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Price Hedonics of Beers: Effects of Alcohol Content, Quality Rating, and Production Country

https://doi.org/10.1515/jafio-2023-0048
Received October 13, 2023; accepted December 15, 2023

Abstract: We examine the association between beer prices and the inherent characteristics of beers within the traditional price hedonic framework. Using a large-scale Norwegian data set with more than 9000 individual beer products from several production countries, we find that alcohol content has a strong, positive, and significant effect on the retail price of beer. In contrast, the effect of expert quality rating on beer price appears to be of only small to moderate importance. We also find significant and substantially important price differences between production countries. Finally, there is effect heterogeneity (i.e. interaction effects) for both alcohol content and quality rating with respect to production country. For example, the association between alcohol content and price is larger in Norway and Germany than in most of the other production countries in the data.

Keywords: beer; beer price; Norway; hedonic price modeling

JEL Classification: C3; C5; C83; D8; Q11; Z1

1 Introduction

While the hedonic price modeling of wines might be labeled a mature research field,[1] similar modeling of beers is still in its infancy. Because this observation is puzzling given the popularity of beer drinking around the world, we draw attention in this study to how beer prices are related to their inherent characteristics within the traditional hedonic pricing framework. We make three main contributions to the admittedly scant research on this topic.

First, we employ a much larger data set than typically used in previous research. That is, we study more than 9000 individual beer products from eight production countries. Second, we introduce expert quality ratings as a factor explaining variation in beer prices. Although expert ratings have played an important role in hedonic price studies of wine in the past, they have so far not been examined in hedonic price studies of beers. Third, we examine interaction effects between our two key beer attributes – i.e. alcohol content and quality rating – and production country on price.

Throughout the analysis, we find that alcohol content has a strong, positive, and significant effect on the prices of beer. We also find significant and substantially important price differences between production countries. In contrast, the effect of expert ratings on beer prices appears to be of only a small to moderate magnitude. Yet we also find interaction effects between alcohol content and production country and between expert ratings and production country.

The study proceeds as follows. In Section 2, we review prior research on hedonic price modeling of beers and present the Norwegian beer market. Section 3 presents the data and descriptive statistics, whereas Section 4 provides the econometric analyses. Section 5 finally summarizes and concludes.

2 Literature Review and the Norwegian Beer Market

2.1 Prior Hedonic Price Modeling of Beer Markets

Hedonic price modeling of beer products is a limited field of study, and Smith et al. (2016) should arguably be considered the first full-fledged study on the topic. By means of an OLS regression model, they related beer prices to consumer ratings and certain other immanent beer attributes for 400

1 A review of the factors determining wine prices within the hedonic framework is beyond the scope of this paper; see Outreville and Le Fur (2020) for such studies covering the period from 1993 to 2018.

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beers. Their findings suggested that consumer ratings, alcohol content, and production country affected beer prices. Yet their regression only explained about 22 % of the price variation. Recently, Michis (2022), Bimbo et al. (2023) and Rousseau, Joly, and Poelmans (2023) attempted to model beer prices in a similar fashion.[2] Michis (2022) studied 675 beers from around the world and examined how certain sensory (i.e. subjective), objective, and chemical attributes affected prices. In particular, he found that consumer ratings, alcohol content, production country, and certain beer styles or types significantly affected prices.[3] Bimbo et al. (2023) studied the Italian beer market in a similar way. By examining 1203 craft beers available online, they found that the type of packaging and size of the package only affected price moderately, whereas certain styles or types of beer induced large premium prices. Finally, Rousseau, Joly, and Poelmans (2023) examined the Belgian beer market and 1517 beer products. Again, consumer ratings, alcohol content, and type or style of beer were the key independent variables explaining variation in beer prices. A common thread in these four studies is the use of rather small samples, providing limited opportunities to study any production country differences in prices in an effective manner. Furthermore, none of the studies addressed how expert ratings affected beer prices, a topic that has been extensively studied in the literature on wine economics.

2.2 The Norwegian Beer Market

Beer has for centuries played an important role in Norwegian culture. However, beer sales are now subject to strict regulations and taxation related to beers' alcohol content. The taxation on content, however, is the same regardless of whether beers are produced domestically or abroad.[4] At present, the market is divided into three main segments: (1) non-alcoholic beer (<0.7 % alcohol) freely sold, (2) beer below 4.7 % alcohol sold in regular grocery stores, and (3) strong beer (>4.7 % alcohol) exclusively sold by the state-run retail monopoly for alcoholic beverages, A/S Vinmonopolet. Vinmonopolet has a wide network of stores in Norway, ensuring that consumers have access to alcoholic beverages including imported and Norwegian strong beer. According to the numbers from the Association of Norwegian Beer and Soft Drink Producers, the total sales of beer in the 12-month period from September 2022 to August 2023 was 288 million liters. Of these 288 million liters, 46 million liters were imported. Only a small fraction of this amount is strong beer (approximately 2–3 %), but this share has increased somewhat in recent years as craft beer and imported beer have gained popularity among Norwegians.[5] Figure 1 presents some time trends.

The most popular among Norwegian consumers are light lager beer and Indian Pale Ale (cf. Table 1), but several other types of beer also have a considerable percentage of total sales.

3 Data and Descriptive Statistics

3.1 Data

We extracted data by scraping Norway's largest food and drink website, aperitif.no,[6] for information on various types of beer sold through Vinmonopolet. This included information on various attributes of the beers (e.g. type of beer, production country, alcohol content, and price), as well as the rating score given as an average of professional tasters' score in a blind test similar to the TWA rating system (i.e. the Robert Parker scale):[7] 50–59 (unacceptable), 60–69 (below average), 70–79 (average), 80–89 (barely above average to very good), 90–95 (outstanding) and 96–100 (extraordinary).

We used the Web-scraping package rvest (Wickham 2022) in R to collect the data from multiple pages on aperitif.no, each containing information about several beers. In the first step of the scraping, the information was extracted from one item (i.e. one beer) on the first page in order to locate the place of the variables we wanted to extract. When this was completed successfully, the extraction procedure was automated in a properly functioning extraction routine. In the second step of the scraping, we created a function pulling all the beer links from a page and then applied the extraction function to create the data set. In the third step, we applied the extraction function to all pages for the different beers. Lastly, since there

2 Łukasz and Marcin (2021) also studied the determinants of beer prices but within a stepwise regression framework that is not comparable to the traditional hedonic pricing approach.

3 Instrumental Variable (IV) regression was used to handle the possible endogeneity of the consumer rating variable. See also (Kaimann, Spiess Bru, and Frick 2023) for a recent wine study addressing the possible endogeneity of the rating variable.

4 The tax levy for 2023 for beer with alcohol content > 4.7 % is NOK 4.95 per volume percent alcohol per liter.

5 This goes against the so-called Lo-No revolution, an evolving consumer trend towards low- or no-alcohol beverages; see, e.g., Anderson (2023).

6 https://www.aperitif.no/.

7 https://www.robertparker.com/about/the-rating-system.

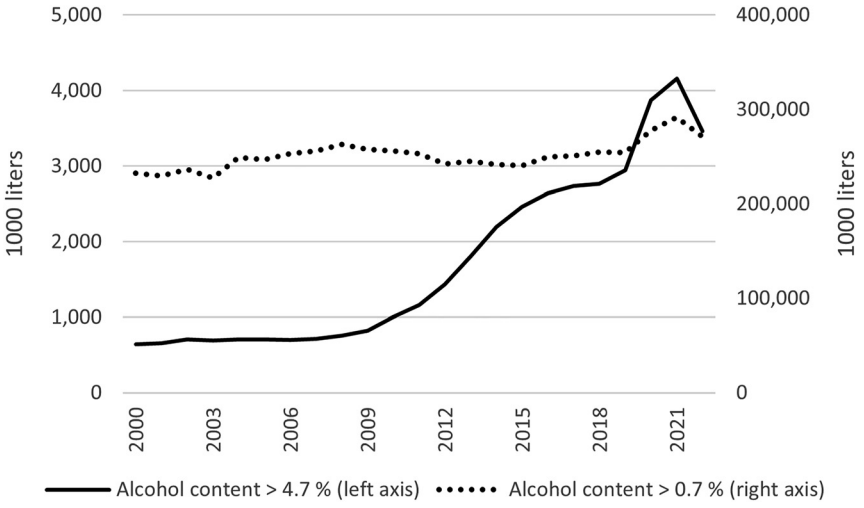

Figure 1: Annual sales in liters of beer of different alcohol content, 2000–2022 (extracted from various annual reports of Vinmonopolet (see e.g. Vinmonopolet (2023)) for alcohol content > 4.7 % and Statistics Norway (2023) for alcohol content > 0.7 %).

Table 1: Sales of strong beer by type at Vinmonopolet, 1000 L 2018–2022 (Vinmonopolet 2023).

Beer type	2018	2019	2020	2021	2022
Light lager	601	700	923	1132	1013
Indian Pale Ale	585	687	952	1021	802
Dark lager	352	310	348	353	309
Wheat beer	230	212	271	300	220
Abbey-style beer	171	176	242	219	187
Porter and Stout	163	187	238	238	187
Sour beer	87	110	207	212	144
Pale Ale	98	94	139	139	121
Light Ale	95	80	114	135	121
Special beer	116	119	135	123	106
Saison Farmhouse Ale	116	114	128	121	105
Brown Ale	54	57	57	59	55
Other	99	103	117	109	91
Total	2767	2948	3872	4161	3463

Table 2: Descriptive statistics for key variables in total sample (Panel A; N = 9251) and in rating sample (Panel B; N = 3766).

	Mean	Median	SD	Min	Max
Panel A: Full sample					
Price per bottle	75.749	65.556	41.501	20.133	570
Alcohol content in %	7.650	7.0	2.403	4.7	20.0
Panel B: Rating sample					
Price per bottle	72.469	60.63	38.657	20.133	429.733
Alcohol content in %	7.648	7.0	2.400	4.7	20
Rating	85.941	87.0	4.167	55	96

were different kinds of strings in the variables, we cleaned and prepared the variables for analysis using the tidyverse package (Wickham et al. 2019) in R. We study two beer samples in the subsequent analyses: The total sample (N = 9251) for which we have complete information on all independent variables save for rating, and the smaller rating sample containing the beers which also were quality-tested using the Parker scale (N = 3766).

3.2 Descriptive Statistics

Table 2 presents descriptive statistics for some of the key variables. The retail price variable refers to a 0.33 L beer bottle in Norwegian Krone (NOK).[8] The average beer in the total sample costs NOK 76, with a range of NOK 20 to NOK 570.[9] Yet since the median is NOK 10 lower than the mean, we note a severe right skew (skewness = 3.498). The average beer in the total sample has an alcohol content of 7.65 %, with a range from 4.7 % to 20 %. This variable is also skewed to the right (skewness = 1.433).

The mean and median prices are lower for the rating sample compared with the total sample, but not much.[10] In contrast, the summary statistics for the alcohol content variable are very similar across the samples. The rating variable, i.e. Robert Parker's quality rating system, has a

8 1 NOK = 0.091 USD as of December 13, 2023.

9 Because the typical beer in the data is contained in a 0.33 L bottle, and that most people by bottles rather than liters of beer, we use bottle price as the dependent variable. Using price per liter gives the same qualitative results, however.

10 There is, however, less skewness for the price variable in the rating sample: skewness = 2.606.

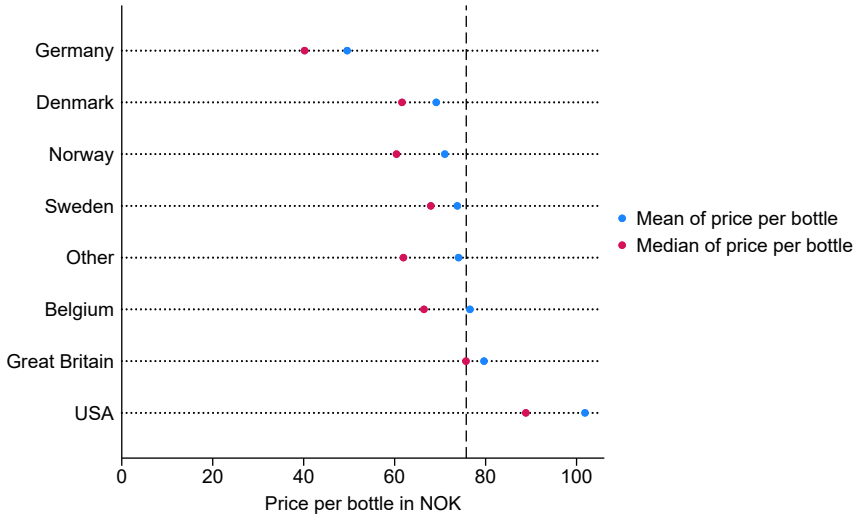

Figure 2: Beer bottle price by production country. The dashed line is the mean price in NOK for the total sample.

theoretical range of 50–100 points. In our data, however, this score ranges between 55 and 96 points. The mean quality score is 86 points, whereas the median quality score is 87 points. The rating variable is thus left-skewed (skewness = –1.736).

Figure 2 shows the mean and median beer prices for the various production countries. While the most expensive beers originate from the United States on average, the least expensive ones are made in Germany. For most of the remaining production countries, the average beer price is close to the mean of the total sample.

Figure 3 presents the mean and median alcohol content for the production countries. USA and Germany are once again the extreme cases. This makes intuitive sense because the previously cited research (see Section 2.1) finds a positive association between alcohol content and beer price.

4 Econometric Models and Analysis

4.1 Model Specification

The core idea underpinning a hedonic price model is based on the premise that consumers assign value to particular attributes of products that enhance its utility, thus influencing their purchasing decisions (Lancaster 1966; Rosen 1974). This concept leads us to interpret the competitive market price of product i ($Price_i$) as the aggregate sum of implicit prices linked to different attributes, designated as x_n:

$$Price_i = f_i(x_1, x_2, \ldots, x_n) \tag{1}$$

In the empirical section, we utilize data on beer attributes and expert ratings obtained from the aperitif.no

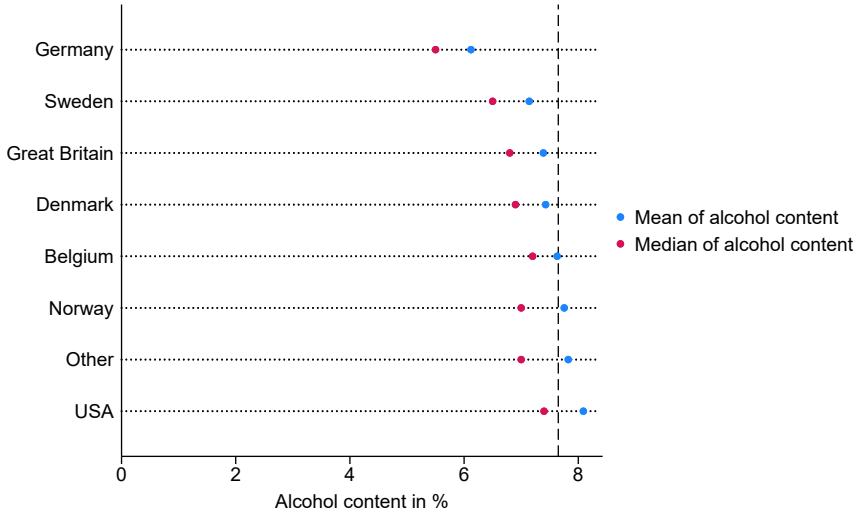

Figure 3: Beer alcohol content by production country. The dashed line is the mean alcohol content in % for the total sample.

website. Equation (2) represents our overarching empirical model for assessing beer prices based on its attributes.

$$\ln Price_i = \alpha + \beta_1 Rating_i + \beta_2 Alcohol_i + \sum_j \beta_j dC_i + \sum_k \beta_k dB_i + e_i \quad (2)$$

where $\ln Price_i$ is the log of the price per bottle of beer i, $Rating_i$ is the expert rating variable for beer i, $Alcohol$ is the alcohol content variable, dC_i are dummy variables for production country, dB_i are dummy variables for beer styles, and e_i is a random error. β are parameters to be estimated.

4.2 Econometric Results

Table 3 presents the main findings of the hedonic price model for the total sample. We note for Model *i* that alcohol content has a positive and significant effect on price: A one-percentage point increase in alcohol content is associated with a 10.41 % increase in beer price ($e^{0.099}$–1 = 0.1041).[11] There are also notable mean differences in price between the production countries. The beers from USA are most expensive, *ceteris paribus*, whereas those from Germany are least expensive – in line with the results of Figures 2 and 3. Compared with the reference, i.e. a domestic or Norwegian beer, one must pay 30.21 % more on average for a US beer ($e^{0.264}$–1 = 0.3021) or 14.62 % less for a German beer ($e^{-0.158}$–1 = –0.1462). The general trend is that foreign beers are more expensive than Norwegian beers. Model *i* accounts for about 50 % of the variation in beer prices.

Model *ii* in Table 3 adds 24 different styles of beer (e.g. Lager, Brown ale, Wheat beer) to Model *i* in terms of a fixed effects regression model.[12] The R^2 increases for this model, as expected. Yet we note only a small reduction in size for the coefficient of alcohol content. Also, German beers are not cheaper than Norwegian ones when beer style is considered in the regression model. That is, Norwegian and German beers are the two least expensive beers in the total sample, *ceteris paribus*.

Based on Model *ii* in Table 3, Table 4 contrasts the overall mean beer price for the total sample with the mean beer prices for the various production countries. Because all the coefficients are smaller than 0.15, they have a rough interpretation as relative differences. For example, the beers from Norway and Germany cost 11 % less than the average beer in the total sample, whereas the beers from USA cost 13 % more than the average beer. The beers from Denmark appear to be closest to the average price of beer in this respect.

Model *i* in Table 5 presents the main findings of the hedonic price model for the rating sample. The quality rating variable has a weak but positive and significant effect on the price of beer.[13] A 10-point difference in rating amounts to a 7 % difference in price (0.007 × 10 = 0.07). The alcohol content

Table 3: Log of price per bottle by independent variables. OLS regressions. Full sample.

Independent variables	Model *i*	Model *ii*
Alcohol content in %	0.099 (0.002)***	0.087 (0.002)***
Production country:[a]		
Belgium	0.114 (0.013)***	0.156 (0.014)***
Denmark	0.067 (0.012)***	0.095 (0.013)***
Great Britain	0.177 (0.009)***	0.166 (0.008)***
Sweden	0.146 (0.130)***	0.128 (0.001)***
Germany	–0.158 (0.179)***	0.000 (0.017)
USA	0.264 (0.014)***	0.240 (0.012)***
Other	0.037 (0.008)***	0.066 (0.007)***
Fixed effects for beer style	No	Yes
Constant	3.168	3.303
R^2	0.505	0.635
N	9251	9251

Robust standard errors are in parentheses. The models control for type of availability through Vinmonopolet (five dummies) and if the beer presently is available (one dummy). [a]Norway = reference country. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$ (two-tailed tests).

Table 4: Production country differences in mean beer price. Total sample.

Contrast	Relative price difference
Norway versus sample mean	–0.106 (0.005)***
Germany versus sample mean	–0.106 (0.015)***
Other versus sample mean	–0.041 (0.006)***
Denmark versus sample mean	–0.011 (0.011)
Sweden versus sample mean	0.022 (0.010)***
Belgium versus sample mean	0.050 (0.012)***
Great Britain versus sample mean	0.059 (0.007)***
USA versus sample mean	0.133 (0.010)***

The entries are based on Model *ii* in Table 3. Standard errors are in parentheses. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$ (two-tailed tests).

11 When coefficients are smaller than 0.15, there is little need to apply the formula to get approximate percentage differences.

12 These fixed effects should in the main also pick up any effects of local micro-breweries producing high-priced beers.

13 If the alcohol content variable is discarded from the regression model, the quality rating coefficient becomes twice as large: 0.014. The Pearson correlation between the alcohol content variable and the rating variable is 0.248. That is, a higher alcohol content seems to imply a better taste.

Table 5: Log of price per bottle by independent variables. OLS regressions. Rating sample.

Independent variables	Model *i*	Model *ii*
Quality rating	0.007 (0.001)***	0.007 (0.001)***
Alcohol content in %	0.090 (0.002)***	0.080 (0.003)***
Production country:[a]		
Belgium	0.100 (0.017)***	0.125 (0.023)***
Denmark	0.059 (0.020)**	0.102 (0.021)***
Great Britain	0.083 (0.018)***	0.097 (0.015)***
Sweden	0.113 (0.026)***	0.097 (0.019)***
Germany	−0.233 (0.028)***	−0.078 (0.029)**
USA	0.167 (0.018)***	0.172 (0.019)***
Other	0.024 (0.013)	0.033 (0.012)**
Fixed effects for beer style	No	Yes
Constant	2.627	2.811
R^2	0.557	0.649
N	3766	3766

Robust standard errors are in parentheses. The models control for type of availability through Vinmonopolet (five dummies) and if the beer presently is available (one dummy). [a]Norway = reference country. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$ (two-tailed tests).

coefficient is of about the same size as it was for the total sample, i.e. a one percentage point increase in alcohol content is associated with a 9.0 % increase in beer price. Price differences between production countries follow the pattern described for the total sample. German and Norwegian beers are least expensive, whereas US and Swedish beers are most expensive, *ceteris paribus*.

Not much happens when the regression model adjusts for the different styles of beer in Model *ii*. For the rating sample, however, we note that German beers are less expensive than Norwegian beers even when controlled for beer style. Based on Model *ii* in Table 5, Table 6 compares the overall mean beer price in the rating sample with the beer prices for the various production countries. Again, US beers come out on top with respect to price, whereas German and Norwegian beers are the least expensive beers.

Table 6: Production country differences in mean beer price. Rating sample.

Contrast	Relative price difference
Germany versus sample mean	−0.147 (0.026)***
Norway versus sample mean	−0.069 (0.009)***
Other versus sample mean	−0.035 (0.010)***
Great Britain versus sample mean	0.028 (0.014)*
Sweden versus sample mean	0.029 (0.017)
Denmark versus sample mean	0.033 (0.012)
Belgium versus sample mean	0.056 (0.020)**
USA versus sample mean	0.103 (0.016)***

The entries are based on model *ii* in Table 5. Standard errors are in parentheses. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$ (two-tailed tests).

We also extended Model *ii* in Table 5 allowing for interaction effects between the production country dummies and alcohol content and between the production country dummies and quality rating.[14] Figure 4 shows the effects of the alcohol content variable based on this interaction regression model, and we note the varying slopes for the regression lines. Compared with Norwegian beers (alcohol coefficient = 0.090; $p < 0.001$), the association between alcohol content and price is significantly weaker for beers from Belgium (−0.046), Denmark (−0.022), Great Britain (−0.022), Sweden (0.026), and Other (−0.013).[15] The alcohol coefficient for US beers is on a par with Norwegian beers. In contrast, the association between alcohol content and price is significantly stronger (0.039) among German beers compared with Norwegians, as Figure 4 clearly shows.

Figure 5 shows similar interaction effects for the quality rating variable. Compared with Norwegian beers (quality rating coefficient = 0.003; $p < 0.05$), the association between quality rating and price is significantly stronger for beers from Sweden (0.012), USA (0.015), and Other (0.013)[16] (The regression lines for Norwegian and German beers are almost identical). In contrast, none of the remaining production countries deviate significantly from the Norwegian quality rating coefficient. This also suggests that a higher price means better quality, especially for US and Swedish beers. On the flip side, the least expensive beers from the USA or Sweden have poor quality (as measured by the Parker scale), and one needs to buy the most expensive beers to secure good quality. The association between quality and price for Norwegian and German beers is weak at best, and one may thus get good value for money even for relatively cheaper beers.

5 Summary and Conclusions

Although the hedonic price model has gained much popularity for examining the implicit prices of wines and other experience products, using the hedonic price framework to examine beer prices remains a limited field of research. Therefore, the aim of the present study has been to contribute to this gap in the literature. In this regard, we used two large samples of beers (N = 9251 and N = 3766) to

14 There was no significant interaction effect between alcohol content and quality rating.

15 The numbers in parentheses stem from the unreported interaction regression model yielding Figure 4; results are available on request.

16 The numbers in parentheses stem from the unreported interaction regression model yielding Figure 5; results are available on request.

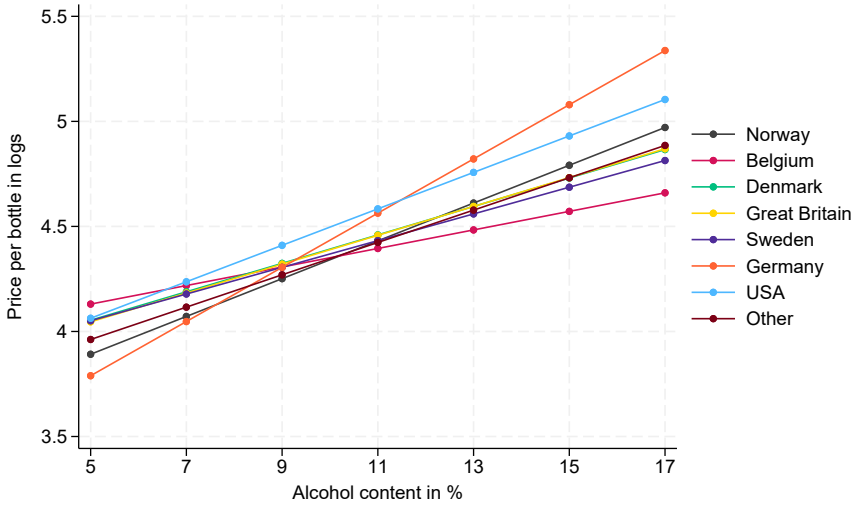

Figure 4: Price per bottle in logs by alcohol content.

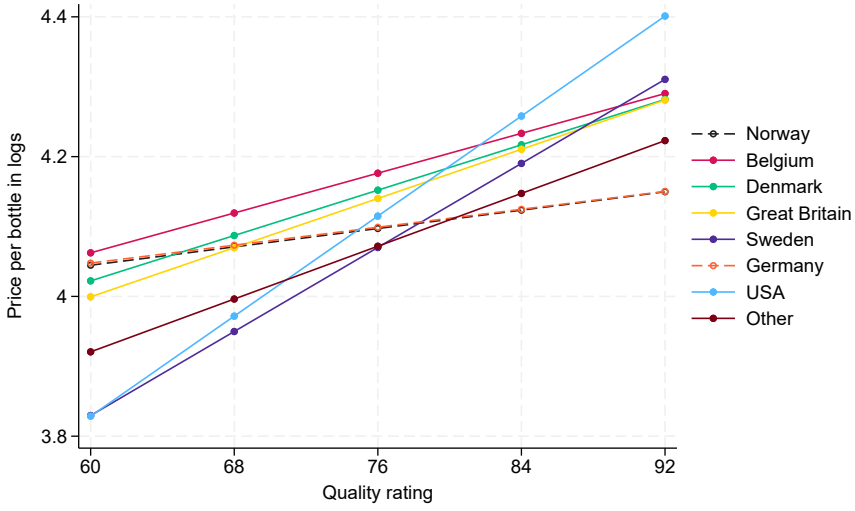

Figure 5: Price per bottle in logs by quality rating.

examine how alcohol content, expert quality ratings, and production country affected retail beer prices.

We present four main findings: (1) Alcohol content has a strong effect on beer price throughout the analyses. The higher the alcohol content of a beer, the more expensive it tends to be. (2) There are substantial differences in beer price with respect to production country. (3) Expert quality ratings have only a small to moderate effect on beer prices. (4) The effects of alcohol content and quality rating on price are to some extent dependent on production country. That is, we find interaction effects.

More research is obviously needed on the determinants of beer prices. Our study, for data limitation reasons only, considered rather few beer attributes. Future research should thus focus on getting more attributes into the hedonic pricing model. A second goal for future research might be to employ quantile regression, which by now has become a part of the standard toolkit of regression modeling. A third possible avenue of research concerns under- and over-pricing using the two-tier stochastic frontier (2TSF) model framework proposed by Polachek and Yoon (1987).

The main implication of our study is that beer prices are influenced by multiple factors, such as alcohol content, country of production, beer style, and quality rating. These findings provide a comprehensive understanding of the dynamics in the beer market and may be used by businesses

and policymakers to inform the development of effective pricing strategies. That said, it is important to note that the results of hedonic price models do not necessarily tell us much about the actual preferences of consumers of alcoholic beverages (Thrane 2004). As such, future beer pricing strategies should also rely on consumer surveys or experiments.

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