**Online Text**

IV. Results

B. ANN Regression Models for Silvaner, Pinot Blanc, and Pinot Noir continued

Table 8 shows the semi-elasticities per quality category of both, important and influential variables for Silvaner prices.[[1]](#footnote-1)

*Table 8**Average semi-elasticity of influential variables for Silvaner per quality category*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **average semi-elasticity** | **semi-elasticity QbA2** | **semi-elasticity Kabinett** | **semi-elasticity Spätlese** | **semi-elasticity Auslese** | **semi-elasticity Batbaice3** |
| Gault&Millau points | 0.0506 | 0.0763 | 0.0475 | 0.0199 | 0.0451 | -0.0037 |
| Alcohol | 0.0369 | 0.0391 | 0.0395 | 0.0537 | -0.0298 | -0.0230 |
| Precipitation Winter Season (sum)1 | 0.0308 | 0.0395 | 0.0355 | 0.0237 | 0.0253 | -0.0251 |
| Air Temperature Winter Season (avg.)1 | -0.0531 | -0.0573 | -0.0459 | -0.0622 | -0.0436 | -0.0149 |
| *Humidity Winter Season (avg.) 1* | *-0.0377* | *-0.0364* | *-0.0376* | *-0.0458* | *-0.0256* | *-0.0206* |
| *Humidity Growing Season (avg.) 1* | *-0.0109* | *-0.0155* | *-0.0187* | *-0.0017* | *-0.0096* | *0.0170* |
| *Humidity Harvest Season (avg.) 1* | *-0.0015* | *-0.0094* | *0.0103* | *-0.0029* | *0.0151* | *0.0082* |
| 1 Winter Season: 01.12.-28.02; Growing Season: 01.03.-15.09.; Harvest Season: 16.09.-31.10.2 Qualitätswein3 Batbaice: Beerenauslese/Trockenbeerenauslese/Eiswein |

Authors’ own calculations

Regarding Gault&Millau points, the influence on prices of the quality categories QbA. Kabinett. Spätlese and Auslese is positive, while it is slightly negative on the category Batbaice. An increase of the alcohol level has a strong positive influence on the lower quality categories QbA. Kabinett and Spätlese and a slightly negative one on the highest quality categories Auslese and Batbaice.

Rising average temperatures in the winter season have in general a negative influence on the prices of Silvaner. Precipitation in the winter season has a positive influence on all quality categories except for Batbaice. The following scatter plots (figures 5 and 6) show the semi-elasticities per quality category of the two most important and influential independent variables for Silvaner: Gault&Millau points and Alcohol.

*Figure 5
Average semi-elasticity of Gault&Millau points for each quality category for Silvaner*



Authors’ own calculations

*Figure 6
Average semi-elasticity of Alcohol for each quality category for Silvaner*



Authors’ own calculations

The prices of higher priced Silvaner in the quality categories QbA and Kabinett increase more than lower priced ones with an additional point Gault&Millau whereas there is hardly a difference between lower and higher priced Spätlese and Auslese or Batbaice.

Especially higher priced Kabinett and Spätlese benefit from rising alcohol levels, while the impact remains negative on most of the Auslese prices and on Batbaice.

Table 9 shows the elasticities per quality category of both. important (significant) and influential independent variables for Pinot Blanc[[2]](#footnote-2). with the strongest influence again of Gault&Millau points.

*Table 9**Average semi-elasticity of influential variables for Pinot Blanc per quality category*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **average semi-elasticity** | **semi-elasticity QbA2** | **semi-elasticity Kabinett** | **semi-elasticity Spätlese** | **semi-elasticity Auslese** | **semi-elasticity Batbaice3** |
| Gault&Millau points | 0.0533 | 0.0701 | 0.0224 | 0.0421 | -0.0024 | 0.0755 |
| Alcohol | 0.0125 | 0.0157 | -0.0041 | 0.0191 | -0.0702 | 0.0457 |
| Trend | 0.0184 | 0.0179 | 0.0187 | 0.0197 | 0.0120 | 0.0132 |
| Precipitation Winter Season (sum)1 | -0.0166 | -0.0189 | -0.0057 | -0.0203 | 0.0065 | 0.0165 |
| Precipitation Growing Season (sum)1 | 0.0102 | 0.0190 | 0.0107 | -0.0024 | -0.0286 | 0.0254 |
| Air Temperature Growing Season (avg.)1 | -0.0273 | -0.0275 | -0.0143 | -0.0346 | -0.0170 | 0.0008 |
| Minimum Air Temperature Growing Season (avg.) 1 | 0.0361 | 0.0348 | 0.0189 | 0.0503 | 0.0111 | -0.0343 |
| Minimum Air Temperature Harvest Season (avg.) 1 | -0.0148 | -0.0012 | -0.0152 | -0.0369 | -0.0109 | -0.0301 |
| *Humidity Winter Season (avg.) 1* | *0.0006* | *0.0095* | *0.0108* | *-0.0180* | *-0.0143* | *0.0075* |
| *Humidity Growing Season (avg.) 1* | *-0.0024* | *-0.0123* | *0.0004* | *0.0112* | *0.0244* | *-0.0127* |
| *Humidity Harvest Season (avg.) 1* | *-0.0223* | *-0.0272* | *-0.0111* | *-0.0208* | *0.0017* | *-0.0219* |
| 1 Winter Season: 01.12.-28.02; Growing Season: 01.03.-15.09.; Harvest Season: 16.09.-31.10.2 Qualitätswein3 Batbaice: Beerenauslese/Trockenbeerenauslese/Eiswein |

Authors’ own calculations

Additional Gault&Millau points lead to the highest price increase for wines of the quality category QbA and even to a price decrease for wines of the quality category Auslese.

The alcohol level only has a low average influence on prices of Pinot Blanc, with the highest positive one on Batbaice and the lowest negative on Auslese wines.

While the impact of rising minimum temperatures does not harm Pinot Blanc prices, the effect of rising average temperatures during the growing and minim temperatures during the harvest season have a negative influence on prices of all quality categories. The results again suggest an earlier harvest.

The following scatter plots (figure 7 and 8) show the semi- per quality category of the two most important and influential independent variables for Pinot Blanc, “Gault&Millau points” and “Minimum air temperature growing season”.

*Figure 7
Average semi-elasticity of Gault&Millau points for each quality category for Pinot Blanc*



Authors’ own calculations

*Figure 8
Average semi-elasticity of “minimum air temperature growing season” for each quality category for Pinot Blanc*



Authors’ own calculations

Here especially higher priced QbA wines benefit from an increase in Gault&Millau points and higher priced QbA, Kabinett and Spätlese wines from an increase of minimum temperatures during the growing season. Table 10 shows the semi-elasticities per quality category of both, important and influential independent variables for Pinot Noir.[[3]](#footnote-3) Weather variables have a high influence on prices of Pinot Noir. but “Gault&Millau points” is still the most important variable (see dependency factor in table 7).

*Table 10**Average semi-elasticity of influential variables for Pinot Noir per quality category*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **average semi-elasticity** | **semi-elasticity QbA2** | **semi-elasticity Kabinett** | **semi-elasticity Spätlese** | **semi-elasticity Auslese** | **semi-elasticity Batbaice3** |
| Gault&Millau points | 0.0519 | 0.0584 | 0.0089 | 0.0418 | 0.0086 | 0.0708 |
| Alcohol | 0.0225 | 0.0276 | -0.0064 | 0.0072 | 0.0101 | -0.0026 |
| Trend | -0.0022 | 0.0006 | 0.0064 | -0.0175 | -0.0017 | -0.0127 |
| Precipitation Growing Season (sum)1 | -0.0003 | -0.0024 | 0.0009 | 0.0022 | 0.0171 | 0.0072 |
| Precipitation Harvest Season (sum)1 | 0.0190 | 0.0197 | 0.0122 | 0.0207 | 0.0090 | 0.0215 |
| Sunshine Hours Winter Season (sum)1 | 0.0176 | 0.0177 | 0.0143 | 0.0205 | 0.0155 | -0.0054 |
| Air Temperature Winter Season (avg.)1 | 0.0182 | 0.0195 | 0.0140 | 0.0124 | 0.0207 | -0.0026 |
| Minimum Air Temperature Harvest Season (avg.) 1 | -0.0222 | -0.0246 | -0.0003 | -0.0197 | -0.0084 | -0.0133 |
| Maximum Air Temperature Winter Season (avg.) 1 | -0.0489 | -0.0505 | -0.0262 | -0.0403 | -0.0556 | -0.0482 |
| *Humidity Winter Season (avg.) 1* | *0.0066* | *0.0065* | *0.0028* | *0.0125* | *-0.0042* | *0.0081* |
| *Humidity Growing Season (avg.) 1* | *-0.0027* | *-0.0015* | *0.0026* | *-0.0064* | *-0.0103* | *-0.0040* |
| *Humidity Harvest Season (avg.) 1* | *0.0066* | *0.0083* | *-0.0105* | *0.0067* | *-0.0095* | *0.0136* |
| Frost4 | 0.0137 | 0.0132 | 0.0085 | 0.0167 | 0.0112 | 0.0287 |
| 1 Winter Season: 01.12.-28.02; Growing Season: 01.03.-15.09.; Harvest Season: 16.09.-31.10.2 Qualitätswein3 Batbaice: Beerenauslese/Trockenbeerenauslese/Eiswein4 Frost: sum of days of frost, with soil temperatures < 0 during winter, growing and harvest season |

Authors’ own calculations

The influence of Gault&Millau points on prices of Pinot Noir is strongly positive. especially for the quality categories Batbaice, QbA and Spätlese.

The alcohol level has a positive influence especially on prices of QbA, while the influence is even negative on Kabinett and the highest quality category Batbaice like for Riesling and Silvaner. Pinot Noir can’t cope with weather extremes. Especially rising maximum air temperatures in the winter season or rising minimum temperatures in the harvest season have a negative price impact in all quality categories. Again an earlier harvest is recommended like for all other grape varieties.

The following scatter plots (figure 7) show the semi-elasticity per quality category of the two most important and influential independent variables for Pinot Noir: Gault&Millau points and minimum air temperature harvest season.

*Figure 9
Average semi-elasticity of Gault&Millau points for each quality category for Pinot Noir*



Authors’ own calculations

*Figure 10
Average semi-elasticity of “minimum air temperature harvest season” for each quality category for Pinot Noir*



Authors’ own calculations

Here especially the prices of higher priced QbA, Kabinett, Spätlese and Auslese wines increase with additional Gault&Millau points, while rising minimum air temperatures during the harvest season have a negative effect on all quality categories, here especially on the higher priced wines within each category.

Online Appendix

*Table A5*

*Descriptive Statistics for “Silvaner”*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Obs. | Mean | Std. Dev. | Min | Max |
| Price 0,75l | 917 | 13.32 | 16.16 | 2.33 | 127.5 |
| Gault&Millau points | 917 | 85.36 | 2.84 | 77 | 96 |
| Age | 917 | 2.03 | 0.20 | 2 | 4 |
| Trend | 917 | 10.36 | 3.89 | 3 | 16 |
| Alcohol | 917 | 12.25 | 1.53 | 5.5 | 15 |
| Precipitation Winter Season (sum)3 | 917 | 76.33 | 46.60 | 17.4 | 333.1 |
| Precipitation Growing Season (sum)3 | 917 | 250.87 | 83.20 | 116.1 | 584 |
| Precipitation Harvest Season (sum)3 | 917 | 147.91 | 55.45 | 40.6 | 500.9 |
| Sunshine Hours Winter Season (sum)3 | 917 | 334.40 | 86.43 | 152.8 | 508 |
| Air Temperature Winter Season (avg.)3 | 917 | 8.00 | 1.40 | 3.91 | 10.71 |
| Air Temperature Growing Season (avg.)3 | 917 | 17.61 | 0.83 | 15.25 | 20.77 |
| Minimum Air Temperature Growing Season (avg.)3 | 917 | 12.16 | 0.64 | 10.62 | 15.07 |
| Minimum Air Temperature Harvest Season (avg.)3 | 917 | 6.17 | 0.90 | 4.45 | 9.19 |
| Maximum Air Temperature Winter Season (avg.)3 | 917 | 13.09 | 1.94 | 7.92 | 17.41 |
| Humidity Winter Season (avg.)3 | 917 | 7.47 | 0.51 | 6.32 | 8.65 |
| Humidity Growing Season (avg.)3 | 917 | 13.66 | 0.45 | 12.01 | 15.80 |
| Humidity Harvest Season (avg.)3 | 917 | 10.33 | 0.73 | 8.78 | 12.51 |
| Frost4 | 917 | 41.85 | 9.33 | 16 | 61 |
|  |  |  |  |  |  |
| QbA1 | 917 | 0.44 | 0.50 | 0 | 1 |
| Kabinett | 917 | 0.23 | 0.42 | 0 | 1 |
| Spätlese | 917 | 0.24 | 0.43 | 0 | 1 |
| Auslese | 917 | 0.036 | 0.19 | 0 | 1 |
| Batbaice2 | 917 | 0.054 | 0.227 | 0 | 1 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Ahr | 917 | 0 | 0 | 0 | 0 |
| Baden | 917 | 0.04 | 0.20 | 0 | 1 |
| Franken | 917 | 0.67 | 0.47 | 0 | 1 |
| Hessische Bergstr. | 917 | 0 | 0 | 0 | 0 |
| Mittelrhein | 917 | 0 | 0 | 0 | 0 |
| Mosel | 917 | 0 | 0 | 0 | 0 |
| Nahe | 917 | 0.03 | 0.2917 | 0 | 1 |
| Pfalz | 917 | 0.04 | 0.20 | 0 | 1 |
| Rheingau | 917 | 0.001 | 0.033 | 0 | 1 |
| Rheinhessen | 917 | 0.189 | 0.39 | 0 | 1 |
| Saale-Unstrut | 917 | 0.02 | 0.14 | 0 | 1 |
| Sachsen | 917 | 0 | 0 | 0 | 0 |
| Württemberg | 917 | 0.01 | 0.081 | 0 | 1 |
| 1 QbA: Qualitätswein2 Batbaice: Beerenauslese/Trockenbeerenauslese/Eiswein3 Winter Season: 01.12.-28.02; Growing Season: 01.03.-15.09.; Harvest Season: 16.09.-31.10.4 Frost: sum of days of frost, with soil temperatures < 0 during winter, growing and harvest season |

Source: Authors’ own calculations

*Table A6*

*Descriptive Statistics for “Pinot Blanc”*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Obs. | Mean | Std. Dev. | Min | Max |
| Price 0,75l | 1,294 | 11.22 | 8.16 | 2.63 | 130 |
| Gault&Millau points | 1,294 | 85.42 | 2.85 | 73 | 94 |
| Age | 1,294 | 2.06 | 0.26 | 2 | 4 |
| Trend | 1,294 | 10.4 | 3.97 | 3 | 16 |
| Alcohol | 1,294 | 12.95 | 0.93 | 6 | 15.5 |
| Precipitation Winter Season (sum)3 | 1,294 | 97.82 | 60.69 | 17.4 | 333.1 |
| Precipitation Growing Season (sum)3 | 1,294 | 319.19 | 122.22 | 116.1 | 584 |
| Precipitation Harvest Season (sum)3 | 1,294 | 188.17 | 95.95 | 40.2 | 500.9 |
| Sunshine Hours Winter Season (sum)3 | 1,294 | 329.60 | 89.58 | 161.8 | 508 |
| Air Temperature Winter Season (avg.)3 | 1,294 | 7.65 | 1.50 | 3.91 | 11.00 |
| Air Temperature Growing Season (avg.)3 | 1,294 | 17.03 | 0.99 | 15.25 | 21.14 |
| Minimum Air Temperature Growing Season (avg.)3 | 1,294 | 11.94 | 0.68 | 10.62 | 14.35 |
| Minimum Air Temperature Harvest Season (avg.)3 | 1,294 | 6.33 | 1.01 | 4.45 | 9.58 |
| Maximum Air Temperature Winter Season (avg.)3 | 1,294 | 12.62 | 2.10 | 7.92 | 17.61 |
| Humidity Winter Season (avg.)3 | 1,294 | 7.41 | 0.52 | 6.32 | 8.99 |
| Humidity Growing Season (avg.)3 | 1,294 | 13.43 | 0.65 | 12.01 | 15.80 |
| Humidity Harvest Season (avg.)3 | 1,294 | 10.28 | 0.81 | 8.78 | 13.69 |
| Frost4 | 1,294 | 40.35 | 9.47 | 14 | 61 |
|  |  |  |  |  |  |
| QbA1 | 1,294 | 0.52 | 0.50 | 0 | 1 |
| Kabinett | 1,294 | 0.14 | 0.35 | 0 | 1 |
| Spätlese | 1,294 | 0.31 | 0.46 | 0 | 1 |
| Auslese | 1,294 | 0.02 | 0.15 | 0 | 1 |
| Batbaice2 | 1,294 | 0.01 | 0.11 | 0 | 1 |
|  |  |  |  |  |  |
| Ahr | 1,294 | 0.003 | 0.055 | 0 | 0 |
| Baden | 1,294 | 0.319 | 0.466 | 0 | 1 |
| Franken | 1,294 | 0.103 | 0.304 | 0 | 1 |
| Hessische Bergstr. | 1,294 | 0.007 | 0.083 | 0 | 0 |
| Mittelrhein | 1,294 | 0.006 | 0.078 | 0 | 0 |
| Mosel | 1,294 | 0.041 | 0.198 | 0 | 0 |
| Nahe | 1,294 | 0.092 | 0.290 | 0 | 1 |
| Pfalz | 1,294 | 0.217 | 0.412 | 0 | 1 |
| Rheingau | 1,294 | 0.015 | 0.120 | 0 | 1 |
| Rheinhessen | 1,294 | 0.145 | 0.352 | 0 | 1 |
| Saale-Unstrut | 1,294 | 0.026 | 0.158 | 0 | 1 |
| Sachsen | 1,294 | 0.020 | 0.140 | 0 | 0 |
| Württemberg | 1,294 | 0.006 | 0.078 | 0 | 1 |

|  |
| --- |
| 1 QbA: Qualitätswein2 Batbaice: Beerenauslese/Trockenbeerenauslese/Eiswein3 Winter Season: 01.12.-28.02; Growing Season: 01.03.-15.09.; Harvest Season: 16.09.-31.10.4 Frost: sum of days of frost, with soil temperatures < 0 during winter, growing and harvest season |

Source: Authors’ own calculations

*Table A7*

*Descriptive Statistics for “Pinot Noir”*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Obs. | Mean | Std. Dev. | Min | Max |
| Price 0,75l | 2,004 | 18.00 | 13.27 | 3.83 | 130 |
| Gault&Millau points | 2,004 | 86.20 | 2.79 | 74 | 94 |
| Age | 2,004 | 3.02 | 0.75 | 2 | 11 |
| Trend | 2,004 | 10.36 | 3.94 | 3 | 16 |
| Alcohol | 2,004 | 13.37 | 0.86 | 5.5 | 16.5 |
| Precipitation Winter Season (sum)3 | 2,004 | 104.71 | 63.95 | 17.4 | 333.1 |
| Precipitation Growing Season (sum)3 | 2,004 | 323.27 | 128.66 | 70.4 | 584 |
| Precipitation Harvest Season (sum)3 | 2,004 | 177.27 | 86.85 | 40.2 | 500.9 |
| Sunshine Hours Winter Season (sum)3 | 2,004 | 328.94 | 90.93 | 65.3 | 508 |
| Air Temperature Winter Season (avg.)3 | 2,004 | 8.14 | 1.34 | 3.91 | 11.00 |
| Air Temperature Growing Season (avg.)3 | 2,004 | 17.24 | 0.99 | 15.25 | 21.14 |
| Minimum Air Temperature Growing Season (avg.)3 | 2,004 | 12.05 | 0.84 | 10.62 | 15.07 |
| Minimum Air Temperature Harvest Season (avg.)3 | 2,004 | 6.36 | 1.09 | 4.45 | 9.74 |
| Maximum Air Temperature Winter Season (avg.)3 | 2,004 | 13.24 | 1.91 | 7.92 | 17.61 |
| Humidity Winter Season (avg.)3 | 2,004 | 7.59 | 0.51 | 6.32 | 8.99 |
| Humidity Growing Season (avg.)3 | 2,004 | 13.57 | 0.64 | 11.92 | 15.49 |
| Humidity Harvest Season (avg.)3 | 2,004 | 10.31 | 0.79 | 8.78 | 13.69 |
| Frost4 | 2,004 | 39.58 | 9.77 | 14 | 61 |
|  |  |  |  |  |  |
| QbA1 | 2,004 | 0.76 | 0.43 | 0 | 1 |
| Kabinett | 2,004 | 0.019 | 0.136 | 0 | 1 |
| Spätlese | 2,004 | 0.144 | 0.351 | 0 | 1 |
| Auslese | 2,004 | 0.066 | 0.249 | 0 | 1 |
| Batbaice2 | 2,004 | 0.011 | 0.106 | 0 | 1 |
|  |  |  |  |  |  |
| Ahr | 2,004 | 0.142 | 0.349 | 0 | 0 |
| Baden | 2,004 | 0.354 | 0.478 | 0 | 1 |
| Franken | 2,004 | 0.064 | 0.245 | 0 | 1 |
| Hessische Bergstr. | 2,004 | 0.003 | 0.055 | 0 | 0 |
| Mittelrhein | 2,004 | 0.010 | 0.102 | 0 | 0 |
| Mosel | 2,004 | 0.031 | 0.172 | 0 | 0 |
| Nahe | 2,004 | 0.034 | 0.182 | 0 | 1 |
| Pfalz | 2,004 | 0.095 | 0.293 | 0 | 1 |
| Rheingau | 2,004 | 0.133 | 0.339 | 0 | 1 |
| Rheinhessen | 2,004 | 0.071 | 0.257 | 0 | 1 |
| Saale-Unstrut | 2,004 | 0.005 | 0.070 | 0 | 1 |
| Sachsen | 2,004 | 0.012 | 0.106 | 0 | 0 |
| Württemberg | 2,004 | 0.046 | 0.210 | 0 | 1 |

|  |
| --- |
| 1 QbA: Qualitätswein2 Batbaice: Beerenauslese/Trockenbeerenauslese/Eiswein3 Winter Season: 01.12.-28.02; Growing Season: 01.03.-15.09.; Harvest Season: 16.09.-31.10.4 Frost: sum of days of frost, with soil temperatures < 0 during winter, growing and harvest season |

Source: Authors’ own calculations

1. Here we choose variables with a dependency factor > 0.14 or an elasticity > 0.03. [↑](#footnote-ref-1)
2. Here we choose variables with a dependency factor > 0.4 or an elasticity > 0.01. [↑](#footnote-ref-2)
3. Here variables with a dependency factor > 0.4 and an elasticity > 0.013 were chosen. [↑](#footnote-ref-3)