

SUPPLY CHANGES CAUSED BY PROPRIETARY HOP VARIETIES

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Abstract

We used the Herfindahl-Hirschman Index (HHI) to evaluate changes of a hop industry concentration and global competitiveness related to the area and production changes in proprietary varieties of hops relative to public varieties. Using the HHI, the reduction of the land competitiveness in the U.S. hop industry due to increased proprietary variety acreage between 2000 and 2020 was analyzed. The HHI analysis of hop acreage and hop production illustrated that market concentration has risen rapidly between the year 2010 (0.0376 and 0.0729) and the year 2020 (0.4927 and 0.5394). This results in decreasing business competitiveness within the market during this period caused primarily by rapid proprietary variety acreage and production increases.

Key words: market concentration, hop varieties, intellectual property, prices

Lastniške sorte spreminjajo razmere v ponudbi hmelja

Izvilleček

Za analizo sprememb koncentracije kapitala v hmeljarstvu v povezavi z območji pridelave in spremembami v lastništvu sort hmelja (lastniške sorte – javne sorte) smo koristili Herfindahl-Hirschmanov indeks (HHI). Z uporabo HHI smo ovrednotili zmanjšanje podjetniške konkurenčnosti pridelave hmelja v ZDA zaradi povečanega deleža površin lastniških sortnih hmelja med letoma 2000 in 2020. HHI analiza površin in pridelave hmelja nakazuje, da je tržna koncentracija med letoma 2010 (0,0376 in 0,0729) in 2020 (0,4927 in 0,5394) hitro naraščala. Posledica tega je zmanjšanje poslovne konkurenčnosti na trgu v tem obdobju, predvsem zaradi hitrega povečanja deleža površin in pridelave lastniških sort hmelja.

Ključne besede: tržna koncentracija, sorte hmelja, intelektualna lastnina, cene

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1 INTRODUCTION

Hops (*Humulus lupulus* L.) are a perennial that grow vines requiring a trellis system capable of supporting the weight of the vines themselves as well as the many cones each vine may produce. Commercial production takes place in latitudes greater than 35 degrees in both the Northern and Southern Hemispheres. Hops, along with malt and water, are the basic raw materials used for beer production. The basic role of hops is to provide beer with a pleasantly bitter taste and a hoppy aroma (Pavlovič et al. 2011; Pavlovič, 2012; Štěrba et al. 2015; MacKinnon and Pavlovič, 2022). Between 2000 and 2020 the proportion of patented hop varieties increased. In the United States during that time, one variety development company, the Hop Breeding Company, grew to the point where its varieties enjoyed significant market share. The agglomeration of hop farms in the area of the Pacific Northwest (PNW) facilitates the exchange of information by reducing monitoring costs thereby increasing market transparency among participants (Gan and Hernandez, 2013). The increase of proprietary variety acreage and production has a causal effect upon hop prices (MacKinnon and Pavlovič, 2022). Tacit collusion results from competitors independently realizing their collective best interests to adjust prices or quantities (Devlin, 2007). The exchange of pest and disease related information including anticipated yields and current prices may lead to a similar outcome (Rees, 1993).

The United States Department of Agriculture (USDA) has collected and published statistical data regarding the U.S. hop industry since 1913. The publication of intellectual property (IP) necessitates the use of symbols for registered trademarks, unregistered trademarks, and copyright, (i.e. “®”, “™” and “©”) respectively, their ownership is publicly available. The USDA complies with these requirements. Proprietary variety ownership is publicly available through the U.S. Patent and Trademark Office (USPTO). The introduction of proprietary varieties, therefore, enabled the calculation of hop market share by acreage and production for the first time. Market share regarding sales of these varieties to brewers remained unavailable but was not important for calculating influence within the U.S. hop industry.

We used the Herfindahl-Hirschman Index (HHI) to measure changes in hop industry competitiveness by way of measuring market concentration. A similar methodological approach was used to measure market concentration in the airline industry (Johnston and Ozment, 2011). According to the 2020 U.S. Federal Register, HHI was used to evaluate the acquisition of the Craft Brew Alliance, Inc. (CBA) by Anheuser-Busch InBev SA/NV (“ABI”) and Anheuser-Busch Companies, LLC (“AB Companies”). The results of such analyses can provide insights into industry behavior. Markets with relatively high HHI values, market share inequality, and the presence of major firms were imperfectly competitive. Under such circumstances, market imperfections are vulnerable to exploitation (Rhoades, 1995).

The presence of IP introduced constraints into the market that had not previously existed. That affected planting decisions (Dixit and Stiglitz, 1977). Changes in

market concentration and price-cost margins can be used to determine the direction of competitiveness (MacAvoy, 1998). The greater degree of specificity, control and profit incentivized private hop breeding companies to invest further in the development of new intellectual property. Their owners are incentivized by the ability to protect and enforce their rights (Bugos and Kevles, 1992). Patent law also enabled IP owners to determine production and distribution via licensing agreements.

In 2020, Germany and the U.S. produced 38 and 39 percent of the global crop respectively so a comparison between the two hop producing countries was reasonable. The year 2020 represented peak proprietary in the United States with 70.19% of U.S. acreage and 73.44% of U.S. production regulated by some form of Intellectual property. Between 2009 and 2019, the annual farmgate value of American hops increased by 282% (USDA NASS, 2020). According to IHGC country reports of the International Hop Growers' Convention between 2009 and 2019, the 70 farmers in the Pacific Northwest (PNW) received approximately \$4.7 billion during that time, \$2.88 billion more than the \$1.87 billion the 1,087 German hop farmers received during the same period (MacKinnon and Pavlovič, 2019).

Between 1998 and 2020, USDA data reported U.S. proprietary variety acreage and production soaring from zero to over 70 percent. Publicly available information regarding proprietary variety ownership enabled us to calculate U.S. hop market share for the first time in history. One variety development company, the Hop Breeding Company (HBC), owned the varieties responsible for over 50 percent of U.S. acreage and production by 2020 (USDA NASS, 2020).

The objective of the study was to evaluate changes to hop industry area and production concentration and competitiveness with respect to the changes in proprietary varieties of hops relative to public varieties. Using the Herfindahl-Hirschman Index (HHI), the reduction of the land competitiveness in the U.S. hop industry due to increased proprietary variety acreage between 2000 and 2020 was quantified. This research analyzed publicly available industry data to determine the market effects resulting from the increased use of branded proprietary varieties by the craft brewing industry during this time and compared it with other periods possessing unique characteristics dating back to 1948.

2 MATERIALS AND METHODS

2.1 Proprietary hop variety supply and market share

The United States Department of Agriculture list each branded proprietary variety together with their respective intellectual property symbols in their publications (Comi, 2020). The details of patents and trademarks are public information. By tracking the ownership of these varieties in patent and trademark records with the U.S. Patent and Trademark Office (USPTO) and through the Google Patent Search web site, we discerned the influence of individuals and entities over proprietary varieties. Data reported by the USDA included season average prices (SAP), inventory levels, production and acreage. Wright and Williams (USDA NASS, 2022)

suggest that when supply is elastic and demand inelastic (as is the case with hops), the accumulation of stocks is typically damped by a compensating production response. The hop industry suffers from something called the Delayed Surplus Response (DSR). Production is highly elastic when prices and demand increase, but there is a delay of several years when prices and demand decrease. This results in surplus production that negatively effects global prices for hops through recurring boom-and-bust cycles (Wright and Williams, 1982). Data published by the USDA enabled us to calculate the accumulation of aggregate stock levels and the annual market share of acreage by variety. We restricted our research to USDA National Hop Report (NHR) data between 1998-2022. That represented the period during which branded proprietary varieties were first reported by the USDA and included the most recently available industry data at the time of our calculations.

The companies that developed proprietary hop varieties own and license the production of multiple proprietary varieties to growers (for production) and sales and distribution of those varieties to merchants in their supply chain, thereby facilitating the management of production and distribution. We calculated the percentage for each proprietary variety produced within the Pacific Northwest (PNW) by the total acreage for the PNW i.e. the total market share. We calculated market share for each entity owning IP listed by the USDA NASS in the USDA National Hop Report (NHR) by grouping those with common ownership of patented and trademarked products (Comi, 2020).

We expanded the variety specific acreage market share calculations to group those varieties together that share common ownership to get a better picture of the influence of the five largest variety development companies. One company, the Hop Breeding Company LLC (HBC) enjoyed increased influence within the industry as its proprietary varieties increased to occupy 51% of acreage in the PNW. According to the [company's web site](http://www.hopbreeding.com) (www.hopbreeding.com), it is a joint venture between John I. Haas, Inc., a hop merchant company, and Yakima Chief Ranches LLC, a company owned by the Smith, Carpenter and Perrault families. These three families are also shareholders of Yakima Chief Hops Inc., a hop merchant company. This complicated ownership structure effectively created a duopoly through which the proprietary varieties of the HBC were processed and distributed. They were used to create a competitive advantage for the shareholders of the HBC and their other companies. These varieties were distributed worldwide via licensing agreements with select merchants. The influence over such substantial acreage afforded the individuals involved with the HBC a disproportionate amount of influence in the industry. Their patents enabled them to decide via licensing agreements who would produce and sell their varieties. The MacKinnon Report, a hop market report published on Substack.com detailed that in 2023 the patent owners must reduce proprietary variety acreage by as much as 8,328 acres (3,371 ha.) in response to a massive surplus that began in 2016. Those decisions have the power to make farms lose economies of scale. Some will be less efficient producers and not able to compete in the future market.

2.2 Calculating HHI

We used the Herfindahl-Hirschman Index (HHI) to evaluate changes to hop industry concentration and competitiveness with respect to the changes in proprietary varieties of hops relative to public varieties. A significant portion of PNW acreage, 7.54% according to USDA figures, were reported in two aggregate categories called “other” and “experimental”. The categories are used to report acreage and production for varieties that do not meet the three-independent-grower threshold set by the USDA. Based on historical data, we believe at least half of this acreage was proprietary.

The HHI is a method used also by the United States Department of Justice (USDOJ) to measure market concentration during mergers or acquisitions, to evaluate one competitor’s position relative to another and to uncover potentially anti-competitive practices. The HHI values of zero to 0.1500 mean a low market concentration. Values of 0.1500 to 0.2500 are considered moderate concentration. Values of 0.2500 and above count as high concentration. The HHI value will be low when market shares among participants are equal. The value will be high when one firm has a disproportionate share of the market (Anon., 2019). The value of the HHI decreases as the number of firms in the market increases. Market concentration is inversely proportional to competitiveness (Depken, 1999). The HHI is responsive to asymmetry of market shares and is used to evaluate changes in the competitiveness within a single industry over time or comparisons of one industry to another (Calkins, 1983). In our research we adopted this method for the first time in the hop industry for the measurement of its market concentration.

The HHI Formula

$$HHI = S_1^2 + S_2^2 + S_3^2 + \dots + S_n^2$$

Where:

- n refers to the number of varieties in the market
- S refers to the percent market share for a variety

3 RESULTS AND DISCUSSION

3.1 Acreage and production linked to proprietary hop varieties

Calculating the Herfindahl-Hirschman Index (HHI) of the U.S. hop industry based on the market share of hop sales to brewers was a hopeless endeavor as information regarding market share based on sales of hops by merchants to breweries was proprietary information and never shared. We discovered an alternative method for measuring market share. The USDA NASS restrictions related to the reporting of proprietary U.S. acreage and production (i.e. that three or more independent producers must list acreage or production for the corresponding statistics to be reported in aggregate form) to meet the needs of this research.

Acreage, and the infrastructure necessary to harvest that acreage, was the scarcest and most valuable commodity in the hop industry in 2020, not the hops

themselves. Acreage was the asset for which there was the greatest competition. The primary method for harvesting hops was via fixed picking machine facilities. Mobile combines exist that harvest cones from the vines in the field. Combines, when they were used, operated in conjunction with the more traditional fixed picking facilities that could process at least 600 acres (242 hectares) of hops in a season. Combines returned cones harvested in the field to the picking facility to separate leaves, twigs and foreign material from the cones themselves through the picking facility's recleaning equipment. Due to the time-sensitive nature of harvest, high ambient air temperatures, which could reach over 100 degrees Fahrenheit (37,78 degrees Celsius) in Washington and Idaho states during harvest, hop growers sought to grow hops on land that was in proximity (not more than 10-15 minutes driving time) to their fixed picking facilities to reduce the possibility of the hops drying en route to the picking facility.

Five companies such as HBC, Simon H. Steiner Hopfen, ADHA, VGF and CLS Farms covered approximately 70 percent of U.S. hop acreage and production in the Pacific Northwest in 2020 (Comi, 2020). These variety development companies can license hop merchant companies to sell their proprietary varieties. They can license hop farms to produce their varieties. In some cases, the variety development company ownership and the licensed merchants and farms shared had common ownership, but licenses extended beyond their ownership transforming previously independent farms into contract growers. The decision makers for the five largest variety development companies therefore enjoyed a disproportionate influence in the industry and upon the market. The acreage on which a company's proprietary varieties were produced represented the market share of influence of the owners of each variety development company. The market share of influence represented a new and significant measurement possible within the industry all made possible by the growing demand for and reporting of proprietary varieties of hops.

Calculating the market share for each ownership group based on their ownership of proprietary hop varieties enabled the calculation of the market share of influence over the scarcest resource in the hop industry, acreage. Branded proprietary varieties are products that enjoy monopoly control by their very nature as patented and trademarked products. Seventy percent of the acreage, therefore, was governed by the decision makers of five entities. Public varieties, on the other hand, are available for any grower to produce.

We calculated the market share for each proprietary variety production and acreage relative to total U.S. acreage for the years 2000 through 2020. During this time, market concentration moved from low to high according to the standards set by the U.S. Department of Justice when evaluating mergers and acquisitions between competitors. Higher market concentration as represented by higher HHI values are inversely proportional to the degree of competitiveness in the market, we can visualize the decreases in competitiveness.

Using the HHI market share data by variety, we calculated the market share for all proprietary varieties collectively as the U.S. hop industry resembles what is referred to as a complex monopoly in the U.K. (Depken, 1999). Using these data and the

HHI, we calculated the increase in market concentration between 2000 and 2020 of publicly reported U.S. proprietary hop varieties. The increasing HHI values between 2000 and 2020 demonstrated the changes in the degree of competitiveness in the industry (Table 1).

Table 1: HHI Values for U.S. Total Proprietary Varieties by Acreage and Production 2000 – 2020

Crop Year	HHI Values for Proprietary Varieties by Acreage	HHI Values for Proprietary Varieties by Production
2000	0.0376	0.0729
2001	0.0900	0.1474
2002	0.0961	0.1709
2003	0.0755	0.1416
2004	0.0898	0.1586
2005	0.0904	0.1425
2006	0.0948	0.1791
2007	0.1200	0.2100
2008	0.1533	0.2441
2009	0.1642	0.2593
2010	0.1393	0.1903
2011	0.1496	0.2050
2012	0.1149	0.1618
2013	0.2024	0.2882
2014	0.1822	0.2700
2015	0.1841	0.2500
2016	0.1832	0.2292
2017	0.2661	0.3170
2018	0.3094	0.3628
2019	0.4058	0.4371
2020	0.4927	0.5394

The U.S. proprietary hop varieties used to calculate market concentration relative to public varieties between 2000 and 2020 listed in alphabetical order: Ahtanum™, YCR 1, Amarillo® VGXP01, Apollo™, Azacca™ ADHA-483, Bravo™, Calypso™, Chelan®, HBC 394, Columbus/Tomahawk®/Zeus (AKA: C/T/Z®), Ekuanot™, HBC 366, El Dorado®, Eureka™, IDAHO 7™, Idaho Gem™, Jarrylo™, ADHA-881, Loral™, HBC 291, Millennium®, Mosaic®, HBC 369, Pahto™, HBC 682, Palisade®, YCR 4, Pekko™, ADHA-871, Sabro™, HBC 438, Simcoe®, YCR 14, Strata™ OR 91331,

Summit™, Super Galena™, Talus®, Warrior™, YCR 5, Zappa® (own study based on (USDA NASS, 2020).

The HHI analysis demonstrates that the market concentration due to the increasing proportion of proprietary varieties rose from low to moderate concentration between 2000 and 2010. It remained in the moderate zone until 2016 when it rapidly began to increase through 2020 as if a tipping point had been reached (Figures 1 and 2). Official government data documented that in 2017 proprietary varieties represented greater than 50% of U.S. hop acreage (USDA NASS, 2020).

3.2 Prices of hops linked to the intellectual property

In the measurement of the effects on price over time, it was necessary to adjust for inflation. No appropriate Producer Price Index existed that could be applied to the U.S. hop industry. Therefore, we decided to use the Consumer Price Index (CPI) as it reflects changes in the economy and the purchasing power of a U.S. dollar over time. Vermeulen (2012) suggests that U.S. producers adjust their prices as often as retailers. This suggested that the use of the CPI for adjusting prices for inflation would be an appropriate strategy.

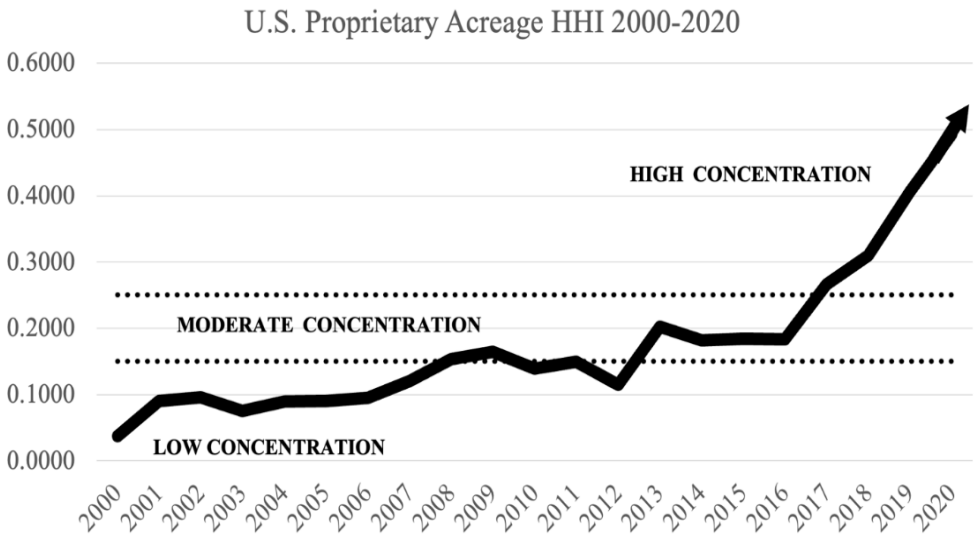


Figure 1: The HHI for total U.S. branded proprietary variety acreage 2000-2020 (own study based on (USDA NASS, 2020))

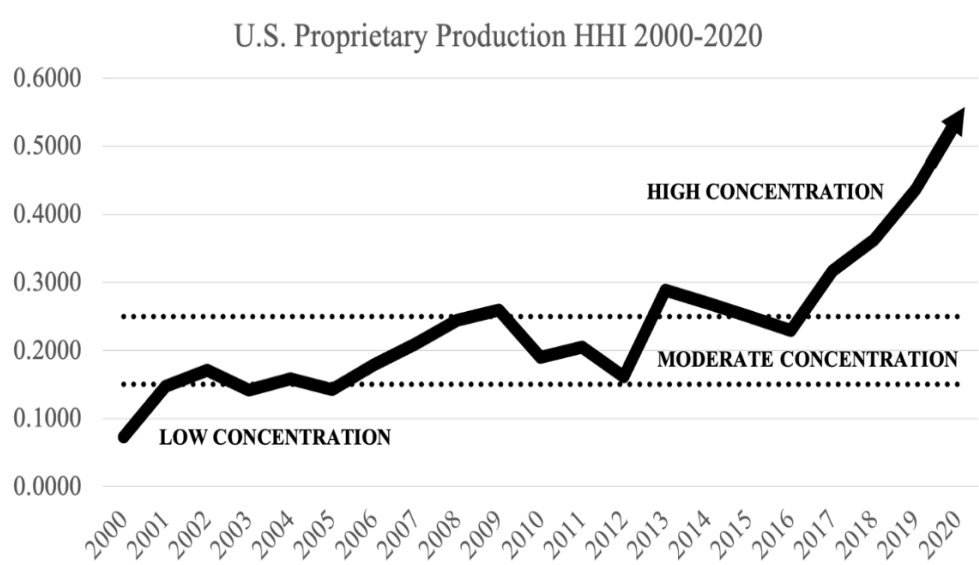


Figure 2: The HHI for total U.S. branded proprietary variety production 2000-2020 (own study based on (USDA NASS, 2020))

U.S. season average prices for hops as reported by the USDA have been affected by the tipping point achieved when acreage and production of proprietary varieties surpassed 50%. Prices when adjusted for inflation rose rapidly following 2016. The rapidly increasing HHI values post 2016 represented rapidly decreasing competitiveness. Reduced competitiveness was both a symptom and a consequence of the predominance of monopolistic products where five entities captured 70% market share. Rhoades (1995) concluded that the results of such analyses can yield useful insights into industry behavior. Concentration and the degree of competitiveness within an industry can impact price. MacAvoy (1998) identified a general hypothesis regarding changes in market concentration and price-cost margins used to determine the direction of competitiveness.

Industry concentration reduced price competition as licensing agreements centralized decisions regarding production, sales and marketing. Standardized quality by controlling harvest timing by IP owners was another result (Pavlovič et al., 2013; Mikyška et al., 2017). Patents enabled similar monopoly control without government involvement or oversight. Quantity or volume regulation and producer allotments of hops through Federal Marketing Orders has previously led to monopolistic policies (Folwell, 1982).

3.3 Discussion

Reduced competitiveness within the hop industry during the period 2000 - 2020, enabled season average prices to remain at elevated levels for a prolonged period as they did between 2016 and 2020. The intrinsic homogeneous traits of branded proprietary varieties of hops such as oil production, which would typically result in symmetrical marginal costs, are overshadowed by extrinsic heterogeneous

characteristics such as brand value and scarcity. These characteristics create the perception of additional value for which the brewing industry is prepared to pay handsomely (Olšovská et al., 2015). The premium price and royalties warranted by proprietary varieties can be considered a deadweight loss ultimately born by the beer consumer.

We expanded the variety specific acreage market share calculations to group those varieties together that share common ownership to get a better picture of the influence of the five largest variety development companies. One company, the Hop Breeding Company, had a much greater share than the rest. Common ownership between the entities that create branded proprietary varieties, individual hop farms and hop merchant firms further increased market concentration in the market. The individuals who own the entities that create proprietary varieties have created a competitive advantage for the merchant companies and farms in which they share a financial interest. We concluded that branded proprietary varieties when their ownership is concentrated into few hands reduced competition within the market and encourage market segmentation.

According to data available between 2009 and 2020 from IHGC economic reports and the Hop Growers of America Statistical Packets, the farmgate value for American hops was \$2.88 billion greater than German growers. That does not represent the added value that processing, packaging and resellers add to the price paid by brewers and beer consumers. During this same period, the USDA reported that proprietary variety acreage increased from 40.52 percent to 70.19 percent in the PNW (USDA NASS, 2020).

4 CONCLUSIONS

The Herfindahl-Hirschman Index calculations offered a glimpse of changes in proprietary variety market share and the impact these changes have had upon market concentration and competitiveness within the U.S. hop industry between 2000 and 2020. During that short time, the industry has gone from one dominated by publicly available varieties to one controlled managed product controlled by a duopoly.

The most relevant of the consequences of increased market concentration of reduced competitiveness was the greater ability for proprietary variety owners to manage the supply of their proprietary products on the market. Through their efforts, they could reduce or eliminate surplus inventory thereby enabling sustained premium prices indefinitely. Additional data now suggested a surplus of proprietary varieties developed and grew between 2016 and 2020. Artificially high prices were sustained since free market forces were not allowed to act. In the face of oversupply, these higher prices artificially increased the cost of production not only for American brewers but for brewers around the globe. The effect of proprietary varieties on the DSR remains to be seen as it is underway in 2023. It appears at the time of this writing the additional opacity created by private management of approximately 70 percent of the U.S. crop also delayed the initial signaling period for the DSR to begin.

The effects of such supply management efforts affect not only proprietary U.S. varieties, but public varieties in the U.S. The relationship between hop varieties (i.e. hop varieties may be substituted with other varieties) extends the effects of proprietary variety management upon farmers in countries where they are not produced. Additional research regarding the complementary relationship between the U.S. and German production regions is recommended to understand price movements, the disparity of pricing and perceived value. The reduction in competitiveness within the U.S. industry this research provides is an important step in furthering the understanding of hop market dynamics and the interrelatedness of world markets. Further research might include an examination of the methods owners of proprietary varieties may use to cooperate with other related entities to alter supply to determine where the border exists for anti-trust violations. This research does not suggest or imply any impropriety by any members of the hop industry. Circumstantial evidence, however, suggests further investigation is warranted.

5 REFERENCES

- Brent, R. The meaning of 'Complex Monopoly'. *The Modern Law Review* 1993, 56, 812-831.
- Bugos, G.; Kevles, D. Plants as Intellectual Property. *Osiris* 1992, 7, 74-104.
- Calkins, S. The New Merger Guidelines and the Herfindahl-Hirschman Index. *California Law Review* 1983, 71, 402-429.
- Comi, M. Other agricultures of scale: Social and environmental insights from Yakima Valley hop growers. *J. Rural Stud.* 2020, 80, 543–552.
- Depken, C. Free-Agency and the Competitiveness of Major League Baseball. *Review of Industrial Organization* 1999, 14, 205-217.
- Devlin A. A proposed solution to the problem of parallel pricing in oligopolistic markets. *Stanford Law Review* 2007, 59, 1111-1151.
- Gan, L.; Hernandez, M.A. Making friends with your neighbors? Agglomeration and tacit collusion in the lodging industry. *The Review of Economics and Statistics* 2013, 95, 1002-1017.
- Folwell, R.J. *The U.S. Hop Marketing Order: The Price of Success is Misunderstanding*; Department of Agricultural Economics, Washington State University: Pullman, WA, USA, 1982.
- Johnston, A.; Ozment, J. Concentration in the airline industry: Evidence of economies of scale? *Journal of Transportation Management* 2011, 22, 59-74.
- MacAvoy, P. Testing for Competitiveness of Markets for Long Distance Telephone Services: Competition Finally? *Review of Industrial Organization* 1998, 13, 295-319.
- MacKinnon, D.; Pavlovič M. Global hop market analysis within the International Hop Growers' Convention. *Hop Bulletin* 2019, 26, 99-108.
- MacKinnon, D.; Pavlovič, M. The delayed surplus response for hops related to market dynamics. *Agricultural economics* 2022, 68, 293-298.
- Mikyška, A.; Olšovská, J.; Slabý, M.; Štěrba, K.; Čerenak, A.; Košir, I.J.; Pavlovič, M.; Kolenc, Z.; Krofta, K. Analytical and sensory profiles of Slovenian and Czech hop genotypes in single hopped beers. *Journal of the Institute of Brewing* 2018, 124, 209-221.
- Olšovská, J.; Štěrba, K.; Pavlovič, M.; Čejka, P. Determination of energy value of beer. *Journal of the American Society of Brewing Chemists* 2015, 73, 165-169.
- Pavlovič, M.; Čerenak, A.; Pavlovič, V.; Rozman, Č.; Pažek, K.; Bohanec, M. Development of DEX-HOP multi-attribute decision model for preliminary hop hybrids assessment. *Computers and Electronics in Agriculture* 2011, 181-189.

- Pavlovič, M.; Production character of the EU hop industry. *Bulgarian Journal of Agricultural Science* 2012, 233-239.
- Pavlovič, M.; Pavlovič, V.; Rozman, Č.; Udovč, A.; Stajko, D.; Wang, D.; Gavrić, M.; Srečec, S. Market value assessment of hops by modeling of weather attributes. *Plant, soil and environment* 2013, 59, 267-272.
- Rees, R. Tacit Collusion. *Competition Policy*. *Oxford Review of Economic Policy* 1993, 9, 27-40.
- Rhoades, S. Market Share Inequality, the HHI, and Other Measures of the Firm-Composition of a Market. *Review of Industrial Organization* 1995, 10, 657-674.
- Stiglitz, J.E.; Dixit, A.K. Monopolistic Competition and Optimum Product Diversity. *The American Economic Review* 1977, 67, 297-308.
- Šterba, K.; Pavel Čejka, P.; Čulík, J.; Jurková, M.; Krofta, K.; Pavlovič, M.; Mikyška, A.; Olšovská, J. (2015): Determination of Linalool in Different Hop Varieties Using a New Method Based on Fluidized-Bed Extraction with Gas Chromatographic–Mass Spectrometric Detection. *J. Am. Soc. Brew. Chem.* 2015, 73, 151-158.
- USDA NASS 2020. [National Hop Reports \(NHR\) for Years 2000–2020. \[Dataset\]. United States Department of Agriculture National Agricultural Statistics Service \(USDA NASS\)](https://www.nass.usda.gov/Statistics_by_State/Washington/Publications/Hops/index.php). Available at [https://www.nass.usda.gov/Statistics_by_State/ Washington/Publications/Hops/index.php](https://www.nass.usda.gov/Statistics_by_State/Washington/Publications/Hops/index.php) (accessed July 18, 2022).
- USDA NASS. National Hop Reports (NHR) for Years 2000–2022. [Dataset]. [United States Department of Agriculture National Agricultural Statistics Service \(USDA NASS\)](https://www.nass.usda.gov/Statistics_by_State/Washington/Publications/Hops/index.php). 2022. Available online: [https://www.nass.usda.gov/Statistics_by_State/ Washington/Publications/Hops/index.php](https://www.nass.usda.gov/Statistics_by_State/Washington/Publications/Hops/index.php) (accessed on 22 December 2022).
- Vermeulen, F. The Narrative Advantage. *London Business School Review* 2012, 23, 55-57.
- Wright, B.; Williams, J. The Economic Role of Commodity Storage. *The Economic Journal* 1982, 92, 596-614.