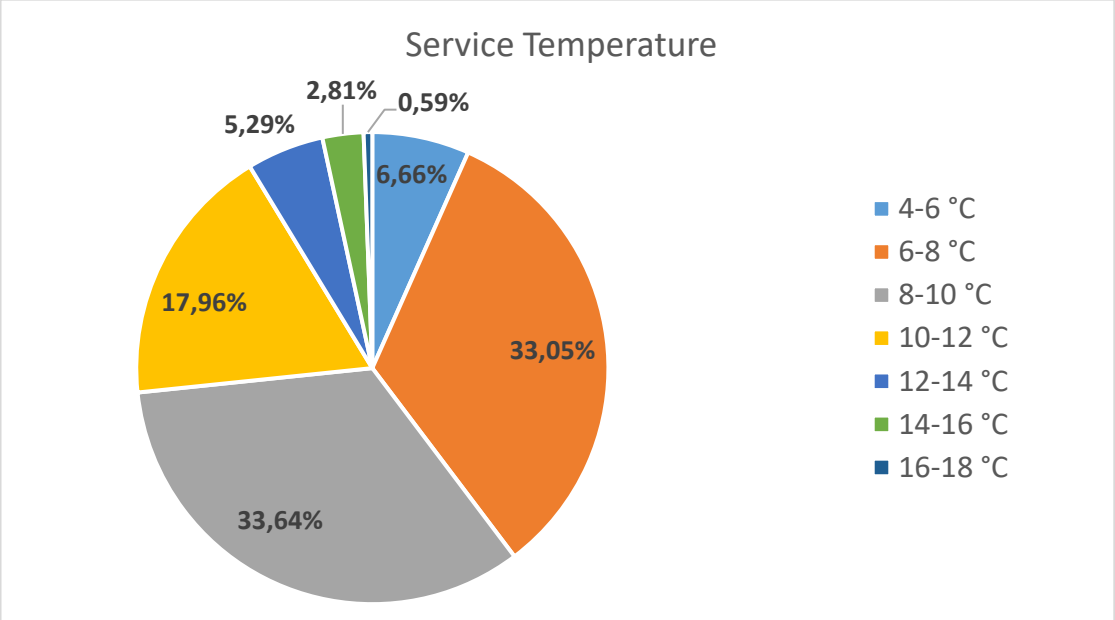

Figure 5-1. Descriptive statistics: Service temperature intervals

- Fermentation can be of three types: top, bottom and hybrid/spontaneous. Also in this case, dummy variables are used as an additional explanatory variable (*fermentation_dum*).

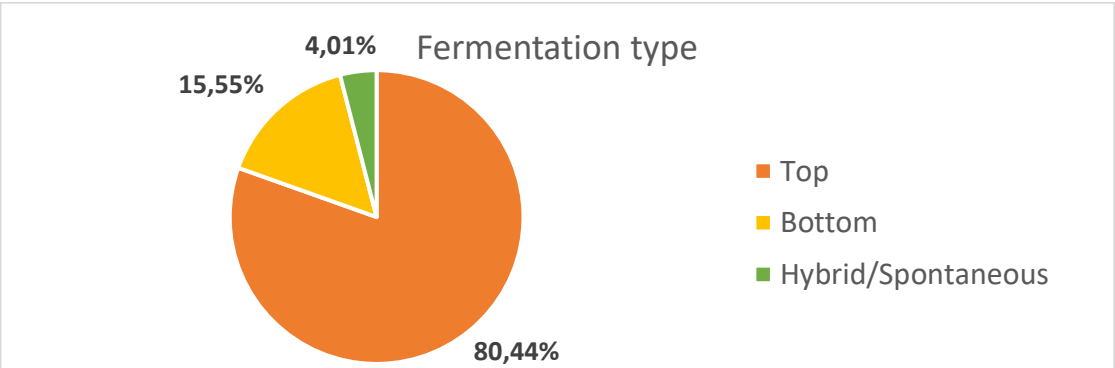

Figure 5-2. Descriptive statistics: Fermentation type

- Bitterness is measured as IBU (International Bitterness Unit) and so through a numerical variable (*IBU*).

Variable	Mean	Standard Deviation	Min	Max
IBU	33.27	18.55	2	150

Table 5-3. Descriptive statistics: IBU

- As said, 33cl beers are in either bottle or can. A dummy variable has been constructed to include in the regressions this information (*packaging_num*). For bottles, the dummy takes value 0, while for cans it takes value 1. There are 986 bottles and 263 cans out of a total of 1,249 beers.
- Beer can be session, gluten-free and organic and so dummy variables have been constructed to add these further details (*session_num, glutenfree_num, bio_num*). Session is about drinkability. A session beer is one that you can comfortably drink several pints of during a "session", which means the main distinguishing feature of these beers is low alcohol content. For example, a session IPA supposedly combines the hoppiness of an IPA with the lower alcohol content of a session beer. In the database, there are 28 organic beers, 36 gluten-free beers and 65 session beers.
- Since each brewery records styles with similar but different names, the designations given to each beer in the database are those established by the BJCP in the 2021 guidelines. The Beer Judge Certification Program, Inc. (BJCP) is a world-wide certifying organization for judges of beer and related fermented products. One of the most important parts of the BJCP is the collection of detailed style guidelines [106]. In these guidelines, in addition to style, there are larger categories of arbitrary groupings of beer with similar sensory characteristics. Being the number of possible styles very high (117), instead of using styles, in the regressions style categories, which are only 34, have been used (*category2021_dum*).

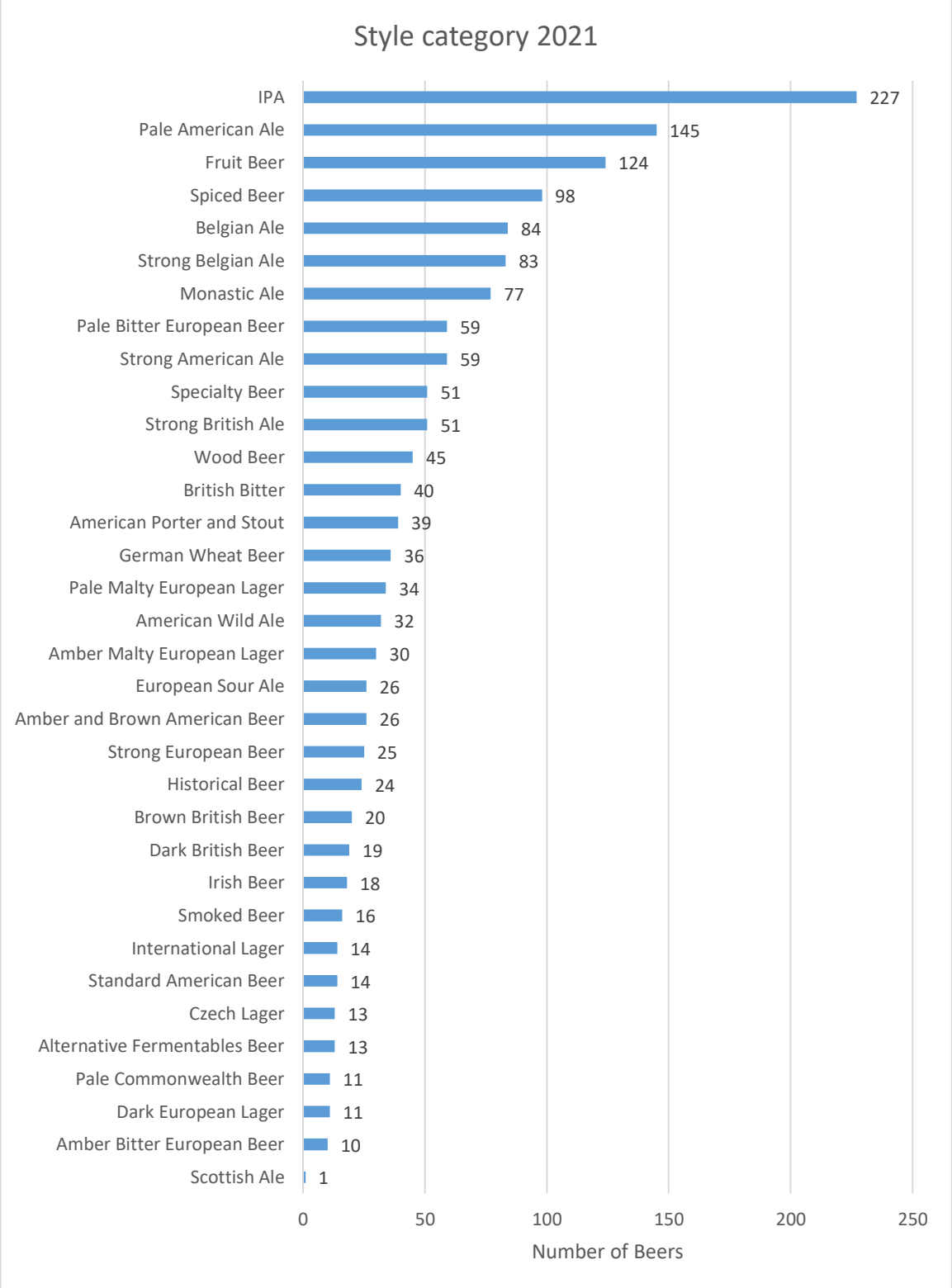

Figure 5-3. Number of beers per style category according to BJCP 2021 classification

From *Guida alle Birre d'Italia 2021*, other information have been taken and added to the database.

- Italian region in which the craft brewery operates. A dummy variable has been created for each region (*originarea_dum*). The regions are 19 since Valle d'Aosta does not have on the guide any breweries with online shops.

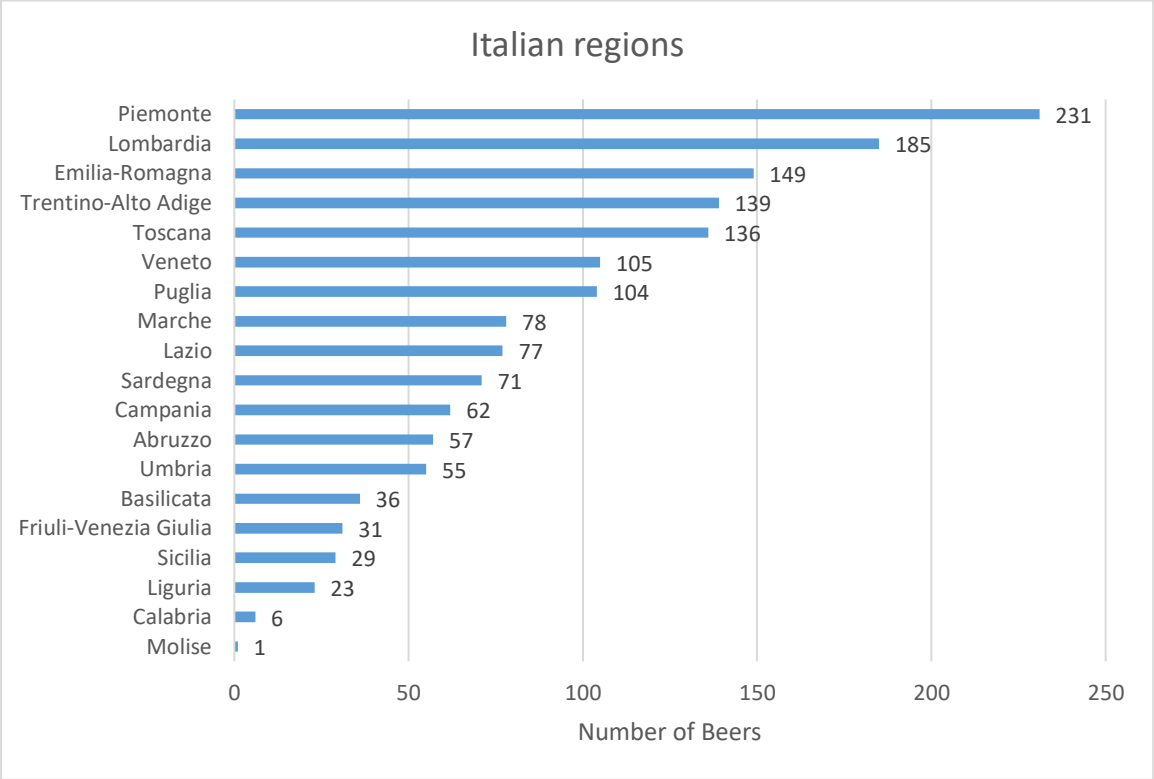

Figure 5-4. Number of beers per region

- Characteristics of the craft brewery: annual production, brewhouse dimension and cellar dimension. These are numerical variables, expressed in thousand hectoliters (*AnnualProduction1000hl*) and hectoliters (*BrewhouseDimensionhl* and *CellarDimensionhl*).

Variable	Mean	Standard Deviation	Min	Max
AnnualProduction1000hl	1.681	2.137	0.06	15
BrewhouseDimensionhl	13.27	10.69	2	65
CellarDimensionhl	251.09	310.22	7	1,800

Table 5-4. Descriptive statistics: Annual production, Brewhouse dimension and Cellar dimension

- If the brewery has been awarded as "Le Chiocciole" or "Le Eccellenze". "Le Chiocciole" are breweries that stand out for the quality and consistency of their beers, for their role in the national brewing industry, for their identity, and for their attention to the land and the environment. [107] "Le Eccellenze" are breweries that express high average quality across all production. [107] Out of a total of 128 breweries in the database, there are 21 breweries awarded as "Le Chiocciole" and 25 as "Le Eccellenze.

Also in this case, dummy variables have been constructed (*chicciole_num* ed *eccellenze_num*).

- Beer color can be of four types: light, light amber, deep amber and dark. Each category has a dummy variable (*color_dum*). For beers not described in the guide, the color has been taken from the brewery website or from www.fermentobirra.com.

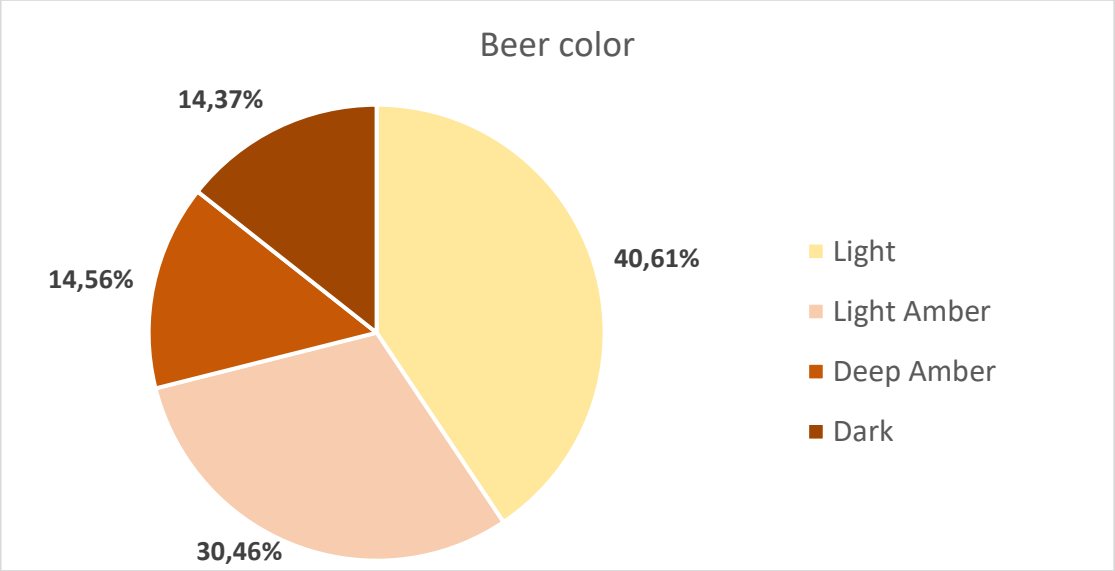

Figure 5-5. Descriptive statistics: Beer color

- Beer type can be regular, seasonal, collaborative, vintage, limited edition and part of a collection. Six dummy variables have been created (*beertype_dum*).

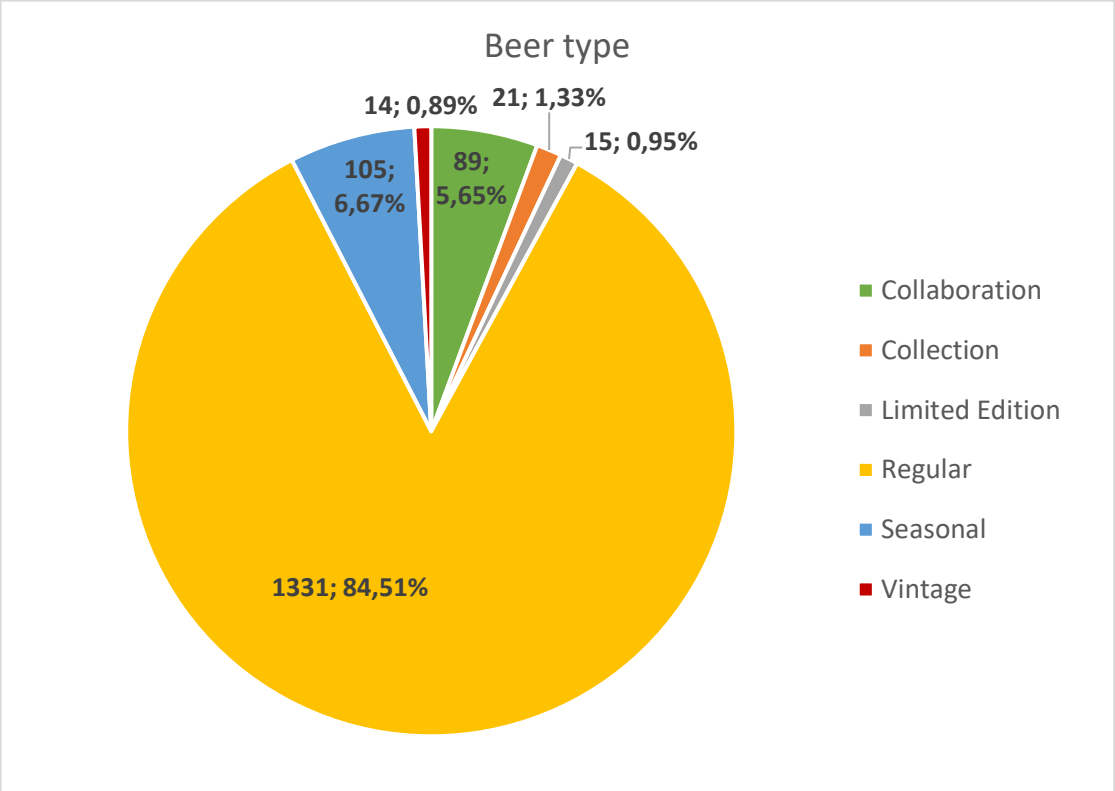

Figure 5-6. Descriptive statistics: Beer type

- If the beer has been awarded as “Birre slow” or “Birre imperdibili”. "Birre slow" are excellent beers in terms of organoleptic quality, capable of telling the story of an area and being a benchmark for their category or exemplary for a brewery. [107] “Birre imperdibili” are particularly outstanding for organoleptic characteristics and overall balance. [107] Out of a total of 1575 beers in the database, there are 56 “Birre slow” and 122 “Birre imperdibili”. Also in this case, dummy variables have been constructed (*slow_num* ed *imperdibile_num*).

Consumer ratings for each one of the beer items included in the sample have been collected from www.untappd.com. Untappd, founded in US in 2010, provides a platform for users to rate the beer they are consuming, earn badges, share pictures of their beers, review tap lists from nearby venues, see what beers their friends are drinking, comment on checked-in beers, and ask the app to suggest similar beverages. The analysis was based exclusively on evaluations that were available online in May 2022. For every beer item available for review, the scores provided by the consumers are in a 0-5 range (*RatingUntappd*). From the same website, also the brewery rating, always in a 0-5 range, has been collected (*BreweryRatingUntappd*).

Variable	Mean	Standard Deviation	Min	Max
RatingUntappd	3.58	0.21	2.57	4.18
BreweryRatingUntappd	3.57	0.15	3	3.85

Table 5-5. Descriptive statistics: Untappd ratings for beers and breweries

From www.RateBeer.com, the overall score assigned to the beers, in a range 0-100, has been also added to the database (*OverallscoreRateBeer*). A beer's overall score reflects the rating given by RateBeer users and how this beer compares to all other beers on RateBeer. RateBeer uses an algorithm when calculating the overall score, considering both the ratings given by each user and the total number of ratings for the beer.

Variable	Mean	Standard Deviation	Min	Max
OverallscoreRateBeer	64.46	21.28	6	99

Table 5-6. Descriptive statistics: Overall score assigned to beers from RateBeer

Calories, taken from www.RateBeer.com, are also present in the database and has been used as a numerical variable in the regression (*Calories*).

Variable	Mean	Standard Deviation	Min	Max
Calories	189.69	54.78	90	435

Table 5-7. Descriptive statistics: Calories

The database also indicates if beers have been awarded in some beer contests, national or international. The ones taken into account are: Birra dell’Anno 2021, Best Italian Beer 2021, SoloBirra 2021, Brussels Beer Challenge 2021 and European Beer Star 2021.

Birra dell'Anno 2021, in addition to the first, second and third placements, gives also a special mention for fourth and fifth placements. Best Italian Beer 2021, differently from Birra dell'Anno 2021, gives a special mention only for the fourth placement. SoloBirra 2021, Brussels Beer Challenge 2021 and European Beer Star 2021 award only the first three beers of the contest. A dummy variable has been created (*awarded_num*). It takes 1 if the beer has received an award and 0 if not.

5.3 Model

In this section, econometric models are estimated for both consumer ratings and beer prices, with the objective, among other things, of understanding how consumer ratings influence prices. As explained in the previous section, Untappd and RateBeer community website provide consumer ratings. However, these ratings do not refer exclusively to product evaluations by well-informed, experienced and appropriately educated experts. It can happen that, for example, reviewers assign a rating on the basis of the price: the higher the price, the higher the rating. Therefore, the associated beer ratings should be expected to be measured with error and correlated with the error term of the hedonic regression model. Consequently, to address this endogeneity problem when estimating the hedonic regression models for beer prices, a regression model for consumer ratings has been first implemented. Since in the database both consumer ratings from Untappd and RateBeer are available, two econometric models have been created for consumer ratings, in order to understand if there are difference in the evaluation provided by reviewers on the two websites.

5.3.1 First regression: (Untappd) Consumer ratings

In the first stage, the model below is estimated for consumer ratings. The rating considered is the one assigned to the beers on Untappad website. To explain the variations in consumer ratings, measurements concerning the following aspects of beers and breweries have been used as explanatory variables: chemical characteristics (bitterness, calories), sensory characteristics (service temperature), objective characteristics (style category, region, beer type, packaging, organic dummy) and breweries' characteristics and reputation characteristics of both beers and breweries (if the beer is "slow" or "imperdibile", if it has been awarded in a national or international contest, if the brewery has been awarded as one of the "Le Chiocciole" breweries and the rating assigned to the brewery on Untappd).

$$Rating\ Untappd = f\left(\begin{array}{c} bitterness, calories, style\ category, region, beer\ type, packaging, \\ slow\ dummy, organic\ dummy, award\ dummy, service\ temperature \\ Le\ chiocciole\ dummy,\ Untappd\ rating\ of\ the\ Brewery \end{array}\right)$$

In this estimation, the omitted variables, used as reference, are:

- For *category2021_dum*: category2021_dum = Standard American Beer
- For *originarea_dum*: originarea_dum = Piemonte

- For *beertype_dum*: beertype_dum4 = Regular
- For *Tservice_dum*: 4-6 °C

The estimation results for the model are included in Table 5-8.

877 observations	Coefficient	Robust Standard Error	P>|t|
chiocciole_num	0.0238**	0.0111	0.032
BreweryRatingUntappd	0.701***	0.0454	0.000
IBU	0.00142***	0.000378	0.000
Calories	0.000998*	0.000161	0.000
slow_num	0.0881***	0.0214	0.000
imperdibile_num	0.0378***	0.0125	0.003
awarded_num	0.0337**	0.0166	0.043
bio_num	0.0611**	0.0282	0.031
packaging_num	0.0586***	0.0121	0.000
	category2021_dum		
Alternative Fermentables Beer	-0.00515	0.0451	0.909
Amber Bitter European Beer	-0.0286	0.0634	0.652
Amber Malty European Lager	-0.0258	0.0309	0.404
Amber and Brown American Beer	-0.0605*	0.0349	0.083
American Porter and Stout	0.00107	0.0474	0.982
American Wild Ale	-0.00170	0.0704	0.981
Belgian Ale	-0.0415	0.0293	0.157
British Bitter	-0.0663*	0.0349	0.058
Brown British Beer	0.0347	0.0365	0.341
Czech Lager	0.0874*	0.0531	0.100
Dark British Beer	-0.0147	0.0497	0.768
Dark European Lager	-0.0378	0.0387	0.328
European Sour Ale	0.0845	0.0554	0.128
Fruit Beer	0.00662	0.0337	0.845
German Wheat Beer	-0.0302	0.0343	0.379
Historical Beer	0.00729	0.0380	0.848
IPA	0.0314	0.0273	0.250
International Lager	-0.0911**	0.0441	0.039
Irish Beer	-0.0455	0.0447	0.308
Monastic Ale	-0.0361	0.0313	0.249
Pale American Ale	-0.0183	0.0266	0.492
Pale Bitter European Beer	-0.0621*	0.0352	0.079
Pale Commonwealth Beer	-0.210***	0.0614	0.001
Pale Malty European Lager	-0.00489	0.0310	0.875
Scottish Ale	-0.268***	0.0339	0.000
Smoked Beer	0.0475	0.0448	0.290
Specialty Beer	0.0272	0.0372	0.464
Spiced Beer	-0.060	0.0447	0.176
Strong American Ale	-0.0189	0.0375	0.615

Strong Belgian Ale	-0.0370	0.0295	0.210
Strong British Ale	0.00389	0.0363	0.915
Strong European Beer	0.00548	0.0437	0.900
Wood Beer	0.0817	0.0746	0.274
	originarea_dum		
Abruzzo	-0.0142	0.0231	0.540
Basilicata	-0.0470	0.0601	0.435
Calabria	-0.0301	0.121	0.804
Campania	-0.0252	0.0244	0.303
Emilia-Romagna	-0.0886	0.0193	0.646
Friuli-Venezia Giulia	0.0237	0.0387	0.541
Lazio	0.0185	0.0273	0.498
Liguria	-0.0251	0.0391	0.521
Lombardia	-0.0413**	0.0169	0.015
Marche	0.0442**	0.0224	0.049
Molise	0.0722***	0.0232	0.002
Puglia	-0.0230	0.0231	0.320
Sardegna	0.0365	0.0295	0.217
Sicilia	0.132***	0.0379	0.001
Toscana	-0.0137	0.0192	0.474
Trentino-Alto Adige	-0.000812	0.0227	0.972
Umbria	0.000527	0.0244	0.983
Veneto	-0.0314	0.0212	0.139
	Tservice_dum		
6-8 °C	0.0563**	0.0226	0.013
8-10 °C	0.0632***	0.0229	0.006
10-12 °C	0.0721***	0.0261	0.006
12-14 °C	0.0887**	0.0380	0.020
14-16 °C	0.0547	0.0617	0.376
16-18 °C	-0.0772	0.104	0.457
	beertype_dum		
Collaboration	0.0556***	0.0190	0.004
Collection	0.0994***	0.0321	0.002
Limited Edition	-0.0400	0.0567	0.481
Seasonal	-0.0342	0.0233	0.143
Vintage	-0.295	0.248	0.233
R-squared		**0.5989**	
*Significance level: ***(1%), **(5%), *(10%)*			

Table 5-8. Coefficient estimates for Untappd consumer ratings model

Before arriving to this result, another regression has been performed, including, also *eccellenze_num*, *ABV*, *color_dum*, *session_num*, *glutenfree_num* and *fermentation_dum*.

For all classes of dummy variables, a joint significance test (*testparm*) has been performed. It is a joint test to see if the dummies among the same class are equal to 0, justifying their presence in the regression.

	Prob > F
category2021_dum	0.0000***
originarea_dum	0.0003***
colordum_dum	0.7514
Tservice_dum	0.0473**
beertype_dum	0.0057***
fermentation_dum	0.9015
*Significance level: ***(1%), **(5%), *(10%)*	

Table 5-9. Joint significance test on Untappd rating for classes of dummy variables

After this test, *color_dum* and *fermentation_dum* have been removed from the regression.

eccellenze_num, *ABV*, *session_num* and *glutenfree_num* have been removed from the regression since they are not significant, obtaining the model reported above.

By looking at the results, it is possible to say that the model provides a good fit to the data, as demonstrated by the relatively high R-squared value: the regressors work to account for about 60% of the variation in the beer ratings provided by Untappd.

The variables statistically significant that affect the consumer rating are:

- Packaging. In case of cans, the packaging affects positively the consumer rating.
- Beer type. Beers that are a result of a collaboration or a collection are valued positively by consumers.
- Organic beers lead also to an increase in the rating.
- Beers awarded in a national or international contest have a higher rating.
- Beers awarded as “slow” and “imperdibili” and breweries awarded as “Le chiocciole” on the guide have a positive impact on the rating.
- The rating received by the brewery on Untappd affect a lot the rating. In fact, considering the maximum and the minimum values that the brewery rating can assume (3,85 and 3, respectively), this variable multiplied by the coefficient can give a contribution to the rating in a range 2.1 – 2.7. So, there is a reputation effect of the brewery on the beer rating.
- Both chemical characteristics, IBU and Calories, are found to be positively related with consumer rating. The higher IBU and Calories, the higher the rating. As before, considering the maximum and the minimum values that these variables can assume and their coefficient, IBU can give a contribution between 0.0028 and 0.21, while calories between 0.09 and 0.43.
- With regard to the beer style indicator variables, only 7 categories out of 33 provide statistically significant coefficients in the estimation procedure: Amber and Brown American Beer, British Bitter, International Lager, Pale Bitter European Beer, Pale Commonwealth Beer and Scottish Ale lower the rating, while Czech Lagers push the rating up. The difference in coefficients can be interpreted as consumer preferences.
- As far as regions are concerned, Marche, Molise and Sicilia (the highest significant coefficient) raise the rating, while it is lowered by Lombardia.

- Beers served at a temperature between 6 and 14 °C are valued positively by consumers with respect to beers served at 4-6 °C. The positive coefficients for serving temperature tend to provide higher scores to beers served at higher temperatures. Betancur et al. [108] note that for beers correctly served at higher temperatures, more aromas are released, and taste properties become more perceptible. Specifically, higher temperatures have been found to increase a taster's sensitivity to sweetness as well as bitterness. Consequently, serving temperature should be expected to be positively related with consumer ratings.

5.3.2 Second regression: Price

The predicted values from the previous regression model were incorporated together with other variables in the following regression model for prices (per liter). This regression has been performed only taking into account the price for 33cl bottles and cans without VAT and excise duty. To explain the variations in price per liter, measurements concerning the following aspects of beers and breweries have been used as explanatory variables: sensory characteristics (service temperature), chemical characteristics (ABV), objective characteristics (style category, region, beer type, packaging, gluten-free, organic or session,), reputation characteristics related to both beers and breweries (if the beer is "slow" and "imperdibile", if it has a placement in a national or international contest, if the brewery has been awarded as one of the "Le Chiocciole" breweries) and brewery's characteristics (its annual production and brewhouse dimension).

The omitted variables are the same used in the consumer ratings model.

$$Price\ (per\ liter) = f\left(\begin{array}{c} Annual\ production, Brewhouse\ dimension, style\ category \\ ABV, imperdibile\ dummy, organic\ dummy, session\ dummy, \\ gluten\text{-}free\ dummy, Le\ chiocciole\ dummy, region\ , packaging, \\ service\ temperature, predicted\ rating \end{array}\right)$$

The estimation results for the model are included in Table 5-8.

889 observations	Coefficient	Robust Standard Error	P>|t|
chiocciole_num	1.010***	0.257	0.000
RatingUntappd_Predicted	-1.370	1.149	0.233
AnnualProduction1000hl	-0.126**	0.0525	0.016
BrewhouseDimensionhl	-0.0102	0.00879	0.246
ABV	0.725***	0.143	0.000
glutenfree_num	-0.265	0.290	0.361
imperdibile_num	-0.311*	0.180	0.084
bio_num	-0.245	0.293	0.403
packaging_num	0.324	0.167	0.052
session_num	1.103***	0.336	0.001
category2021_dum			
Alternative Fermentables Beer	-0.868	1.0525	0.170
Amber Bitter European Beer	-0.984	1.119	0.472

Amber Malty European Lager	-1.478**	0.574	0.020
Amber and Brown American Beer	-1.075**	0.543	0.046
American Porter and Stout	-1.317**	0.573	0.026
American Wild Ale	1.913*	0.975	0.085
Belgian Ale	-0.373	0.444	0.333
British Bitter	-0.400	0.519	0.237
Brown British Beer	-0.329	0.559	0.825
Czech Lager	-0.699	0.542	0.643
Dark British Beer	-0.240	0.553	0.348
Dark European Lager	-1.950**	0.832	0.022
European Sour Ale	1.332	1.713	0.443
Fruit Beer	0.947*	0.518	0.096
German Wheat Beer	-1.423**	0.642	0.048
Historical Beer	-0.395	0.492	0.589
IPA	-0.776	0.455	0.140
International Lager	-1.241**	0.482	0.016
Irish Beer	-0.745	0.486	0.138
Monastic Ale	-1.682***	0.515	0.003
Pale American Ale	-0.616	0.446	0.274
Pale Bitter European Beer	-0.762	0.476	0.112
Pale Commonwealth Beer	0.482	0.564	0.825
Pale Malty European Lager	-1.109*	0.560	0.061
Scottish Ale	2.267***	0.596	0.000
Smoked Beer	-1.461*	0.788	0.190
Specialty Beer	-0.482	0.598	0.632
Spiced Beer	-0.696	0.496	0.167
Strong American Ale	-0.826	0.573	0.169
Strong Belgian Ale	-1.256**	0.491	0.013
Strong British Ale	-0.417	0.687	0.333
Strong European Beer	-0.718	0.595	0.201
Wood Beer	5.336***	1.097	0.000
	originarea_dum		
Abruzzo	-0.251**	0.239	0.022
Basilicata	-0.186	0.256	0.742
Calabria	-1.773***	0.369	0.003
Campania	1.131***	0.332	0.002
Emilia-Romagna	0.341	0.236	0.605
Friuli-Venezia Giulia	-0.0238	0.252	0.991
Lazio	-0.0818	0.307	0.587
Liguria	-1.136*	0.557	0.091
Lombardia	-0.110	0.196	0.615
Marche	-0.576**	0.248	0.037
Molise	-2.058***	0.217	0.000
Puglia	-0.342	0.219	0.269
Sardegna	1.031***	0.288	0.001
Sicilia	1.922***	0.448	0.000
Toscana	0.816***	0.242	0.018

Trentino-Alto Adige	0.283	0.490	0.846
Umbria	0.0818	0.2844	0.600
Veneto	-1.151***	0.266	0.000
	Tservice_dum		
6-8 °C	-0.459*	0.268	0.087
8-10 °C	-0.374	0.229	0.219
10-12 °C	-0.178	0.263	0.934
12-14 °C	-0.691	0.366	0.138
14-16 °C	-0.537	0.432	0.457
16-18 °C	-1.094	1.267	0.192
R-squared		**0.4467**	
*Significance level: ***(1%), **(5%), *(10%)*			

Table -10. Coefficient estimates for price model (with predicted Untappd consumer rating)

Before arriving to this model, another regression has been performed, including, also *eccellenze_num*, *CellarDimensionhl*, *BreweryRatingUntappd*, *IBU*, *Calories, color_dum*, *slow_num*, *fermentation_dum and award_num*.

For all classes of dummy variables, a joint significance test (*testparm*) has been performed. It is a joint test to see if the dummies among the same class are equal to 0, justifying their presence in the regression.

	Prob > F
category2021_dum	0.0000***
originarea_dum	0.0000***
colordum_dum	0.8872
Tservice_dum	0.0328**
beertype_dum	0.1007
fermentation_dum	0.6716
*Significance level: ***(1%), **(5%), *(10%)*	

Table 5-11. Joint significance test on price for classes of dummy variables

After this test, *color_dum*, *beertype_dum* and *fermentation_dum* have been removed from the regression.

eccellenze_num, *CellarDimensiohl, BreweryRatingUntappd*, *IBU, Calories, slow_num* and *award_num,* have been removed from the regression since they are not significant, obtaining the model reported above.

The regressors included in the analysis work to account for about 45% of the variation in price. The coefficients, reported in Table -10, can be interpreted as the Willingness-To-Pay of consumers. By looking at the results, it is possible to see which are the variables statistically significant that influence the price:

- There is a reputation effect of the brewery on the beer rating: consumers are willing to pay more for beer produced by breweries awarded as “Le Chiocciole”.
- Annual production has a negative effect on the price that, considering its maximum and minimum values (0.06 and 15 thousand hectoliters, respectively), can vary

between -0.0076 and -1.89 €: the higher the annual production, the lower the price are ready to pay. This can be explained by the fact that higher annual productions tend to be associated with mass-consumed beers whose price is generally lower than craft beers.

- Session beers lead to an increase in price, meaning that consumers are open to pay more for the same style but with lower alcoholic content.
- The alcoholic content has also a positive effect on the price and, considering the maximum and minimum values it can assume (3 and 18), it can give to the price a contribution between 2.18 and 13.05 €.
- Beers awarded as "imperdibili" on the guide have lower prices. Consumers are not willing to spend more unmissable beers.
- Packaging. Cans have higher prices with respect to bottles. Surprisingly, against the prejudice toward canned beers as products of poor quality, consumers may pay more for this kind of packaging.
- Of the 33 beer category segments included, only 14 generate statistically significant values. Amber Malty European Lager, Amber and Brown American Beers, American Porter and Stout, Dark European Lager, German Wheat Beer, International Lager, Monastic Ale, Pale Malty European Lager, Smoked Beer and Strong Belgian Ale push the price down. American Wild Ale, Fruit Beer, Wood Beer and Scottish Ale push the price up, meaning that consumers may spend more for this kind of beers. The price premiums of these beer segments could represent differences in their production processes. For example, wood beers undergo a wood-barrel aging process and involve specialized production methods.
- Abruzzo, Calabria, Liguria, Marche, Molise and Veneto regions have lower prices with respect to Piemonte. Campania, Sardegna, Sicilia and Toscana regions have higher prices with respect to Piedmont.
- With respect to the reference interval of service temperature (4-6), service interval 6-8 tends to decrease prices.

If, in the model, instead of the predicted rating, the original rating is used as regressor, it happens that there is a positive relation between price and rating, demonstrating that the original rating is biased. In addition, it has also significant at 99%.

	Coefficient	**Robust Standard Error**	**P>|t|**
RatingUntappd	1.251***	0.358	0.001

If, instead of the price without VAT and excise that is proportional to the alcoholic content, as said, it happens that the coefficient assigned to ABV is higher (0.925 instead of 0.725). Since the coefficients represent the willingness-to-pay and in the regression with price without VAT and excise duty, the willingness-to-pay associated to ABV is underestimated, since consumers pay the full price with VAT and excise duty.

5.3.3 First regression and second regression by using the RateBeer overall score

In this section, other two models have been created for consumer rating and price. However, in this case, the first regression is no more based on the ratings assigned to beers on Untappd, but on the overall score assigned to the beers on RateBeer.

The estimation results for the consumer ratings model are reported in the table below. Note that the observations in this case are significantly lower with respect to the Untappd consumer ratings model.

298 observations	Coefficient	Robust Standard Error	P>|t|
eccellenze_num	-6.005***	2.274	0.009
BreweryRatingUntappd	53.430***	9.176	0.000
IBU	0.368***	0.764	0.000
slow_num	10.025***	3.169	0.002
imperdibile_num	4.675*	2.572	0.070
awarded_num	-2.443	2.711	0.368
glutenfree_num	17.820**	7.014	0.012
packaging_num	5.926*	3.208	0.066
category2021_dum			
Alternative Fermentables Beer	35.278***	12.123	0.004
Amber Bitter European Beer	31.768***	9.925	0.002
Amber Malty European Lager	19.616**	7.608	0.011
Amber and Brown American Beer	34.639***	7.556	0.000
American Porter and Stout	32.996***	6.920	0.000
Belgian Ale	28.554***	6.411	0.000
British Bitter	17.790**	8.689	0.042
Brown British Beer	46.019***	8.586	0.000
Czech Lager	38.469***	6.399	0.000
Dark British Beer	19.853*	10.413	0.058
Dark European Lager	21.154***	7.563	0.006
European Sour Ale	45.776***	7.833	0.000
Fruit Beer	32.522***	7.446	0.000
German Wheat Beer	25.051***	6.562	0.000
Historical Beer	38.138***	9.094	0.000
IPA	36.828***	5.555	0.000
International Lager	15.509	13.206	0.241
Irish Beer	18.453*	9.533	0.054
Monastic Ale	30.245***	7.570	0.000
Pale American Ale	34.547***	6.038	0.000
Pale Bitter European Beer	31.487***	7.364	0.000
Pale Commonwealth Beer	14.947*	8.945	0.096
Pale Malty European Lager	34.839***	9.004	0.000
Smoked Beer	36.745***	8.540	0.000
Specialty Beer	44.282***	7.178	0.000

Spiced Beer	29.798***	6.604	0.000
Strong American Ale	35.395***	7.904	0.000
Strong Belgian Ale	36.313***	6.513	0.000
Strong British Ale	32.510***	8.200	0.000
Strong European Beer	37.700***	7.357	0.000
Wood Beer	50.101***	8.734	0.000
	originarea_dum		
Abruzzo	-5.196	5.792	0.371
Campania	1.328	5.014	0.791
Emilia-Romagna	6.924	4.476	0.123
Friuli-Venezia Giulia	-1.263	4.183	0.763
Lazio	6.334	5.241	0.228
Liguria	22.384***	4.826	0.000
Lombardia	4.422	3.534	0.212
Marche	4.551	5.017	0.365
Puglia	-5.514	7.284	0.450
Sardegna	6.319	6.771	0.352
Sicilia	10.379	11.554	0.370
Toscana	8.033**	4.029	0.047
Trentino-Alto Adige	-6.409	4.615	0.166
Umbria	6.289	5.276	0.235
Veneto	-5.617	8.063	0.487
	Tservice_dum		
6-8 °C	6.987*	3.825	0.069
8-10 °C	6.718*	3.785	0.077
10-12 °C	12.785***	4.281	0.003
12-14 °C	10.822**	5.285	0.042
14-16 °C	-0.0332	6.306	0.996
	beertype_dum		
Collaboration	0.159	4.021	0.969
Collection	-13.754***	4.729	0.004
Limited Edition	-2.054	7.192	0.775
Seasonal	2.654	3.650	0.468
Vintage	6.282	6.918	0.365
R-squared		**0.6875**	
*Significance level: ***(1%), **(5%), *(10%)*			

Table 5-12. Coefficient estimates for RateBeer consumer ratings model

By looking at the results, it is possible to say that the model provides a good fit to the data, as demonstrated by the relatively high R-squared value: the regressors work to account for about 69% of the variation in the beer ratings provided by RateBeer. As for the Untappd consumer ratings model, beers served at a temperature between 6 and 14 °C are valued positively by consumers with respect to beers served at 4-6 °C. IBU, as before, affects positively the rating, while calories, not present in the table, have been not included because of a very low significance. As before, beers awarded as “slow” and “imperdibili” and breweries have a positive impact on the rating, while breweries awarded

as “Le chiocciole” on the guide, omitted in the table, as calories have been not included because of a very low significance. In contrast to the model developed for Untappd rating, beers that are a result of a collection are valued negatively by consumers, while the variable associated to collaboration is no more statistically significant. As in the Untappd model, the rating received by the brewery on Untappd affect a lot the rating and cans affect positively the consumer rating. However, the main difference between the two models is that in the RateBeer one all beer categories, with the exception of International lager, are statistically significant, with the coefficient of Wood beer resulting the highest, as before. In addition, now, the only two significant region are Liguria and Toscana, both valued positively by consumers.

The price model is reported in the table below.

1,092 observations	Coefficient	Robust Standard Error	P>|t|
chiocciole_num	0.836***	0.193	0.000
RatingUntappd_Predicted	-0.00387	0.00651	0.552
AnnualProduction1000hl	-0.109**	0.0396	0.006
BrewhouseDimensionhl	-0.0103	0.00791	0.193
ABV	0.630***	0.0936	0.000
glutenfree_num	-0.236	0.308	0.444
imperdibile_num	-0.353*	0.197	0.073
bio_num	-0.184	0.232	0.430
packaging_num	0.134	0.135	0.324
session_num	0.942***	0.270	0.001
category2021_dum			
Alternative Fermentables Beer	-1.916*	1.026	0.062
Amber Bitter European Beer	-0.853	1.139	0.454
Amber Malty European Lager	-1.196**	0.588	0.042
Amber and Brown American Beer	-1.035*	0.577	0.073
American Porter and Stout	-1.172*	0.665	0.078
American Wild Ale	1.691	1.131	0.135
Belgian Ale	-0.396	0.467	0.396
British Bitter	-0.616	0.564	0.274
Brown British Beer	-0.300	0.652	0.646
Czech Lager	-0.642	0.613	0.296
Dark British Beer	-0.264	0.586	0.653
Dark European Lager	-2.064**	0.854	0.016
European Sour Ale	1.015	1.168	0.385
Fruit Beer	0.784	0.551	0.155
German Wheat Beer	-1.196*	0.641	0.062
Historical Beer	-0.352	0.549	0.522
IPA	-0.730	0.540	0.177
International Lager	-1.074**	0.485	0.027
Irish Beer	-0.818	0.534	0.126
Monastic Ale	-1.714***	0.542	0.002
Pale American Ale	-0.606	0.501	0.227

Pale Bitter European Beer	-0.763	0.510	0.135
Pale Commonwealth Beer	0.425	0.571	0.456
Pale Malty European Lager	-1.108*	0.598	0.064
Scottish Ale	2.119***	0.589	0.000
Smoked Beer	-1.367	0.874	0.118
Specialty Beer	-0.426	0.793	0.591
Spiced Beer	-0.522	0.554	0.346
Strong American Ale	-0.630	0.665	0.344
Strong Belgian Ale	-1.317**	0.548	0.016
Strong British Ale	-0.683	0.731	0.350
Strong European Beer	-0.613	0.667	0.358
Wood Beer	4.762***	1.850	0.010
	originarea_dum		
Abruzzo	-0.205	0.247	0.407
Basilicata	-0.0911	0.243	0.708
Calabria	-1.512***	0.415	0.000
Campania	1.282***	0.305	0.000
Emilia-Romagna	0.319	0.217	0.141
Friuli-Venezia Giulia	0.0655	0.253	0.796
Lazio	0.122	0.283	0.666
Liguria	-0.760	0.764	0.320
Lombardia	0.0141	0.254	0.956
Marche	-0.417*	0.244	0.088
Molise	-2.148***	0.215	0.000
Puglia	0.0239	0.227	0.916
Sardegna	0.721**	0.296	0.015
Sicilia	1.887***	0.439	0.000
Toscana	0.854***	0.236	0.000
Trentino-Alto Adige	0.298	0.485	0.539
Umbria	0.231	0.297	0.436
Veneto	-0.943***	0.236	0.000
	Tservice_dum		
6-8 °C	-0.375*	0.221	0.089
8-10 °C	-0.313	0.236	0.186
10-12 °C	-0.0593	0.287	0.836
12-14 °C	-0.417	0.390	0.282
14-16 °C	-0.807*	0.423	0.057
16-18 °C	-1.138	1.338	0.395
R-squared		**0.4262**	
*Significance level: ***(1%), **(5%), *(10%)*			

Table 5-13. Coefficient estimates for price model (with predicted RateBeer consumer rating)

The regressors included in the analysis work to account for about 43% of the variation in price, more or less as before.

If, in the model, instead of the predicted rating, the original rating is used as regressor, it happens that there is a positive relation between price and rating, demonstrating that the

original rating is biased, as occurred with the Untappd rating. However, in this case, the overall score is not statistically significant, and the bias is lower than before.

	Coefficient	**Robust Standard Error**	**P>|t|**
OverallscoreRateBeer	0.00714***	0.00818	0.384

6 CONCLUSIONS

In recent years, up to 2019, Italy has recorded a long series of successes in the beer world with history-making increases in production, consumption and exports, proving that it plays a leading role foremost in the landscape of the beverage industry and thus in the national economy. These results have been achieved thanks to the growing appreciation of Italians for beer (traditionally more attracted by wine), which is increasingly present on our tables and of an industry that has invested in innovation, research and development, but also dissemination of the beer culture. The long series of successes was stopped only by the spread of Covid-19 pandemic in 2020, when the national beer production decreased by 8.4%, from 17,288 thousand hectoliters produced in 2019 to 15,829, after the previous 10 years had seen production increase volumes by 35%. These results are the mirror of a crisis that has involved the entire supply chain of beer and in particular the consumption of the out of home that, with the restrictions imposed, have marked a drop in consumption of 11.4% (18,784 thousand hectoliters vs. a 2019 that had exceeded 21 million hectoliters). Exports, similarly to production and consumption, after years of growth suffered a 4.8% drop in 2020, while imports recorded a 15% drop.

It is worth to mention that the level of consumption per capita in Italy is considerably below the European average. In 2020, Italy ranked second from last on the list of volumes of beer consumed per capita in Europe by country. Analyzing the consumption trend per capita with respect to other alcoholic beverages, wine remains the most drunk alcoholic beverage. But it must be noticed that beer is shortening the distance. While in 1980, wine consumption per capita was 5.56 times the beer consumption, in 2020 there is a difference of only 2.5 liters.

On the Italian beer market, there are mainly five brewing companies with industrial production in our area: Heineken Italia Spa, Birra Peroni Srl, Anheuser-Busch In.Bev Spa, Carlsberg Italia Spa and Birra Castello Spa. They have approximately 70% of the Italian market share. Then, craft production units, such as microbreweries and brewpubs, and third-party imports must be added to the total computation of brewing companies in Italy. The first craft beer producer entered the market in 1988. The initial spread of increasing numbers of new entrants was initially rather slow, but there was an exponential increase after 2000. The boom of the craft beer sector, whose legislative definition was introduced in Italy only in 2016, has been favored by different factors: increasing revenues that led to a consumer demand more sophisticated, more refined, and inclined to greater variety; food scandals and environmental concerns which led to growing attention to signs and information attesting to the safety of consumer goods; attitude in favor of local production; international integration that contributed to increasing consumers'

knowledge about the existence of a great variety of food products which had previously been unknown or less known.

Italian creativity contributed to the international success of Italian craft beer. The re-interpretation of traditional beer styles, the experimentation with new recipes, the strategy to characterize beer with the addition of traditional local ingredients contributed to the acknowledgment of Italian producers in the international beer panorama. The proliferation of made-in-Italy beers has been accompanied by a surprising growth in microbreweries and brew pubs: in the last 10 years microbreweries have recorded a percentage increase of 235% (from 186 to 624 units), while brew pubs increased by an amount equal to 22% (passing from 108 to 132 pubs). In 2019, the Italian government took some measures to support and protect small Italian craft breweries and to incentive the growth of this sector. It provided a 40% reduction (50% only in 2022) in excise duties for craft breweries that do not produce more than 10 thousand hectoliters a year, which are independent at company level and do not carry out pasteurization and microfiltration.

The empirical analysis to estimate Italian craft beer prices through a hedonic regression model suggests that Italian craft beer prices are not influenced by consumer ratings, while there is a reputation effect of the brewery: consumers are willing to pay more for beer produced by breweries awarded as “Le Chiocciole” on *Guida alle Birre d’Italia 2021*, which is the most important publication in Italy for craft beer enthusiasts. In addition, beers awarded as “slow” or “imperdibili” have a positive impact on the beer rating. As far as the chemical characteristics of the beer are concerned, ABV is one of the main determinants of the beer price, while bitterness is positively related to the consumer rating. Serving temperature is positively related with consumer ratings since at higher temperatures, more aromas are released, and taste properties become more perceptible.

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