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BREWING BEER IN THE MIDDLE AGES (750 - 1500): BEER PRODUCTION AND PRODUCT DIFFERENTIATION IN MEDIEVAL NORTHERN GERMANY. PART III

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Beer Types

Establishing the beer types which were brewed in the Middle Ages, and comparing their differences is instrumental to understand the level of product differentiation in medieval beer production. Beer types have received considerable attention in some scholarly works which allow a wider period frame than this investigation, due to the fact that an immense amount of beer types are recorded in medicinal and herbal books in the Early Modern Period. However, a critical examination of beer types specifically for and limited to only the Middle Ages has, as far as I am informed, not been performed before.

Once again, we find a limitation in the source material. Whereas recipes which include flavourings are often found in the sources from the Early Modern Period, this is not the case for the Middle Ages. Furthermore, beers are often named in a way which give an indication of the ingredients, strength, quality, or spice of the beer in the Early Modern Period, such as Lanvendelbier, Kirschenbier or Rosmarinbier,[1] whereas the naming in the Middle Ages rarely provides such indications. Therefore, an investigation of beer types specifically for the Middle Ages cannot be performed from a historical reading of the sources alone, as the sources generally reveal little about the specific characteristics of beer types. However, a firm understanding of medieval beer production, which the previous sections provided, makes it possible to expose certain specific characteristic of different kinds of beer and establish roughly various types for comparison.

For instance, from what has already been discussed, it can safely be assumed that the Carolingians brewed different beer types in the Early Middle Ages based on *The Plan of Saint Gall*. The Carolingian brewers brewed three different kinds of beer, which were intended for different consumers based on social status. It may be assumed that the cheapest beer, intended for pilgrims and poor, would have a lower alcohol percentage, due to smaller amounts of malt, and it would be spiced with cheap, easily available flavourings. The beers for the monks and the guests and nobles would be of higher quality, respectively, and therefore include higher malt quantities and more expensive flavourings. Possibly, the grain bill for the higher quality beers would also be different from the lower quality beers, but this is purely a hypothesis as there appears to be no written evidence of malt preferences prior to the above Bremish chronical.

Thus, from the beginning of the period, differentiation is to be expected on a qualitative level. When looking into contemporary sources from the High Middle Ages, there are references to 'Bier und Dünnbier'[2] from the early 14th century which suggests that the qualitative distinction between a 'normal beer' and a beer of lesser malt quantity was either carried on from the Carolingians or reappeared on its own. The Dünnbier would most likely have been produced from a second running of the malts as explained previously as this would be the most obvious and resource optimising process. Mention of a 'Dubbelbier' appears in 1500 in a statute regarding German merchants' customs in Bruges.[3] As the name suggests, a 'Dubbelbier' is a stronger beer with a higher malt quantity than regular beer, up to twice as high, and subsequently a higher alcohol percentage. From these observations, it can be proposed that beers were sometimes or frequently aimed at obtaining different alcohol percentages, strength, and body at the time of the Carolingians and again from the late 13th century or, most likely, throughout the entire medieval period.

An investigation of the beers recorded in the German Urkundenbücher and the Hanserecesse reveals that they are named after the places they were brewed. Hamburger Bier, 'Dudesches Bier' (German beers) or the overarching 'Oestersches Bier' (beers from the Baltic Sea) are, by far, the most frequently mentioned beer types, while variations of Bremener Bier, Wismarer Bier, Rostocker Bier, Danziger Bier, and Lübecker Bier from the Northern German area are

relatively frequently mentioned as well as Braunschweiger Mumme and Einbecker Bier from inland Germany.[4] References to 'Hansischen Biers' and variations of 'hoppinbier' and 'oppenbier' are found *specifically* in sources originating in the Low Countries and France,[5] while in Scandinavia the beers are often labelled as Dudesches Bier or Hamburger Bier.[6]

Amongst other beer names recorded in the Middle Ages or shortly after is Jopenbier,[7] Keutbier or Koventbier,[8] which were probably also lower quality beers, as they were later recorded as such.[9] When Christian II of Denmark was held in captivity in 1532-1549 in Sønderborg, he drank Quackeltheiss, or Kakabille beer, from Eckernförde,[10] suggesting that this type of beer was of higher quality.

However, most recordings of beers are only identified by origin, which make qualifying the beers difficult, but there are some measures. Statutes from towns are the most informative sources (see below), but it would be useful to first establish the overall framework for the beer types. Firstly, by discussing sources on pricing, which are also indicative of beer types. For instance, in a source from Danzig from 1454 prices of different beers, wine, and mead are fixed. In the statute, Hamburger Beers are established to twice the cost of Danzig beers and beers from the local area, if the local beers are payed for at a taproom. Elsewhere, Danzig beer and local beers would be slightly cheaper. Other foreign beers are priced directly in between Danzig beers at taprooms and Hamburg beers, while 'Schiffsbiers, gemeinen Biers und Tafelbiers' are priced much cheaper than regular Danzig beers.[11]

Due to transportation costs and tolls, it should not be a surprise that foreign beers were more expensive than local beers. What is most noticeable is that Hamburger beers are so much more expensive than Danzig beers, which were also export beers, and other foreign beers. The price of Hamburger beers was equal to the price of foreign mead, which had higher production costs due to the raw material of honey, and the price therefore signifies how high quality the Hamburger beers were perceived to be in the mid-15th century. As a beer type, it can therefore be qualified as its own as it is set apart from other export beers of the time.

It is also noticeable that other foreign beers are collectively set at a price directly in between Danzig beers and Hamburg beers, making up for the cost of transportation, but not specifying any of the other beer producing towns in the region as better than the rest, save Hamburg. This indicates two things. First, that enough different kinds of foreign beers were sold in Danzig, or expected by authorities to be sold in Danzig, to which the authorities found it too difficult to specify all the beer types with individual prices, which indicate rich variation. Second, that these numerous beer types were perceived as being of overall equal quality, if one set the price as the measure for quality, which meant that individual consumers decided to buy one product rather than another based on personal preference. Furthermore, in making this choice they chose against buying the otherwise good quality, but cheaper Danzig beer or the most popular Hamburg beer, which ultimately reveal product differentiation based on different criteria.

In the sources there is also a specification of three differentiated lower quality beers, namely ship's beer, common beer, and table beer. Ship's beer, as the name suggests, was designed for keeping sailor's hydrated when onboard ship and of low alcohol percentage.[12] As the beer had to be durable enough to last the journey, it may be expected to be quite spicy, possibly heavily hopped or with an immensely high content of other anti-microbial herbs, such as bog myrtle or marsch. Contrary to the durable ship's beer, common beer and table beer were local beers designed for everyday consumption, yet as we can see, even at this price level there is product differentiation. Durability would not be as highly prioritised in the local beer types, which were designed for quick consumption, and consequently they did not require the addition of anti-microbial herbs. To keep costs low, it is most likely the that the beers were brewed with easily available and cheaper flavourings with no or small amounts of hops.

It is important to remember that even though the Northern German brewers produced hopped beers, which they frequently exported, it is not until the Modern Period that brewing with hops became universal.[13] Hence, it can be expected that local beers were spiced with a variety of spices. We can gather from the sources from the Low Countries and France that the export beers were hopped, which made them appear much different to the local beers in those areas as they were only allowed to brew with gruit until the late 14th century. However, in the Northern German area where there were no restrictions on additives, the options for product differentiation through flavourings would have been immense.

Differentiation in colours are frequently mentioned by scholars, but in fact it rarely appears in the source material and mostly towards the end of the Middle Ages. Thus, in a household account from 1494 Lübeck '1 tn rott beer de folk' and '1 tn. Einbecker Bier à 2½ mk.' is listed,[14] which reveal that red beers were traded and that they were of a lower quality as they were intended for the servants. In a statute from 1482 Cologne 'Keutbier und geelem biere' and 'roitbier' are mentioned,[15] which shows that different coloured beers were produced during the Middle Ages. However, one

should be careful not to over-emphasise differentiation in colours as they are, in fact, not that frequently mentioned in medieval source material, but they are a large topic in the Early Modern sources.

For instance, in Matthäus Schlüter's *Tractat* from 1698 frequent discussions of coloured beers appear,[16] including a reference to a change in beer colours in 1374 Hamburg:

> Noch deutlicher wird es in einer geschriebenen handelerischen Chronicâ, wovon der Herz Gerhard Schröder/U.J.D. mir folgenden Extracts mitgetheilet
> Anno 1374
> In diesem Jahr Hamburger Bier ward geeler Farb/ da es sonst schier weiβ war/ wie dann Bier ze Bremen/ Denn diese Farb ist angenehmer.
> [Even clearer it becomes in a written trade's chronical where Herz Gerhard Schröder/U.J.D. with the following passage announces in the year 1374
> In this year Hamburger Bier was of a yellow colour/that was otherwise almost white/as the beer from Bremen/As this colour was more pleasing][17]

Schlüter writes of a chronicler, which reported a change in beer colours, but the chronical seems to have since gone missing. Problematically, the changes in beer colours do not appear in the Hamburgische Burspraken and if they did change colour in 1374, it was probably not due to governmental interference. Yet, Schüter's statement are often presented as a 'fact' in beer history.[18] Thus, whilst different coloured beers were certainly present in the Middle Ages, we must be cautious not to over-emphasise their meaning due to the popularity of recognizing beers by colours in the Early Modern period. In the Middle Ages, it was much more common to distinguish beers by origin.

Visualisation and comparison

From the above framework we can gather some specific beer types and visualise them for more effective comparison, which will later be utilised in a product differentiation model. But first, certain reservations must be made. Unfortunately, establishing the exact alcohol percentages for pre-modern beers is impossible. Starch contents in the malts cannot be determined from archaeobotanical evidence and so we do not know how much sugar would be fermented into alcohol even if we could establish the exact ratio of malt to water[19] and the efficiency of mashing and fermentation. For the sake of this illustration, we fix the alcohol percentage to 3.5% for a 'regular' beer. This is a relatively low alcohol percentage and would have been achievable in the beers which were exported or consumed locally as good quality beers. The thinner beers we fix at half the alcohol percentage of regular beers. The alcohol percentage for double beer we fix at just below double the alcohol percentage, from the expectation that twice the amount of malt was used, but a relatively lower efficiency resulted in a less than doubling of alcohol percentage.

The brewing calculator *BeerSmith* is used to illustrate the beer types and to produce comparable statistics. Specifically, we use *BeerSmith* here to calculate the expected colour of the beers, measured in EBC, and the expected bitterness, measured in IBU, and the statistics are compared to each other and to a normal industrial lager, e.g. Carlsberg, for the sake of a familiar reference. Four comparisons are made. First, we will show how the Trave beer would compare to a normal industrial lager and what effect a significant number of noble hops would have had on the beer. From the two malt combinations in the 1363 Lubecian statute I will show the width of their difference. We will then compare a Dünnbier and Dubblebier to the Lubecian beers and, lastly, we will illustrate a hopped ship's beer in comparison with the normal Dünnbier.

Trave beer from the Ratzeburg chapter contained 4/8 of oats and 2/8 of wheat and barley. Whether the beer was hopped or not cannot be established with certainty as hops would have been attainable, but not necessarily preferred. Assuming that the beer reached an alcohol percentage of 3.5 % and was fermented with wild yeast at c.18-20 ºC, the beer would have been very pale as illustrated beneath. The red, yellow and green lines on the statistics chart illustrate how the beer compares to a normal industrial lager by showing a black arrow. The more central the arrow is on the line, the better it compares to an industrial lager. As shown, the Trave beer would have been in the lighter part of the colour spectrum, but within the green zone, which mean it would be quite comparable to a modern pilsner type. If the beer was brewed with bog myrtle it would have had a sweet taste and not be comparable to an industrial lager, as illustrated on the second line 'Bitterness (IBUs)' where the black arrow is at the far-left side. At 3.5 % the beers are also lighter in alcohol than industrial lagers.

Assuming that the Ratzeburg brewers added a very significant number of hops (here: 5 kg of hops is added to a 60 kg malt recipe, which is a very substantial amount) early on in the brewing process and extracted as much bitterness as possible from the hops, the beer would still not be as bitter as a common industrial lager.

A normal industrial lager is usually between 18-25 IBU, while the Trave beer, as shown, would have a lower number, here 15,9, even if it was heavily hopped. The reason for this

Figure 1. Trave beer based on Ratzeburg Cathedral Chapter, containing 4/8 of oats, 2/8 of wheat and 2/8 of barley, partially smoked. Five kg of bog myrtle is added and a small dose of wild yeast. (In colour online).

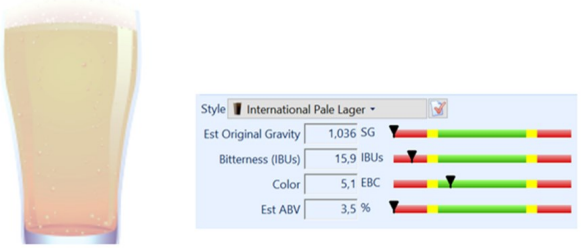

Figure 2. Trave beer based on Ratzeburg Cathedral Chapter containing 4/8 of oats, 2/8 of wheat and 2/8 of barley, partially smoked. Five kg of Spalter hops are added and a small dose of wild yeast. (In colour online).

Figure 3. Wheat beer, based on a Lubecian statute, 1363, containing 1/8 of oats to 7/8 of wheat, five kg of Spalter hops and a low dose of wild yeast. (In colour online).

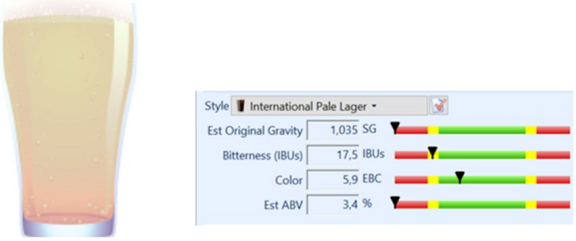

Figure 4. Barley beer, based on a Lubecian statute, 1363, containing 1/8 of oats to 7/8 of barley, five kg of Spalter hops and a low dose of wild yeast. (In colour online).

is the very low alpha acid content of old-style hops and the fact that medieval brewers would be using fresh hop plants and not the compressed, highly concentrated hop pellets, which modern brewers use. Thus, even though the hop plants would add bitterness, the beer would not have been very bitter.

The Lubecian brewing statute from 1363 allowed brewers to brew beer with 7/8 of wheat to 1/8 of oats or 7/8 of barley to 1/8 of oats. From that we can gather that the brewer brewed either wheat beer or barley beer on a weekly basis. If the allowance of 1/8 of oats was also reflected in the recipes then the two types of beer which was brewed in Lübeck from 1363, would compare as follows.

The barley-based beer would be slightly darker than the wheat-based beer, measuring 5,9 EBC and 5,5 EBC, respectively, but both would be in the lighter end, compared to an industrial lager and generally not very different in colour. Due to the malt combinations they would be more bitter than the previous Trave beer, if they were also heavily hopped at an early stage of the brewing process. But they would still not be perceived as bitter compared to an industrial lager. The same total amount of malts and hops are added in these recipes, but the alcohol percentage of the wheat beer is higher than the barley beer and bitterness is slightly lower in the wheat beer. This is due to a higher amount of fermentable sugars in wheat.[20] Therefore, the wheat beers would have slightly more body, which would balance the bitterness, in addition to other flavour characteristics, which are specific to wheat beer types, such as haze and a wheat bready flavour. In essence, the Lubecian brewers would be brewing two beer types, which were differentiated both in colour, flavour, and aroma, and quite possibly alcohol percentage and body, even if they used exactly the same quantities, brewing methods, and flavourings.

If we use the barley-based quantities as a base for a locally consumed Dünnbier and an exported Dubblebier, the two types would be lighter and darker, respectively. The alcohol percentages would not double and half precisely, if the malt quantities were doubled and halved, due to the circumstance

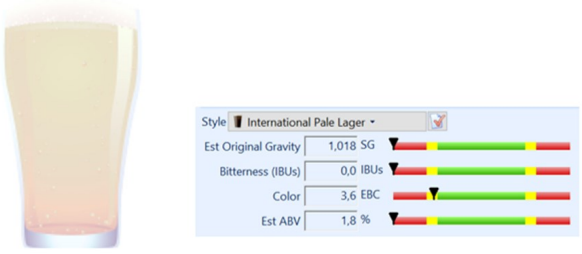

Figure 5. A Dünnbier from 1/8 of oats and 7/8 of barley, half the quantities of the barley-based Lubecian beer from 1363. Bog myrtle is added to the recipe in a small amount. (In colour online).

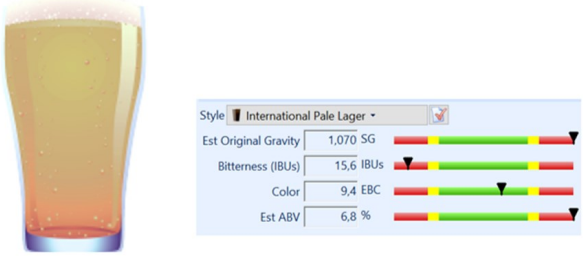

Figure 6. A Dubblebier from 1/8 of oats and 7/8 of barley, double the quantities of the barley based Lubecian beer from 1363. Hops are added in the a slightly higher amount, but they cannot be doubled as they would clog the system. (In colour online).

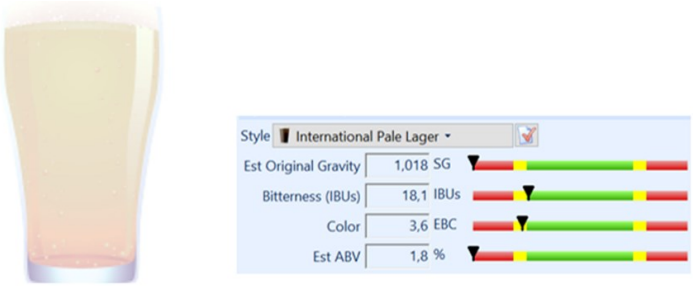

Figure 7. A hopped ships beer containing the same ingredients as a Dünnbier with the addition of slightly reduced amounts of Spalter hops. (In colour online).

that the brewhouse efficiency is exponentially falling as quantities rise.

In this example, the Dünnbier is made with gruit, but might as well be made with small amounts of hops and/or other local ingredients. The double beer is produced with hops to balance the sweetness of the beer and, as it was sometimes exported to the Netherlands, it would likely have been hopped. Note that hops cannot be continuously added in higher amounts as they tend to clog openings and create filters and so the double beer would most likely have been sweeter than the regular barley-based beer.

If we assume that the ship's beers had hops as a preservative flavouring or made from second runnings on hopped beer, they would be quite bitter, more accurately resembling the bitterness in modern beers, due to the high ratio of hops to malts and provide a more bitter alternative to locally spiced, thin beers. Thus, for the first time the black arrow is just in the green area on the Bitterness arch.

Interestingly, the Lubecian beers were all brewed with oats, barley and/or wheat, but as previously discussed most locally consumed, home produced beers would most likely have contained high amounts of rye and taste quite differently to the commercially produced beers. We do not have any grain bills on this kind of beer and so an illustration of this kind of beer would be purely speculative. From the above illustrations, it is clear that the beers from only one beer producing town was differentiated both in look, bitterness, flavour and aroma, body and alcohol percentages before beer flavourings further differentiated them from each other.

One last important note to highlight is that the export beers would change fundamentally over the course of transportation time, due to wild fermentation. As previously discussed, the fermentation, which went on in the barrel after it left the brewhouse, would help keep the beer fresh and free from volatile bacteria, but it would also make the taste drier and tarter. Therefore, when the beers were sold, they would taste

differently depending on how long they had been travelling to reach their destinations or stored in the cellar of the buyer. Thus, in a town like Danzig, not only did they have access to beers of different alcohol percentages, differently spiced beers, local beers, own export beers, and imported beers, but they would also experience the imported beers as different depending on the storage time.

Product Differentiation in Medieval Beer Production

The previous chapters have shed light on the development of beer production on a particularly detailed level. Yet from the observations and discussions above, it is difficult to organise the findings in a systematic manner, which will bring insights to the economic and welfare development of Northern Europe without some guidance. For this purpose, we use product differentiation theory to systemise the findings of different products and gather information on the diversity of the industry, the level of effective demand amongst consumers, quality improvement and the possible long-term effects on the economy and welfare of society.

Vertical- and Horizontal Product Differentiation

From statutes on price and the statements of chroniclers, it can be established that from the beginning of the 14th century, beer from Hamburg was considered a higher quality product than other export beers. Predating Hamburg's success, it can also be learned from two different chronicles that Bremen beer was considered superior before Hamburger beer and so it can be asserted that there existed a level of higher quality beers above 'normal' export beers which were collectively acknowledged as such in the High Middle Ages. At a level beneath 'normal' export beers, we find the local beers, ship's beer, red beer, and table beers according to the price setting and household account, discussed earlier. Now, if we consider a situation where all the beers were sold at the exact same price and all consumers had equal access to all the beers sold in Danzig, all consumers would choose the Hamburg beers first, as they were considered the highest quality, and the lower quality local beers last. This is also what economists call a situation of *vertical product differentiation*, where there exists a clear-cut preference pattern shared by all consumers.[21]

Furthermore, the Carolingian distinction of beer types based on social status is another example of vertical product differentiation, originating in the Early Medieval Period and thus predating Bremen beers. Here, it can be assumed that the beers for the nobles and guests would be considered the best quality beers and the beer for the poor, would be considered the lowest quality beers, given the expected differences in ingredients, which was discussed earlier.

Differences in alcohol content exemplified by Dünnbieren, export beers, and Dubblebieren constitute another vertical product differentiation, which can be difficult to date the precise origin of, as it may well have been in operation on a local, unrecorded level throughout the Middle Ages. Yet, it was recorded in operation in the same period as Hamburger beers were considered superior and, therefore, constituted a second branch of vertical product differentiation in the High Middle Ages.

Vertical product differentiation will usually have a positive effect on quality improvements, not least due to competition, and a reductive effect on the number of similar, competing producers, which tend to affect the industrial development as a whole (see below).[22]

However, if we return to the 14th and 15th century and look aside from the Hamburger beers and the local beers and consider only the different options of export beers, we are in a different situation if we study the price statute from Danzig. Here, all export beers are fixed at the same price which indicates that they are roughly considered of equal quality or not considered from a qualitative perspective at all. Considering a situation where Wismar beer, Rostock beer, and Lübeck beer are sold in different taverns in Danzig at the same price, how do consumers choose what product to buy? In this context personal preferences and transaction costs, e.g. the distance to the taverns, would be decisive on choice and, hence, highly individual. Thus, in this case there is no shared preference pattern and the product differentiation is considered *horizontal*. If the transaction costs of each consumer are equal, for instance, if all beers were sold at the same place, and price of the beers were equal, then it can be rationalised that all producers would obtain an equal market share, thus generating profit for many producers rather than few and creating ground for co-existence of several producers.[24] This is unlike the effect of vertical product differentiation, which tend to reduce the number of producers.

If we study the lower levels of the quality spectrum and turn our attention to the 'daily' beers and local beers, we find another example of horizontal product differentiation regarding the Danzig pricing statute. Due to the multiple combinations of grain bills and flavouring, the options for differentiation between these similarly priced beers would have been immense. Furthermore, because the product, local beers, can be differentiated in so many ways as they turn practically incomparable, e.g. fruit beers are substantially different to herbal beers, they become subject to symmetric preferences, which will be the topic of the next section.

Thus, from these observations, it can be learned that both vertical- and horizontal product differentiation were in operation during the Middle Ages, possibly throughout the entire period in the form of differentiated alcohol levels. In the 14th and 15th century various kinds of vertical- and horizontal product differentiation were in operation in the Northern German area revealing true diversity in products and subsequently in demand.

Asymmetric and Symmetric Preferences

Turning from the relative 'patterns' of products to the investigation of consumer preferences and demand, it can be learned from the relationship between the products on offer that both symmetric and asymmetric preferences were present in the Northern German medieval society and amongst their foreign consumers.

At a basic level, products on offer reveal the preferences of consumers and their effective demand, because the products would not be produced and sold unless consumers bought them. This is a common-sense argument and, naturally, there are some reservations as taxes, privileges, and regulations interfere with the natural selection of the most desirable products. The Gruit Recht in the Netherlands is a good example of such a situation, where gruit beer may not have been the most desirable beer towards the end of the 13th century, but due to privileges and subsequent regulations, it was still the most consumed beer until regulations were lightened.[25] Regulations on production were not as strict in the Northern German area, but as noted earlier, it was far from free of government interference. Still, the very fact that products were differentiated as we saw in the previous chapter reveals that differences in preferences sustained a market of differentiated goods, which were upheld by effective demand at different income levels of society. Thus, while the products sold in the markets may not have perfectly represented the preferences of consumers, they do reveal consumers' preferences within the limits of government's regulations.

Beginning with Dünnbiere, export beers, and Dubblebiere their main defining feature is their differences in alcohol content. There can naturally be other smaller differences, but generally the consumer would evaluate these beers on a few characteristics and 'strength' would be definitive. Say that a consumer prefers Dubblebier, but this product is either not available or too expensive, they would choose a substitute, which would be a less-than-ideal choice. They would then prefer to choose a product most like the ideal. In this case, where the beer is evaluated mostly by alcohol content, they would choose the product which closest resembles this specific characteristic, which would be an export beer.

This is also called a situation of asymmetric preferences, where a multitude of similar products are presented and a consumer's personal preference is a product which holds a certain combination of characteristic, *i*, while other products are similar to different degrees to *i*. In the situation where *i* is not available, the products which resemble *i* the most, will be preferred. If the price of *i* is significantly higher than other products, which have similar characteristics, the consumer may choose a less-than-ideal choice, due to price. The central issue here is that products are potential substitutes for each other and price (and conspicuous consumption) is a major factor.[26] This situation is common when products can be evaluated from a few characteristics, e.g. alcohol percentage and hopped or not hopped. In this situation, firms only face competition from local competition, which produce goods that are its near substitutes in characteristics.

The same preference pattern can be broadly observed in the situation of the vertically differentiated beers in the Carolingian monastery, although the system is different as the beers are produced for specific socially levelled consumers and social rules restrict economic behaviour. In other words, social customs may not enable a pilgrim to buy a beer intended for nobles due to status rather than economic power, but this is another discussion. Looking merely at how the products are differentiated, they would be modelled as an instance of asymmetric preferences.

On the other hand, in a situation of symmetric preferences, all products are similar, but they are also all perceived as equally different to each other. This is usually a situation where many characteristics are taken into account and there exists no natural ordering of the products. Here any brand of product is objectively an equally good substitute for another and oftentimes, the consumer's choice depends on income, relative prices, and personal taste.[27]

The export beers and the lower quality beers, which were set at an equal price in Danzig, are adapted to this consumer preference pattern. Ultimately, the choice between a Wismar beer, a Rostock beer, or any other beer would be down to personal preference and transaction costs and it is not possible to diagram the different beers in proximity to each other in a fashion, which consumers would agree on, as there would be too many characteristics which differentiate them from each other. The same would be true for the highly differentiated local beers. Thus, in this situation, where the producers face competition from all other producers they would generally all gain an equal market share, if they positioned themselves to keep transaction cost at the same level, which means that the entry of new producers would generate lower profits for the individual producers, but generally not make anyone worse off than others.

In the area between the lower quality beers and export beers, the good quality local beers provide a quite interesting middle ground, where consumers could either spend a little more or a little less depending on their income level and fluctuations in their household economy. Thus, between the two areas of symmetric preferences, a zone existed where consumers of low-quality beers could pick a better-quality beer when they had the funds and, conversely, consumers of export beers could save money on buying the local high-quality beers. Naturally, the consumers of export beers could also choose to buy the most expensive beer, Hamburg beer, in times of flourish. While the symmetric preferences have been observed at different price levels, the individual consumer had the option of jumping slightly between layers and choose different products both from a completely personal preference and from a quality or taste improvement perspective, e.g. from asymmetric preferences.

Thus, something very interesting about the preference patterns is that they reveal that within the beer industry, lower-income consumers, as well as higher income consumers, were faced with a choice in both variety and to an extend in quality beyond the basis of what was affordable and, certainly, beyond what is oftentimes associated with living at a subsistence level. It seems there was, in fact, true diversity in preferences on different income levels and that the beer industry adapted to the needs and wants of consumers beyond a simple division into basic products and luxury product.

Product Quality, Taste, and Market Structure

From the above modelling of preference patterns and product diversity, it has been argued that that the product differentiation in beer production created variety and choice beyond basic or luxury. Variety and choices which optimise our life experiences; the most fundamental being daily food and drinks, may not be classical economic growth promoting factors, but they are quite obviously important factors when discussing welfare. At a basic level, most would agree that variety is good and promotes the well-being and 'good living' of all, and therefore product variety is a sign of welfare. Another important sign of welfare is quality as it can be generally agreed upon that we all want the best quality we can afford.

Generally, from a producer's perspective, product quality can be improved in three different ways; i) by making the product's quality a perfect substitute for quantity, ii) by creating a demand (e.g. through reputation and/or superior technology), or iii) by increasing the durability of the product.[28] In the first possibility, making a product's quality a perfect substitute for quantity, the consumer is not truly looking for a quality improvement, but rather optimising their way of purchasing goods. In a modern context, this kind of quality improvement could be exemplified by a highly intensive washing powder, which would require less powder in each wash, rather than many lower quality washing powder boxes, where more powder is needed.

Regarding medieval beers, this kind of quality improvement is not very inviting, due to the hydrating effect of beer. Even though it can be argued that a highly alcoholic beer could be a substitute for two beers of lesser alcohol, it would not be a perfect substitute as the highly alcoholic beer would be less hydrating and taste would be significantly different. Hence, aiming for this kind of product improvement is not attractive in beer production.

The second possibility, creating a demand, is, however, of great interest on the topic of medieval beers. As previously discussed, the urban Northern German brewers had greater access to better equipment due to their proximity and specialisation as brewers. They also had superior brewing processes due both to the equipment used and the regulations on fermentation periods, water, and fire. Thus, brewers in Hamburg, Wismar, Bremen etc. were able to produce beers that had fewer off-flavours due to superior brewing technology and the beers would have tasted cleaner than local beers in areas where the same advantages were not enjoyed. Therefore, from a biological-chemical perspective, the Northern German beers would have 'tasted' better due to the absence of unwanted volatiles. But what about from a cultural perspective?

Taste is a difficult field to analyse, because it exists in an area between the objectively experienced, e.g. fragrant and flavoursome molecules which are intercepted by our senses, and the subjectively processed, when we decide whether we like the flavour or not. It therefore ought to be highly individual 'what we like', yet certain flavours do seem to be more popular than others. Black coffee, for instance, is by some described as an acquired taste, while milk chocolate is liked by most. While some may argue that these differences are due to evolutionary traits, e.g. a preference towards high calorie diets, research in taste patterns reveal that taste is in fact subject to fashion and, hence, culture.

Studies in cookbooks' spices and flavourings reveal that the Medieval palette was more in favour of savoury dishes, than the modern sweeter palette. Thus, the recipes for pies and cakes, for instance, oftentimes include spices like ginger and cloves in the Middle Ages, whereas from the late 16th century more recipes appear which call for rose water and honey.[29] With that in mind, the hopped beers which offered

balance to the sweet malts can be viewed as a qualitative upgrade from bog myrtle beer or gruit beer in the Low Countries and Eastern Germany from a taste perspective. In these areas, where hopped beers were banned from production until the late 14th century, the Northern German beers would have been a welcome taste improvement as they were more savoury. The same would be true in areas where hops and other bittering herbs were not as easily available. Therefore, it can be expected that the Northern German beers were qualitatively better tasting from a chemical perspective, with fewer 'flaws', and better adapted to the specific taste palette of the period, hence, better adapted to the demand of the time.

The third option, increasing durability, is also of interest regarding medieval beer production. The central issue of durability is that producers produce a stock of goods, while consumers are interested in a flow of goods.[30] In the case of beer, holding a large stock of beers and hoping to sell them all at once won't be a good strategy if the beer sours within a couple of weeks, which was common for some of the locally produced beers especially in the Early Middle Ages. Yet, only from producing greater stocks of a product, can producers reap the benefits of large-scale production and, so, increasing the durability of a product highly benefits the producers and secures the flow of goods for consumers.

Here, the production methods in the urban breweries from the 13th century and onwards are most interesting. We have already noted that the Northern German beers produced in towns had longer durability, not only due to anti-microbial additives, but also due to the fermentation procedure and boiling efficiency. It has been argued that the fermentation, which kept on during shipping and helped improve the durability of the beer, would either stale during peak of winter or overflow and mutate during the peak of summer. In these periods, local production as well as regional trade was difficult.

Looking at beer export from Hamburg in the 1480s, trade is concentrated in the milder months of March, April, October, and November, where outside temperature is low and suitable for fermentation and/or conditioning. During summer, little beer is traded especially in the hottest months, June and July. Yearly differences occur, notably, with regards to the end of the trading season which suggests that if the winter seemed to come early, producers would attempt to sell their beer earlier.

As all producers faced great uncertainty in regard to successful production in the warmest and coldest months, they had little incentive to produce beer in these periods. Therefore, the export beers, which had finished fermentation during shipping and could keep for a couple of months, until production was again safe, would be in particular high demand. Thus, durability was key in the beer industry, where production periodically became troubling, yet where products were still in daily demand. Hence, not only did the qualitative improvement of prolonging beers' durability help the urban Northern German brewers reap advantages of large-scale production and specialisation, but also helped them take advantage of the specific periodic 'beer market' of the Middle Ages.

The Gains from Trade under Product Differentiation

Looking at brewing development during the Middle Ages, it is now clear that though the beers, which were produced and occasionally sold on a local level in the beginning of the period, were differentiated through different spices and possibly alcohol percentages, the product differentiation from the 13th century was of a far more sophisticated character. The introduction of urban export beers led to product differentiation beyond 'simple' differentiation where products are too dissimilar to be truly compared. Both horizontal and vertical product differentiation became operable during the period and at different income levels which opened up to variety in beer which was obtainable to a larger part of the medieval consumers.

Thus, consumers gained the 'welfare' of product diversity as more and more towns began producing and selling beers locally and abroad. The amount of product differentiation at different income levels also reveal a demand vertically through society for beer beyond basic subsistence. Consumers had preferences both from a personal- and a qualitatively perspective as horizontal and vertical product differentiation were in operation. In essence, the 'industry' of brewing adapted to the transformation of society, where more consumers became able to consume beyond the necessities of life, by providing more choice and better quality.

Hypothetically, horizontal product differentiation would result in a larger number of producers and product varieties and a proportionally smaller amount of each due to equal market shares amongst competitors.[31] Thus, the gain from having a high level of horizontal differentiation would be the sustainment of a high number of producers, which meant that a higher amount of the population could be employed. Naturally, this tendency would also be heavily influenced by the authorities of the times, which regulated both the production, trade, and privileges, but from a purely economic perspective, the horizontal product differentiation helped keep the number of producers high.

On the other hand, vertical differentiation tends to lead to the elimination of similar lower quality products as produc-

ers are pushed out of the market by the superior producers.[32] Hypothetically, consumers would choose to buy the better product if the products were affordable and, therefore, the lesser products would be out-competed. The surviving producers will enjoy greater marginal returns from quality improvements, when fewer competitors were present, and subsequently increase quality in the industry as a whole.[33] Furthermore, products which were successfully differentiated as 'better' in the eyes of consumers would have the opportunity to take higher prices and gain a greater market share, as seen in the case of Hamburg beer, which would both lead to more opportunities for innovation and generate incentive to better the quality of products throughout the industry. Thus, the economic forces of product differentiation would push the industry towards higher quality and a high number of good producers. Naturally, these forces would also be influenced by the regulations of authorities, but the exact relationship between these two forces is for another, more trade-concerned investigation to clarify.

Ultimately, the product differentiation adapted to the consumers demand for good products and diversity on different income levels, which gained both the welfare of consumers and generated positive forces towards innovation, quality improvement, further diversity, and a high number of producers over long-term development.

Conclusion

This investigation of production methods showed that significant processes were optimised throughout the period. Not much can be established with certainty about the rural production methods due a lack of evidence, but certain important innovations originated in this period where brewers began producing beers in towns. Most notably, boiling techniques improved, so eliminating difficulties which resulted in lack of durability and an inconsistency of product. With the increase in brewing equipment, brewing was divided into separate mashing and boiling processes which also improved quality. Furthermore, securing of adequate water and efficient firewood also improved brewing conditions. Significantly, statutes on fermentation periods reveals that brewers gave the export beer the necessary 72 hours rest before allowing them to be shipped, where they would finish fermentation, generating fewer off-flavours and contributing to durability and defence against micro-organisms.

The study of ingredients revealed that malt preferences seemed to change during the late 13th century and early 14th century towards wheat- and barley-based beers. Oats in beer was slowly abandoned and rye seems to have been used mostly for local or lower quality beers, which meant that the export beers would have had a significantly different malt flavour than many local beers. Furthermore, the tradition of instigating fermentation by adding froth from good brews would have resulted in slower improvement in fermentation in the urban breweries, where brewing was constant. The yeast, which was a mix of microorganisms, unlike the domesticated yeast of modern brewing, would contain high levels of *Brettanomyces* due to the high ratio of contact with wood. Ultimately, this meant that the beers which were exported and kept for months would slowly go drier and tarter and create a flavour which would have been considerably different to locally produced beers.

One of the more significant findings to emerge from this study is that production methods had more impact on the durability and reputation of Northern German beers than previously acknowledged. Generally, scholars have tended to conclude that the adoption of hops were the game changer, which made Northern German beers the most sought-after for a period of time. This is even though a comparative study of hops' and bog myrtle's anti-microbial properties have yet not been conducted and so it ought not to be assumed that hops were more fit as a preservative. We have argued that while (some) German export beers were certainly hopped, the tradition of brewing with hops was already established by the time towns like Bremen, Wismar, Hamburg etc. began exporting beers.

By investigating the changes in production methods during the period, it has become clear that while hops were probably added to beers throughout the period, many brewing processes were upgraded, innovated, or improved with the specialisation of brewers in the towns to which it is impossible to point to one factor and attribute it with the success of German beers. In contrast, it was a multitude of factors which made the Northern German beers better, not least the statutes on fermentation periods, energy, and the access to better equipment and knowledge sharing.

This investigation of the source material has revealed that the mentioning of Northern German beers as hopped almost exclusively appear in the areas where beer production was regulated by Gruit Recht or where beer production was subject to other strong traditions. Therefore, it is claimed that the over-emphasis on hops as a 'new invention' came from investigating German beers from a non-German perspective, typically English, French, or from the Low Countries, where other beer types were more prominent and where it was necessary to clearly distinguish German beer production from the regional-traditional. Unfortunately, this focus has established a firm belief that adding hops to beer made the beer superior, which has clouded the investigation for other factors which has subsequently led to the negli-

gence of other innovations within beer production in the period.

The investigation of beer types showed that beers were differentiated both by the specific towns in which they were produced, the amount of alcohol they held, the spices, which were considerably varied, the amount of time that elapsed before they were consumed, the kilning of the malts, and generally qualitatively distinguished. The beers would have tasted much different to a modern industrial pilsner, being spontaneously fermented and brewed from a more varied, partially smoked grain bill. They would not have been as bitter, due to the low alpha-acid content of traditional hops and because they added fresh flowers rather than the highly intense pellets, which are common today.

By investigating the medieval beers through production differentiation theory, the study has revealed that sophisticated levels of product differentiation emerged during the Middle Ages with the urbanisation of society and professionalisation of beer trade in the Northern German towns. On the basis of the study of brewing methods, ingredients, and beer types, the investigation has shown that product differentiation increased during the period, and particularly, we have identified horizontal- and vertical product differentiation from the late 13th century, when various beer types were recorded in different price levels. Symmetric and asymmetric preference patterns were found at different price levels revealing a *general* demand for quality and variety, and producers responded with diversity and product quality improvement which were available at different income levels.

Specifically, in the medieval period, where urbanisation increased and real wages slowly rose for the majority of the population, the beer industry transformed with the economic changes in society and adapted to produce more variety and quality at different price levels beyond merely 'basic' for the population and 'luxury' for the nobles. With long-distance trade, the Northern German brewers also learned to take advantage of the time period, where the beers were at sea, to improve the flavour and durability making German beers competitive in foreign markets, when beer production was periodical difficult due to temperature changes.

In light of this investigation, which has concentrated on beer production, it would be interesting for future research to analyse trade for a fuller comprehension of medieval economic development.

References

1. Unger, R.W. (2004) *Beer in the Middle Ages and the Renaissance*. Philadelphia: University of Pennsylvania Press, pp.185-187; Behre, K.-E. (2016) 'Vom Getreide zum Bier, mit allen seinen Zutaten – seine Geschichte in Mitteleuropa' In: Wiechmann, R. et al.: *Kein Bier Ohne Alster – Hamburg – Brauhaus der Hanse*, Museum für Hamburgische Geschichte, p.34.
2. E.g. *Hansisches Urkundenbuch* (HUB) Vol. II, Accessed through Hansischer Geschichtsverien e. V., n. 15: 8.
3. HUB VI, n. 1234.31: 770.
4. Eg. HUB II, n. 493: 213, HUB III, n. 206: 98, n. 223: 103, n. 245: 108, n. 364: 155, HUB V, n. 130: 76, n. 526: 267, n. 860: 445, HUB X, n. 624: 424, HUB XI, n. 659: 422, HR II, n. 43: 417.
5. Eg. HUB V, n. 1: 1, n. 16: 21.
6. Eg. HUB II, n. 493: 213.
7. HUB XI, n. 652: 419.
8. *Publikationen der Gesellschaft für Rheinische Geschichtskunde XXXIII. Quellen zur Geschichte des Kölner* , ed. Bruno Kuske, P. Hansteins Verlag, 1918, n. 880: 462.
9. Schlüter, M. (1698) *Historische- und Rechts begründerte Tractat von denen Erben in Hamburg*, Conrad Neumann, pp.122-128.
10. Aarsberetninger fra det kongelige Geheimearchiv indeholdende Bidrag til Dansk Historie af Utrykte Kilder, II, ed. C. F. Wegener, I Commision hos C. A. Reitzel, Bianco Lunos Bogtrykkeri ved V. S. Muhle, 1852-83. (Geh. Ark. Årsb.), p.50.
11. HUB VIII, n. 368: 241.
12. Eg. Unger, R.W. (2004) op. cit., p.189.
13. Alsleben, A. (2007) 'Food Consumption in the Hanseatic Towns of Germany', In: Karg, Sabine et. al.: *Medieval Food Traditions in Northern Europe*, Publications from the National Museum Studies in Archaeology & History, Vol. 12, National Museum of Denmark, p.22.
14. Archiv der Hansestadt Lübeck, Vereinsarchive, St. Antonius-Bruderschaft, *Rechnungsbuch der Schaffer*, n. 9, 1494, fol. 67v.
15. *Kölner Handels*, op. cit., n. 880: 462.
16. Different coloured beer types are discussed at length in Schlüter, M. (1698) op. cit., pp.122-128.
17. ibid., n. 8, p.124.
18. E.g. Von Blanckenburg, C. (2001) *Die Hanse und ihr Bier – Brauwesen und Bierhandel im hansischen Verkehrgebiet*, Köln: Böhlau, p.177.
19. Examples of estimates of malt to beer ratios and malt to hop ratios are sometimes found in the literature, e.g. Huntemann 22-23, but I remain sceptical towards these estimates as they are often based in calculations of import/export ratios, which I would argue entails a high level of uncertainty and, furthermore, does not take potential local beer sales and sales in taverns into consideration.
20. As previously explained, starch contents cannot be determined from archaeobotanical evidence and for this reason it cannot be verified that medieval wheat contained more fermentable sugars

than barley, if we assume that the chemical structure of the grains have changed fundamentally over time. For this experiment, I can therefore only hypothesise that the wheat beers would have had a slightly higher alcohol percentage.

21. Beath, J. & Katsoulacos, Y. (1991) *The Economic Theory of Product Differentiation.* Cambridge: Cambridge University Press, p.109.
22. ibid. p.133.
23. ibid.
24. ibid.
25. Unger, R.W. (2001) *History of Brewing in Holland*, *900-1900: Economy, Technology, and the State*. Leiden: Brill pp.12-27.
26. Beath, J. & Katsoulacos, Y. (1991) op. cit., pp.11-12.
27. ibid., p.42.
28. ibid. p.74.
29. Baatsen, I. (2016): *A Bittersweet Symphony – The Social Recipe of Dining Culture in Late Medieval and Early Modern Bruges*, Dissertation, University of Antwerp, pp.79-80.
30. Beath, J. & Katsoulacos, Y. (1991) op. cit., p.88.
31. ibid., p.176.
32. ibid., p.177.
33. ibid., p.180.