

# How One of The World's Oldest Food Safety Standards Approaches Expiration – The Case of German Beer<sup>1</sup>

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## Abstract

*The paper at hand contemplates the effect of a centuries-old national food safety standard on innovation in a globalizing market. To that end, the case of the German Beer Industry is analysed to explicate the relationship between a longstanding beer purity decree and brewing innovation. Over 500 years of existence the so-called “Reinheitsgebot”, now laid down in federal German law, has served to restrict variety and safeguard the quality of locally-produced beers. In turn, the standard prominently shaped the national image as well as consumer preferences across all regions in Germany. This research however demonstrates how this has overwhelmingly brought about adverse consequences for the international relevance of German beer in an increasingly globalised economy, which favours diversity in tastes. Due to changing consumption trends and the constricted innovative ability of German brewers, the findings inform government’s responsibility in standardisation for traditional consumer goods industries at a time of urgent need for action.*

## Introduction

Beer is widely celebrated for its association with culinary distinctiveness, traditional values and quality (Meussdoerffer 2009). As the most popular drink in the world, behind tea and water, the history of beer brewing dates back several thousands of years, from as early as the Neolithic period to the ancient civilisations of Egypt and Mesopotamia (Nelson 2005). It is therefore no wonder that one of the first food safety and consumer protection standards in the world relates to its production. In 2016, the famed Bavarian “beer purity law”, locally known as “Reinheitsgebot”, celebrated its 500<sup>th</sup> anniversary, stipulating that beer shall be made from strictly four basic ingredients, namely hops, malt, barley and water. The product requirements laid down in this law can be seen as a governmental standard (Wiegmann et al, 2017).

The government’s commitment to this standard is largely to thank for Germany’s world-famous reputation as one of the most prominent beer producing countries. Even beyond its national borders, it impacted the way the foreign markets for beer evolved over time, since its specifications served as a reference to promote high-quality brewing (Schmitt 1995). Nevertheless, with most German breweries still tied to this tradition, some are beginning to question its value in an increasingly globalised marketplace. Today, it seems that the consumer preferences of younger generations both internationally and domestically are shifting on the count of substantial demographic and socio-economic changes. Thus, by holding on to purity

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standards tightly interwoven with cultural pride, the German beer industry is characterised by greater rigidity than its European and transatlantic peers.

In the advent of the craft beer revolution, where more weight is given to innovation in tastes and variety of ingredients, German brewers are finding themselves amidst an identity crisis, unable (and unwilling) to modernise at the same pace. What is more, experts suggest that the world no longer looks to Germany for the best beers. Naturally, several questions pose themselves: It is it finally time to abandon the longstanding standard to avoid losing international relevance? Is the “Reinheitsgebot” locking Germany into inferiority?

This paper consults history, the opinions of brewing experts, standardisation literature and market trends to explain and assess the severity of the situation.

## **The History of Brewing Guilds, Professionalism and the Bavarian Purity Decree**

Even though the purity decree is one of the first and oldest consumer protection laws in the world, professionalism in regards to beer brewing, through the development of markets and branding, dates back even longer. Records of specialised craftsmen in this profession can be found throughout the eleventh and twelfth century in Europe (Hornsey 2003). Subordinate to the political elite, they provided the population with an important food staple. Subsequently, brewers formed guilds in charge of providing training, delegating the admission of breweries and ensuring product quality (Meussdoerffer 2009). These guilds represent a first collective action for standardisation and quality assurance in the industry. Over time brewing guilds became associated with considerable political influence in cities due to their ability to impose binding regulations and fines. First cases of brewers’ guilds can be traced back to 1200 in London, 1230 in Regensburg and 1280 in Munich, with evidence of brewing associations seen at a later stage (ibid.).

Due to the widespread popularity of beer, it also played a vital role for the health of rural and urban citizens. However, in medieval times it was common to add “fillers” to the brewing process, which affected its safety for consumers. Examples of these fillers were cheaper additives such as grasses and roots, which could have other intoxicating properties (Glenn 2016). Besides expenses there was also a general lack of knowledge about the harmful side-effects of certain additives which made appropriate brewing more difficult for commoners. Consequently, it was evident that regulations needed to be put in place to specify the ingredients of beer. The first examples of such efforts have been documented for instance in Bavaria and Paris in the 13th century, though they had only seen enforcement in cities rather than larger regions (Meussdoerffer 2009). The goals of these decrees were among other things, consumer protection through defining quality requirements as well as the rules for taxation of the beer trade. However, restrictions on the use of ingredients was not just tied to quality assurance, but also imperative to protect the supply of grains, like rye and wheat for bakers in bread (Alworth 2017). Due to regular tensions between brewers and bakers over this supply in times of food scarcity, regulation was formalised to the end of avoiding price inflations and ensuring availability (Mason 2010)

The origins of the “Reinheitsgebot” are evident as early as 1447, when the city council of Munich responsible for the “Bier-Aufsicht” (“beer oversight”), first stated that beer was to be brewed exclusively from hops, barley, malt and water. In 1487 the Duke of Munich then made

these propositions legally binding, for the first time setting the rules about pricing, inspection, third party approval and defining the term “beer” (Wikipedia 2018).

After the war for the succession of power between Munich and Landshut in 1503, the Bavarian dukedoms were reunited and requirements had to be harmonised across the state. To this end, the “Landesordnung” (“land order”), containing requirements on beer purity was drawn up and signed into effect by Wilhelm IV and Ludwig X of Ingolstadt in 1516. This standard prescribed that beer had to be made through “bottom fermentation”, prohibiting brewing in the summertime and giving way to the tradition of “lager” beer, unique to the Bavarian region in this period. Before the 15<sup>th</sup> and 16<sup>th</sup> century, the northern guilds in Germany were known for having stricter rules and said to have produced the superior beers, often relying on a range of different ingredients to make “ales” (McGavin 2018). However, after implementing the “Landesordnung”, Bavaria soon became synonymous with the best brewing traditions.

The influence of the Bavarian aristocracy can be regarded as a form of governmental invention through mandatory standardisation, that shaped drinking habits via the implementation so-called “hierarchy” or “regulatory” standards (Adolphi 1997). Not brewing in accordance would have led to fines or market expulsion. In standardisation, government’s role is to use its hierarchal power to mandate the diffusion of superior standards, when the free market provides public goods that inadequately serve the interests of end-users and society at large (Wiegmann et al. 2017). In turn, the requirements established a kind of “dominant design” that differentiated the local product from virtually any region in the world. The stern competition that ensued between Germany’s beer styles, is epitomised by the fact that the more westerly situated Cologne, even went as far as banning lager-beer brewing in 1606 (Alworth 2016). Though with strict regulation and a high level of attention for the coherence in brewing techniques, it became clear what a Bavarian “beer” should be, which swiftly led to improvements in its quality. Furthermore, because of the relatively vague terms, the decree managed to spur healthy competition between the different brewing constituencies, namely the nobility, the bourgeoisie and the church (Meussdoerffer 2009).

Over the centuries, the beer purity decree of Bavaria underwent several amendments to accommodate new ingredients and brewing techniques. It was the unification of the German Empire in 1871, which first brought the northern “ales” and the southern “lager” beer face-to-face. In 1906, a modified version of the standard for the first time including yeast, was therefore written with separate specifications for the two prominent types (McGavin 2018). After World War I in 1919, Bavaria only agreed to join the newly founded Weimar Republic, under the condition that the “Reinheitsgebot” would be adopted nationwide, signifying the importance to its cultural identity. Bavaria therefore achieved the agreement on standards referred to as “harmonization” in the literature, replacing distinct standards between the regions with one common standard (Chen & Mattoo 2008). This led to the drafting of “deutsche Biersteuergesetz” in 1923, specifying rather strict rules for bottom-fermented beers and more lenient ones for the top-fermented “ales”. Crucially, it also limited the import of beers to those brewed compliant with the “Reinheitsgebot” and strictly prohibited brews containing unwanted additives. Foreign suppliers would thus have to specify whether this condition was met, if they planned on selling their products with the label “beer” in Germany.

With growing industrialisation and globalisation in the second half of the 20th Century, the external pressure on this stipulation steadily grew. In 1987 the European Court of Justice eventually dismissed the purity law as protectionist on that grounds that it was violating the free trade agreement of the Treaty of Rome (Lee 1988). This paved the way for all imported beers produced in EU member states to be allowed. Only German brewers were still bound by

the long-held standard. The “provisional beer law” (“Vorläufiges Deutsches Biergesetz”) as it is known today was then drafted in 1993, allowing for more variety in malted grains, grounded hops, hops extracts and stabilizing agents to be used for production (Wikipedia 2018). Finally, though it was partially repealed in 2005, the stringent regulations especially for domestically brewed “bottom-fermented” beers for the German market are still intact. New ingredients may be introduced with an exceptional permission or for exported products.

Despite these changes and expansions throughout history, the “Reinheitsgebot” still plays a very prominent role for German brewers, as a sign of quality and pride in German tradition. The clear majority therefore still brew adheres to it, selling their bottles with the purity etiquette (“nach dem deutschen Reinheitsgebot gebraut”). This is done for marketing purposes, since for many of the local consumers “it is still the de facto law of the land” (Debenedetti 2011). But, also internationally the label is a powerful advertising tool, as it is closely entangled with a romanticised brand image of Germany as a nation (Anholt 2007).

The Reinheitsgebot started as a governmental decree and is nowadays laid down in legislation. Strictly speaking it is therefore not a standard anymore. However, because of its economic purpose it can be considered as a (governmental) standard (de Vries, 1997; Wiegmann et al., 2017). The extent to which governmental standardisation helps or hinders innovation is a topic of fierce debate. While intervention can be aimed at boosting social welfare and promoting national industries, it can also reduce the incentive to innovate when there is less competition between standardised products (Gao et al. 2014). Likewise, the sentiments on how this form of standardisation is affecting the German beer market, international competitiveness and variety are greatly dispersed. The following two sections will therefore elucidate how the “Reinheitsgebot” both supports and restricts innovators.

## “Reinheitsgebot” as a Catalyst for Innovation

The beer purity decree in its original form is a curious case, because in terms of the standardisation literature it can be regarded as a combination of two standards. For one, it is a ‘variety reduction’ standard, because it specifies the level of variety that is tolerated in the end-product’s ingredients. While this clearly limits the number of alternatives in the market, it can also enable economies of scale for producers (Ho & O’Sullivan 2015). This may explain why, following the passing of the standard in the 16<sup>th</sup> century, Bavarian brewers could improve their reputation so drastically compared to regions where strict variety regulations were absent. Secondly, the decree is an example of ‘quality/reliability’ standard, which specifies acceptable levels of performance (in purity). This reduces transaction costs by raising buyer confidence and trust between trading partners (Swann 2010).

One of the economic functions of standards for innovation is influencing the ‘direction of search’ in a technological field (Bergek 2008). This implies that standards provide industry players with transparency and technical guidance for improvements, as they help identify learning activities to concentrate on new areas for resource allocation, hence facilitating the discovery of creative methods. When it comes to “pure” beer brewing, traditionalists like Marc-Oliver Huhnholz of the “German Brewing Foundation” exclaim this to be the case, because the potential variety compliant with this ideal is still not fully realised and breweries never halted their development of new styles (Connolly 2016). Moreover, it is argued that it takes the true mastery of the craft to derive different types of beers from only four main ingredients. Martin

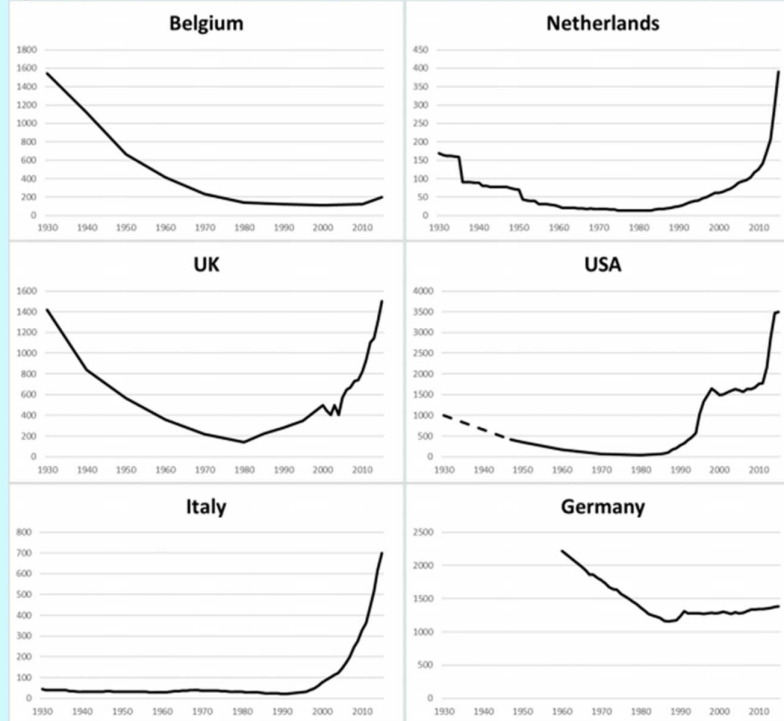
Zuber, the brew master of “Paulaner”, one of Bavaria’s most iconic brands, adds that there is still a great deal of experimentation to be done that will produce highly diverse outcomes, for instance with different fermentation times, hops, malts and yeasts (Glenn 2016). Accordingly, advocates of the purity decree see it both as a benchmark that requires unique skills to attain as well as an inspiration for novel ways of doing things that may yield innovation. This is likely why many Germans believe that domestic beers are of higher quality, as brewers elsewhere are not bound by the same lengthy and complicated procedures. Conclusively, it can be argued that having a technical standard in the German brewing industry has been a common starting point, accepted by the different stakeholder groups, to facilitate improvements (Ho & O’Sullivan 2017).

## **Standardisation at Odds with Beer Innovation**

Before delving into how the standardisation of German beer has affected the nation’s ability to innovate along with the rest of the world, the term must be defined. Innovation in this evolving context closely relates to the ongoing trend of “craft brewing”, which for the purpose of this paper can be broadly conceptualised as; *“quality beer produced in smaller quantities, typically made from a large and versatile variety of ingredients”*.

In fact, craft beer is seen by many to be a direct reaction to increased standardisation, convergence and consolidation among the major breweries in the 20<sup>th</sup> century (Garavaglia & Swinnen 2018). Consolidation and more standardised tastes were consequence to advancements in automated production allowing for greater capacities and advertising budgets as well as to a string of large-scale multinational mergers (Tremblay & Tremblay 2005).

Figure 1: Number of Breweries, 1930–2015



Source: Swinnen and Emmers (2017).

Figure 1 - Number of Breweries per country, 1930-2015 (Swinnen & Emmers 2017)

Figure 1 illustrates how the number of breweries in some of the most prominent beer producing countries first strongly declined and then recovered at the turn of the millennium. Yet, from the graph it can also be observed that this recovery was far less pronounced in Germany.

The ambiguous effect of ‘variety reduction’ standards on innovation in the literature is reflective of these developments at the German industry level. Despite the achievements in economies of scale, these tend to be associated with more capital-intensive methods leading to fewer suppliers with greater relative market power, while the innovative alternatives of smaller firms are excluded (Tassey 2000). Exemplary of this, the rigidity of the purity standard is historically argued to have brought about the extinction of once widely celebrated brewing traditions, such as spiced and cherry beer (Wikipedia 2018). Alternative brewers could not compete in the long haul, unable to market their brews effectively without the permit to sell them as “beer”. Furthermore, over time the decree perpetuated a negative public perception among Germans about brewing that was not compliant with the standard. Though most consumers are probably ill-informed about its specifications, experimentation was demonised and innovation stifled.

Consequently, there are now only about 20 common German brewing styles, while the U.S. craft brewers work on over 100 (Debenedetti 2011). Many are conscious that the German brewing culture has stagnated, with little to split the prominent beer brands on offer in terms of taste (Nicholson 2016). In contrast, brewers abroad like in the neighbouring countries Belgium and Denmark are free to experiment with spices and fruits, leading to richer variety that has allowed them to evolve up to speed with the craft beer revolution (Willcox 2016). It becomes apparent that standardisation not just hinders the German brewers to partake in craft brewing but also keeps innovative companies from coming into the country to reshape the landscape because they must meet the *Reinheitsgebot* if they produce in Germany, while exporting deviating beers from other countries to Germany is allowed. Aggravatingly, the standard’s primary appeal of ensuring superior purity recently came under scrutiny, when the Munich Environmental Institute (Umweltinstitut München) found traces of the weed killer glyphosate in all 14 of best-selling German beers inspected, suggesting that the health and safety of other breweries are not automatically inferior (Copley 2016).

Jim Koch, the founder of the Boston Beer Company, producing the popular American “Samuel Adams” craft brand, effectively summarises popular opinions about the “*Reinheitsgebot*” these days: “In one sense, it drives innovation and creativity because you must do things without the shortcuts. On the other hand, if you don’t allow yourself as a brewer to colour outside the lines, you are missing out on one of the unique things of the brewer’s art.” (Kell 2016).

## Changing Consumer Preferences and “*Brauereisterben*”

To understand why the hindered innovative ability may be so such a devastating blow, it is useful to consider how consumer preferences have changed in recent decades and how this has compromised domestic brewing. Beer experts are alarmed by the drinking culture of the younger generations, since in 2015 the German Ministry of Food and Agriculture recorded merely two-thirds of the per capita beer consumption typical in the peak times of the mid-1970s (Anderson 2017). In post-world war II Germany, with rising incomes said figure amounted to roughly 145 litres annually compared to the current levels of only around 100 litres (Colen & Swinnen 2016).

The perception of alcohol in general has shifted consumers to be more aware of its drawbacks on health, therein demanding more alcohol-free beverages. Moreover, through increased

mobility German workers on average live further from their workplace, meaning less people can grab the occasional drink with colleagues after work. Garavaglia & Swinnen (2018) additionally find that consumers in Europe generally desire greater variety in their food and that due to higher average incomes can afford more imported goods as they did in the past. This also favours the craft beer demand in Germany, as these tend to be more expensive and diverse.

Globalisation coupled with higher incomes, has likewise driven greater homogeneity in alcohol consumption across countries, where the “traditional beer-drinking” nations now show more interest in alternatives (e.g. wine, liquors, spirits) and vice versa (Swinnen 2017). The German Federal Statistical Office has representatively recorded that the level of consumption of imported beer has increased from 3% to 8% between 1995 and 2012, despite the clear decline in overall demand (Birnbäum 2013). The repercussions for German brewers facing crippling demand have been dramatic, producing 20% less since the passing of the “provisional beer law” in 1993 (Filtz 2014). The term “Brauereisterben” (“Brewery-dying”) is therefore widely used, descriptive of how the hard times for producers are disseminating closures and consolidations. As for instance Berlin’s number of breweries shrunk from 700 to roughly a dozen since the 19<sup>th</sup> century, many talented young German brew masters now look for employment in other places (Debenedetti 2011).

The urgency of the predicament is likewise recognised by insiders, who are painfully aware that the youth is decidedly more interested in innovations like craft beer (Anderson 2017). Unable to satisfy this growing call for change due to the inflexibility of the purity decree, German brewers now work more on “acceptable” innovations like beer-mix drinks and alcohol-free brews. With these, the beer is made with the standard in mind and supplementary tastes are added after brewing.

In contrast, Europe has experienced a doubling in the number of breweries from 2008 to 2016 now totalling as many as 5000, with the new openings predominantly falling into the craft category (Willcox 2016). The craft beer revolution is however most observable in the U.S. market, as a nation few previously associated with quality beer, took a hard turn from just eight operating craft breweries in the 1980s, to 2800 in 2013 to a staggering 5000 in 2016 (Rowland 2017). This sensational recovery, has opened the door to new-found success with American beers taking home numerous international awards and honours (Nicholson 2016).

## Discussion and Conclusion

The value of standards depends on their functionality and quality. Innovation and/or, market strategy may be reasons for change in the form of modification or withdrawal of the standard, or such a change is just a natural phase in the standard’s life cycle (Egyedi, 2008). The German beer standard survived several centuries without major modifications though some adaptations were made to accommodate new ingredients and brewing techniques. The initial reason for the standard, consumer protection, developed to a profile of quality. This gave German breweries a strong position in the global market. However, times have changed. Consumers appreciate more variety for which ingredients may be needed that are forbidden due to the Reinheitsgebot. The fact that traces of pesticides were found shows that the conformity assessment needs adaptation as well – checking basic ingredients differs from checking pollution with pesticides. This is also not what consumers appreciate – eco-certified beers gain attraction.

Indeed, faced with a shrinking domestic market and the head-starts of competing brewing cultures in craft beers, Germany finds itself at a crossroads where the government should decide



how to proceed with its beer requirements. This will prove to be a complex trade-off for several reasons.

Firstly, the nation's brand image is at least partially contingent on the traditional-style beers that currently comply with the requirements. Therefore, in the long run dismissing the law could greatly change the landscape for breweries in Germany, ultimately forcing some traditional styles to go out of business. Arguably, this could lead to an undesirable loss of long-held culture and even change Germany's national image for tourists.

Secondly, the standard helps promote the sale of these traditional labels in emerging markets of countries like China and India, where German "purity" and quality are greatly appreciated (Castello 2018). As Walter König of Bavarian Beer Association points out: "We can compensate for what's not being drunk inland with export increases and alcohol-free beer" (Anderson 2017). For example, since 2003 China has surpassed the U.S. as the largest beer consuming nation in the world with 45.5 billion litres annually (Swinnen & Briski 2017). Depending on the consumer sensitivity to the purity "etiquette", it may therefore be wise to hold on to it, given the huge potential revenues in the future.

Thirdly, though Germans appear to be unhappy about the lack of differentiation and converging tastes, the German Brewer Association states that local support for the law is uncontested, with some 85% of consumer still in favour (Brauer-bund.de 2014). In turn, abandoning it could also alienate the loyal domestic consumer base. Finally, as discussed earlier, historically it has greatly promoted the level of expertise and quality needed to brew "real" German Beer, which may be diminished once brewers can start taking shortcuts in production.

Nevertheless, the market research presented above is overwhelmingly indicative of the fact that other countries are better fit to serve the evolving preferences in desired variety, which will likely make German breweries less profitable in the future.

We therefore suggest that it is time for the German government to once again intervene, by making changes to its legislation as it has done previously. One way of doing this effectively, without letting go of the essence of the purity requirements, would be to devise separate rules and standards for "domestic" craft brewing. In turn this market segment would be able to grow alongside the established brands to meet the changing demand patterns in-land and Germany's innovative brewing spirit may be revitalised. Although, it could take a long time before the average German consumer fully and openly embraces the shift towards local craft beers, it should be up to them to decide what he or she considers "real" beer.

An alternative recent development in this direction from 2018 has been proposed by the association for creative brewers ("Deutscher Kreativbrauer e.v."), who would like to replace and complement the "provisional beer law" with the implementation of a common "Natürlichkeitsgbot" ("biological standard") throughout Germany. This would allow brewers to advertise that their beer is made exclusively from safe and natural ingredients to convince local consumer sceptical of craft brewing. Furthermore, it may serve to differentiate German beers in a globalised market, the same way he purity decree once did in the past.

Finally, another option would be to introduce a "New Approach" with legislation only prescribing ecological requirements. Then voluntary standards combined with private conformity assessment would protect different categories of beer in parallel. E.g., the 'old' category meeting the old Reinheitsgebot requirements and one or more other categories that would allow the addition of other ingredients to enable innovation. In this way, the 'essential requirements' would be performance-based, whereas voluntary standards could describe a solution – though still with a bandwidth. As De Vries and Verhagen (2016) show, this can be the optimal mix to enable innovation. The legal requirements then would give justified

confidence to people and authorities in export markets like China and Russia that appreciate governmental control.

## References

Alworth, J. (2016). Attempting to Understand the Reinheitsgebot. [online] All About Beer. Available at: <http://allaboutbeer.com/article/happy-birthday-reinheitsgebot/> [Accessed 2 Mar. 2018].

Anderson, E. (2017). Why Germans are losing their taste for beer. [online] Thelocal.de. Available at: <https://www.thelocal.de/20170215/why-germans-are-losing-their-taste-for-beer> [Accessed 3 Mar. 2018].

Anholt, S. (2007). Competitive identity: The new brand management for nations, cities and regions. *Journal of Brand Management*, 14(6), pp.474-475.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy*, 37(3), pp.407-429.

Birnbaum, M. (2013). In Germany, a U.S. beer invasion. [online] Washington Post. Available at: [https://www.washingtonpost.com/world/in-germany-a-us-beer-invasion/2013/04/30/0d03f6e6-adf3-11e2-8bf6e70cb6ae066e\\_story.html?utm\\_term=.1401e873c813](https://www.washingtonpost.com/world/in-germany-a-us-beer-invasion/2013/04/30/0d03f6e6-adf3-11e2-8bf6e70cb6ae066e_story.html?utm_term=.1401e873c813) [Accessed 5 Mar. 2018].

Brauer-bund.de. (2014). Willkommen beim Deutschen Brauer-Bund: 85 Prozent der Deutschen für den Erhalt des Reinheitsgebotes. [online] Available at: <http://www.brauer-bund.de/presse/textarchiv/2014/04/85-prozent-der-deutschen-fuer-den-erhalt-des-reinheitsgebotes.html> [Accessed 1 Mar. 2018].

Castello, P. (2018). In Germany, creative craft beer brewers face off against a medieval purity law. [online] Public Radio International. Available at: <https://www.pri.org/stories/germany-creative-craft-brewers-face-against-medieval-purity-law> [Accessed 9 Feb. 2018].

Chen, M. and Mattoo, A. (2008). Regionalism in standards: good or bad for trade?. *Canadian Journal of Economics/Revue canadienne d'économique*, 41(3), pp.838-863.

Colen, L., and J. Swinnen. 2016. "Economic Growth, Globalization and Beer Consumption." *Journal of Agricultural Economics* 67(1):186–207.

Connolly, K. (2016). Medieval beer purity law has Germany's craft brewers over a barrel. [online] *Guardian*. Available at: <https://www.theguardian.com/world/2016/apr/18/germany-reinheitsgebot-beer-purity-law-klosterbrauerei-neuzelle> [Accessed 5 Mar. 2018].

Copley, C. (2016). German beer purity in question after environment group finds.... [online] U.S. Available at: <https://www.reuters.com/article/us-germany-beer/german-beer-purity-in->

question-after-environment-group-finds-weed-killer-traces-idUSKCN0VY222 [Accessed 3 Mar. 2018].

De Vries, H. (1997). Standardization – What’s in a name? Terminology – International Journal of Theoretical and Applied Issues in Specialized Communication, 4, 1, 55-83. <https://dx.doi.org/10.1075/term.4.1.05vri>. (Rectification in 4, 2, 198).

De Vries, Henk J. & Verhagen, W. Pieter. (2016). Impact of changes in regulatory performance standards on innovation: A case of energy performance standards for new-built houses. *Technovation*, 48-49, 56-68. <http://dx.doi.org/10.1016/j.technovation.2016.01.008>.

Debenedetti, C. (2011). Brauereisterben: The sad state of German beer culture [online] Slate Magazine. Available at: <http://www.slate.com/articles/life/drink/2011/03/brauereisterben.html> [Accessed 2 Mar. 2018].

Egyedi, T.M. (2008). Conclusions. In: Egyedi, T.M., Blin, K. (eds) *The Dynamics of Standards*. Edward Elgar, Cheltenham, UK / Northampton, MA.

Filtz, M. (2014). German Beer’s Existential Crisis. [online] *The New Yorker*. Available at: <https://www.newyorker.com/business/currency/german-beers-existential-crisis> [Accessed 4 Mar. 2018].

Gao, P., Yu, J., Lyytinen, K., 2014. Government in standardization in the catching-up context: case of China’s mobile system. *Telecomm. Policy* 38, 200–209

Garavaglia C., Swinnen J. (2018) *Economics of the Craft Beer Revolution: A Comparative International Perspective*. In: Garavaglia C., Swinnen J. (eds) *Economic Perspectives on Craft Beer*. Palgrave Macmillan, Cham.

Glenn, A. (2016). Innovation Reigns under Reinheitsgebot at Paulaner Brewery. [online] *All About Beer*. Available at: <http://allaboutbeer.com/innovation-reigns-reinheitsgebot/> [Accessed 10 Mar. 2018].

Ho, J. and O’Sullivan, E. (2015). The evolving role of standardisation in technological innovation: the case of photovoltaics. 2015 IEEE 9th International Conference on Standardization and Innovation in Information Technology (SIIT).

Ho, J. and O’Sullivan, E. (2017). Strategic standardisation of smart systems: A roadmapping process in support of innovation. *Technological Forecasting and Social Change*, 115, pp.301-312.

Hornsey, I. (2003). *A history of beer and brewing*. Cambridge: Royal Society of Chemistry.

Kell, J. (2016). How this 500-year-old law shaped the global beer industry. [online] *Fortune*. Available at: <http://fortune.com/2016/04/23/reinheitsgebot-german-beer-law/> [Accessed 6 Mar. 2018].

Lee, Mimi Y. (1988). "Commission v. Germany and Article 36 protection of human life and health". *Northwestern Journal of International Law and Business*, Vol. 9 (Fall 1988): 444-61

Mason, B. (2010). April 23, 1516: Bavaria Cracks Down on Beer Brewers. [online] WIRED. Available at: <https://www.wired.com/2010/04/0423deutsche-reinheitsgebot-german-beer-purity-law/> [Accessed 16 Apr. 2018].

McGavin J. (2018). Ever Heard of Reinheitsgebot? It's Been a German Beer Law Since 1516. [online] *the Spruce* Available at: <https://www.thespruce.com/what-is-the-reinheitsgebot-1446817> [Accessed 7 Mar. 2018].

Meussdoerffer, F. G. (2009) A comprehensive history of beer brewing, in. Handbook of brewing: Processes, technology, markets (Eßlinger, H. M. Ed.) pp. 1-42, Wiley-VCH Verlag, Weinheim. 5.

Nelson M. (2005) *The Barbarian's beverage: A history of beer in Ancient Europe*. Routledge, London (and New York)

Nicholson, E. (2016). Germany's Beer Purity Law Is 500 Years Old. Is It Past Its Sell-By Date?. [online] NPR.org. Available at: <https://www.npr.org/sections/thesalt/2016/04/29/475138367/germanys-beer-purity-law-is-500-years-old-is-it-past-its-sell-by-date> [Accessed 6 Mar. 2018].

Rowland, Kenneth (2017) "Craft Beer Craze: Fad or Here to Stay?," WRIT: GSW Journal of First-Year Writing: Vol. 1 : Iss. 2 , Article 12. Available at: <https://scholarworks.bgsu.edu/writ/vol1/iss2/12>

Schmitt, N. (1995). Product Imitation, Product Differentiation and International Trade. *International Economic Review*, 36(3), p.583.

Swann, P. (2010). *The economics of standardization: An update*. Report for the UK Department of Business, Innovation and Skills (BIS).

Swinnen, J. (2017). Beer Consumption and Trade in an Era of Economic Growth and Globalization. *Choices*, 32(3), 1-6. Retrieved from <http://www.jstor.org/stable/90015009>

Swinnen, J., and D. Briski. 2017. *Beeronomics. How Beer Explains the World*. Oxford: Oxford University Press.

Swinnen, J., and D. Emmers. 2017. *Database on the Global Beer Industry*, LICOS.

Tassey, G. (2000). Standardization in technology-based markets. *Research Policy*, 29(4-5), 587-602.

Tremblay, V.J., and D.H. Tremblay. 2005. *The US Brewing Industry: Data and Economic Analysis*. Cambridge, MA: MIT Press.

Wiegmann, P.M., de Vries, H.J. and Blind, K. (2017). Multi-mode standardisation: A critical review and a research agenda. *Research Policy*, 46(8), pp.1370-1386.

Wikipedia.org. (2018). Reinheitsgebot. [online] Available at: <https://en.wikipedia.org/wiki/Reinheitsgebot> [Accessed 3 Mar. 2018].

Willcox, K. (2016). Germany's Devotion to The Beer Purity Law Is Going To Leave Its Beer Industry In Europe's Dust. [online] VinePair. Available at: <https://vinepair.com/wine-blog/germanys-devotion-to-the-beer-purity-law-is-going-to-leave-its-beer-industry-in-europes-dust/> [Accessed 7 Mar. 2018].