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Wine production in Denmark

Do the characteristics of the vineyards affect the chances for awards?

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Abstract: By the end of the former century there were less than 10 commercial vintners producing wine in Denmark. There was widespread acceptance of the view that commercial production of wine in the most northern parts of Europe was impossible. However, the number of commercial wine growers in Denmark grew to more than 60 at the end of 2009 and the Association of Danish Winegrowers now counts more than 1400 members. Denmark can no longer be seen as a non-wine producing country! Formally, the transformation of Denmark to a wine producing country took place in year 2000 when Denmark was accepted as a commercial wine producing nation within the European Union. Based on a remarkably detailed micro data set this paper first gives a description of wine production in Denmark and thereafter we address the question whether vineyard characteristics are important for the quality of the wine and/or whether individual characteristics of the wine grower are important. Using a hedonic model the focus is especially on the importance of general factors like the type of soil, slope, geography, grape variety etc. in relation to the awards obtained by the respective vineyards.

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1. Introduction

According to the international alcohol statistics Denmark belongs to the group of countries that have a relatively high consumption level of wine. In 2007 the total consumption of wine in Denmark amounted to 168 million litres which corresponds to nearly 33 litres per capita. Thus, next to wine producing countries like e.g. Italy, France and Greece, Denmark belongs to the very top of wine consuming countries.

However, according to history Denmark has not been a wine producing country. Of course besides tradition the main reason is sub-optimal climate conditions. No one – maybe except for ambitious Danish winemakers - recognize Denmark as a potential wine country. Still, at all times there were in fact private persons who produced wine in small quantities for their own consumption and some wines were of relatively good quality. Moreover, during the latest decade more and more people have established small wine fields and bought facilities to produce wine in a more professional way. Climate changes, i.e. better weather in August and September combined with milder winters and less risk of frosty periods in the spring has caused an increasing interest for wine production in Denmark. Furthermore, the development of grape varieties which are more suitable for production of wine in cool climate areas also boosted the interest for a more widespread wine production. Due to pressure from the Danish Government the August 2000 revision of the EU Wine Regulation made it legal also to produce wine on a commercial basis in Denmark (the same was decided for Sweden and Ireland). Thus, Danish commercial wine growers got acceptance to produce 'vin de table' without geographical origin on the label. At the same time Danish regulative rules were implemented. Consequently a new wine producing country was born. However the Danish producers didn't get access to the EU subsidy system like the old wine producing countries.

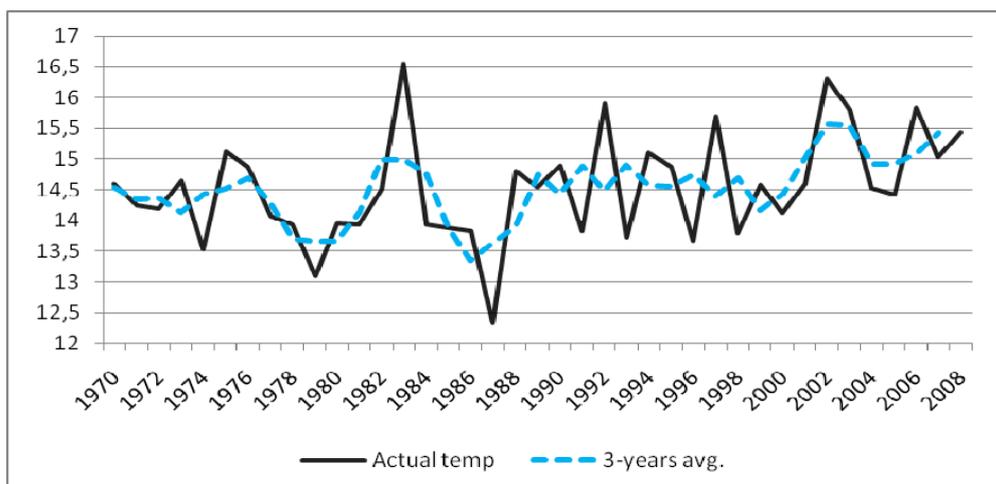
Since 2000 the Danish wine industry has increased rapidly and by now the Association of Danish Wine Producers has more than 1400 members. Furthermore, due to the rapid development of production Denmark asked for permission to produce 'vin de table' with a geographical indication on the label, which means that year of harvest and grape variety could be announced on the label. The EU commission accepted this request in 2007 and hereafter Danish wines can carry the label 'regional wine' from Jutland (the mainland), Funen (an island), Zealand (an island) or Bornholm (a small island in the Baltic Sea).

The aim of this article is twofold. Firstly, we give an introduction to Danish wine production. Thus, in the following section we illuminate production landscape and the legal framework for wine production as seen from the input side. Secondly, we look at the output and discuss which factors are of importance for obtaining high quality in a newborn wine country. Thus, attention is put on wine growers characteristics and factors like terroir, grape varieties, field and row orientation, steepness of the vineyard, soil and harvest conditions etc. Using a hedonic model set up the chances for awards at the yearly Danish Wine Contest is tested against the natural hypothesis that in a newborn industry unobserved characteristics may be dominant for the performance of the producers.

2. Wine production in Denmark

The most important factor for producing wine in the northern regions of the EU is the climate conditions. Thus, a sufficiently long season from opening to harvest is critical and at the same time a long warm period up to harvest is crucial. Normally opening takes place in the first part of June and harvest is in the middle of October. Figure 1 gives the overall temperature for the weather in Denmark in June-September since 1970. It is easily seen that the growing conditions vary significantly from year to year, obviously with good conditions in e.g. 2002 and 2006. On the other hand 1987 illustrates that in some years wine production seems hardly possible at all.

Figure 1. Average temperature June-September, Denmark 1970-2008.



Source: Statistics Denmark

Of course, sunshine hours from June to September are highly important. Again significant variation to the rule appears, e.g. in 2005 the average monthly number of

sunshine hours was 199 but in 2006 it increased to 230. June-September in 2007 was not only cold but gave only 181 sunshine hours and again it rose to 217 in 2008. Thus it is clearly seen that Denmark is a cool climate area with huge variation in growing conditions. Traditional grape varieties cannot mature. As an example Spätburgunder, which does well as northern as Sachsen in Germany can hardly mature in Denmark. Therefore special varieties are used, see below. As a consequence, the micro climate and location of the wine fields is very important in Denmark, see below.

2.1 Regulation

In line with other wine producing countries there are strict regulation for commercial wine production in Denmark, see The Danish Agricultural Ministry (2008).

Commercial wine producers are only allowed to use grape varieties which have been accepted, see Box 1. And furthermore only a few basic-wines are accepted for grafting. Moreover, in order to start selling wine on a commercial basis the growers must have an EU-passport for all their wine-stocks.

BOX 1. Grape varieties approved for use in Denmark (ordered alphabetically), 2009.

Akolon (N), Bianca (B), Blå Donau (N), Castel 19637 (N), Don Muscat (N), Dunkelfelder (N), Ehrenbreitsteiner (B), Eszter (B), GF.GA 48-12 (B), GF.GA 64-170-1 (N), GM 4-46 kl 10 (B), GM 6493-2 (Rs), GM 6495-3 (B), GM 7932-1 (B), Goldriesling (B), Huxelrebe (B), Kerner (B), Kernling(B), Léon Millot (N), Madeleine Angevine 7672 (B), Madeleine Sylvaner (B), Merzling (B), Nero (N), Optima (B), Orion (B), Ortega (B), Phoenix (B), Précose de Malingre (B), Reflex (B), Reform (B), Regent (N), Regner (B), Rondo (N), Siegerrebe (Rs), Sirius (B), Solaris (B), Tidlig Blå Burgunder (N), Zalas Perle (B), Bacchus (B), Chardonnay (B), GM 8221-3 (N), Malvasie (N), Maréchal Foch (N), Pinot Auxerrois (B), Pinot Blanc (B), Pinot Meunier (N), Pinot Noir (N).

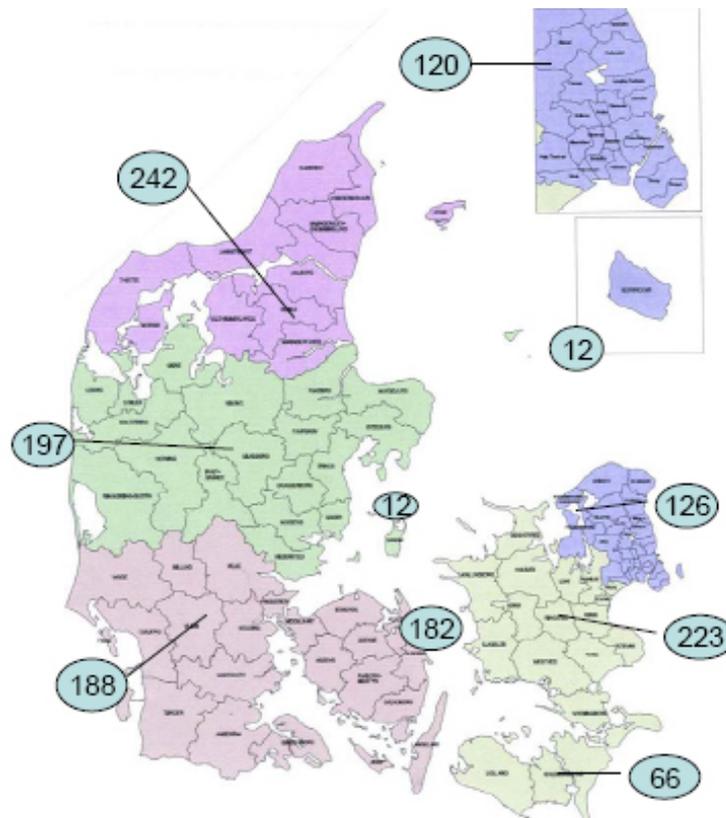
B = Blanc, Rs = Rosé, N = Noir

Furthermore, each commercial wine grower must report total field size, grape varieties, harvest information, production and stocks of wine. These rules are in accordance with the EU regulation, which has been implemented in order to supervise wine production in Europe. In addition, Denmark has a number of exemptions from the EU rules because Danish wine producers are not accepted for EU subsidies. The most important is the exemption rule concerning use of saccharose. Due to climate conditions this is rather vital for Danish wine production.

2.2. Location of wine producers in Denmark

Danish wine growers are organized in the Association of Danish Wine Producers. By the end of 2008 there were 1389 members out of which 58 were commercial producers (in 2000 the corresponding number was 8).¹ The wine growers are located in all areas of Denmark. Figure 2 shows that there is no central region for wine production in Denmark even though the micro climate varies considerably.

Figure 2. Members in The Association of Danish Winegrowers, by region, Nov. 2008.



Source: The Association of Danish Winegrowers, 2009.

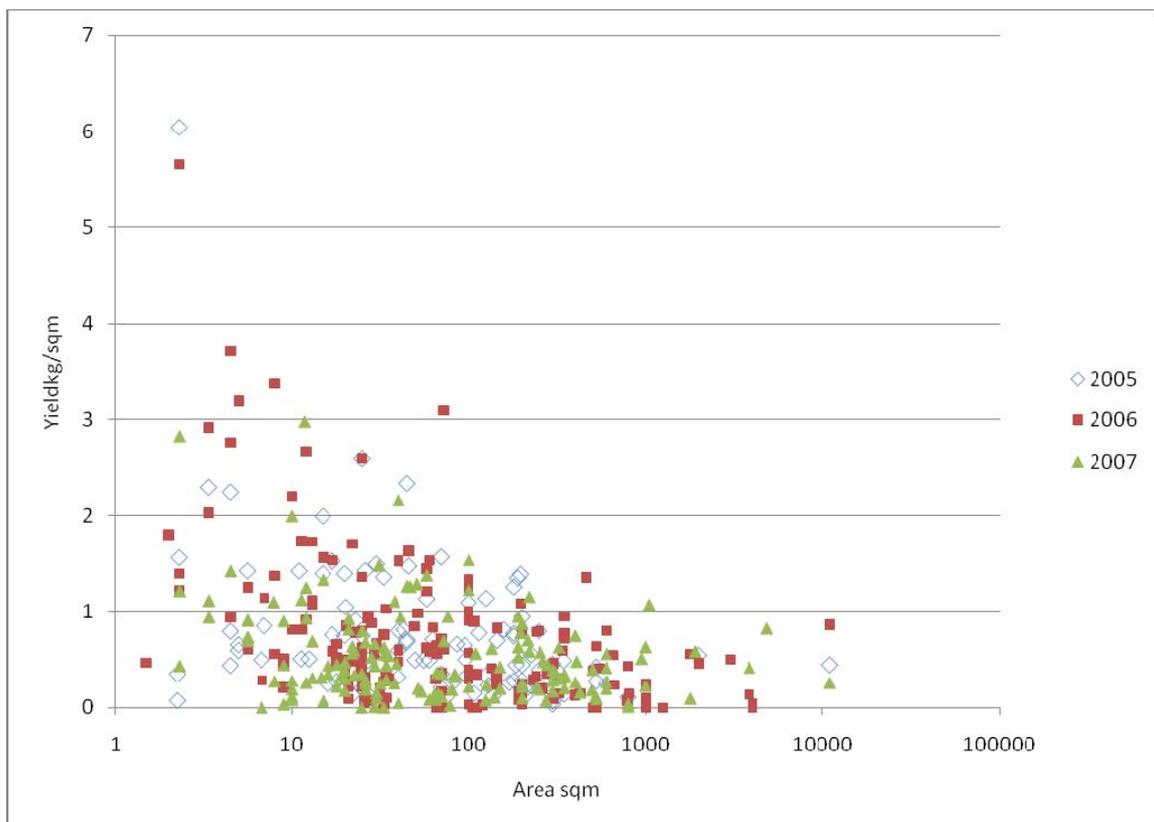
Thus location close to coastal areas have less risk of frosty nights in May, more sunny conditions during the summer, but at the same time colder temperatures during the summer because of the sea, i.e. the sea temperature is normally around below 18-19 degrees Celsius. In the middle of Jutland (the green region) cold nights are quite normal in April and May and in some years even with frost in the last part of May.

¹ By August 1. 2009 the number of commercial growers had grown to 63. The Danish Wine Growers Association expects this number to increase by 10 during the next year, see Vinpressen no6, 2009.

2.3 Production

Because of reporting rules, there are no formal statistics on all wine production in Denmark as is the case for e.g. other agricultural products. Non-commercial producers do not have to report on their production to the authorities, which means that the wine statistics is incomplete, i.e. underreporting is present.

Figure 3. The harvest of grapes, 2005-2007 (kilo/m²) by size of reported field (m²).



Source: The Association of Danish Winegrowers, 2009. The figure includes only producers reporting to the annual harvest statistics of the association.

Therefore, the figures for the overall Danish wine production depend on how many producers actually give harvest information in a particular year. Thus, in 2005 the reported harvest was 24.400 kg., in 2006 71.000 kg and in 2007 45.900 kg., which reflects that the weather conditions in 2006 were really good, i.e. harvest in 2006 did benefit from optimal weather conditions especially in August/September and with a dry sunny period in October, where the harvest took place. In addition, in less good years the incentive to report is lower, which also is reflected in the figure. For 2008 the estimated production is around 75.000 bottles of wine. Figure 3 gives the yield (kg/sqm) by size of producer.

Firstly, it is easily seen that the size distribution of Danish wine growers is highly skew, with a significant amount of small garage producers. Calculating a Herfindahl concentration index based on the field size distribution in figure 2 we get H2005 is 0.19; H2006 is 0.17 and H2007 is 0.08. Again, the latter is highly influenced by bad climate conditions which caused some of the larger producers to be highly selective in their harvest. Recalculated into number equivalents the Herfindahl indices correspond to a hypothetical situation with 6, 6 and 12 producers of equal size within the three years. Consequently, wine production in Denmark is relatively concentrated.

Looking at the yield in nearly all fields, the yield is less than 2 kg per square meter irrespective of the year looked at. Given the variation in harvest condition this of course reflects selection of grapes. There is a clear tendency that micro-producers get the highest yield which most likely is caused by better suited location of their plants. Larger producers have open wine fields which of course makes the yield more dependent on general weather conditions. Except for one producer all larger producers (>1000 sqm.) obtain a yield below 1 kg per square meter.

Figure 4 gives an overview of the importance of various grape varieties. The most important grape variety is Rondo, which is used for producing single grape red wine and also the basic component in blends. Rondo is really suitable for the Danish weather conditions. It does not need a long summer for maturing and it is rather resistant to plant diseases like fungous attacks. The grapes Leon Millot and Regent, which are well known old grape varieties in Germany too, are second most important. Still new sorts are introduced, e.g. Cabernet varieties, which seem to do pretty well too in the wine experiments performed until now.

Danish Wine Contest, which is held in the same tradition as concurs in France etc. Furthermore, professional referees are included in the panel of blind tasters and like elsewhere the wines are rewarded by a 0-20 point system. The evaluation takes into account colour, nose and of course taste. At the 2008 contest 211 wines coming from 20 commercial wine growers and 76 private non-commercial producers were submitted for evaluation. Box 2 shows the distribution of points. Note that in order to be included in the contest at least 8 points are needed. 45 wines did not pass this threshold. The average score was 11 points.

Box 2. The annual wine contest of Danish wines, 2008.

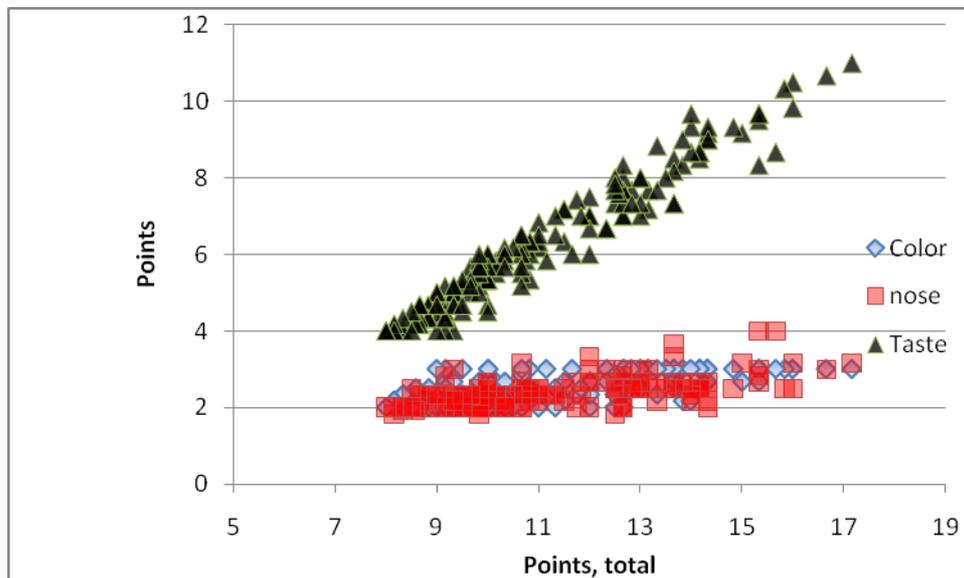
45 wines did not pass the minimum conditions. (Grade < 8.00 points)
63 wines were acceptable (Graded between 8.00 and 9.99 points)
50 wines got the character accepted with praise (Graded between 10.00 and 12.49 points)
30 wines got a bronze medal (12.50 - 13.99 points)
12 wines got a silver medal (14.00 - 14.99 points)
11 wines won gold (over 15 points)

Source: The Association of Danish Winegrowers. The figure includes producers who contribute to the annual harvest statistics.

Moreover, 6 out of the 11 gold winners were non-commercial 'garage-producers' but in the opposite end of the scale the same group counted 35 of the 45 wines which did not pass the contest. As expected, the non-commercial wine growers split into two groups, i.e. wine production in the very high quality/high skill segment and a segment in the other end of the scale, i.e. the low quality. Naturally, in a new born wine industry such differences are to be expected.

Figure 5 presents the point distribution for wines at the 2008 contest. It is clearly seen that taste is the most important factor behind the total score. Thus, there is only minor variance in assessment for nose and colour, i.e. most wines obtain between 2 and 3 points.

Figure 5. Grading of wines (points) at the 2008 Danish wine contest.



Source: Association of Danish Wine Growers. The figure includes producers who contribute to the annual harvest statistics.

3. Which factors determine quality – chances for awards?

Wine production at the commercial level is relatively new in Denmark and obviously the quality and rankings of the Danish wines attract much attention. Consequently, it is important to evaluate which factors that are important for producing good wine. Consequently, it is interesting to analyse the factors behind wine quality. In line with other studies, see e.g. Ashenfelter et al. (2001) we set up a hedonic model for wine quality where terroir factors, the grape composition of the wines and wine growers characteristics are included. The wine quality is approximated by the number of points received at the annual Danish wine Contest, which results in the following model (P equal to log(points))

$$(1) P = a + b \cdot X + c \cdot Z + d \cdot Y + f \cdot S + e$$

where X is a vector of grape variety characteristics, Z denotes terroir factors, Y stands

for growers characteristics. S is the sugar content (Oechsle) and finally e is an error term assumed to be NID. In a newborn wine industry certain varieties are expected to perform better than other types of grapes. Therefore, a number of dummy variables for the type of grape used in producing the specific wines are included in the model. Most important is Rondo which is the dominating grape in Danish wine production, see above. It is expected that wines made out of Rondo, which is the most suitable grape for making wine in Denmark, obtain more points than other wines. Furthermore the grape dummies include control for white and red wines.² The main terroir variables are field direction (south) and the steepness of the vineyard. More steepness and southern direction of the wine field (rows) is expected to give higher quality. Furthermore, control is made for plant intensity, i.e. the more plants per square meter the lower quality is expected and furthermore high yield per square meter is expected to give poorer quality through less thorough selection of grapes.

Finally grower characteristics must be included in the model. In particular experience seems important because wine production demands high skill and knowledge on e.g. the correct harvesting time, producing the wine and the ropes and tricks of making the final product where time lags of several months exist before the final results can be evaluated. The data set gives information on the age of the year of establishing the wine fields which is assumed to approximate the experience of the wine grower. Thus, longer experience is assumed to influence the wine quality in a positive direction. In addition, we add the size of the producer. Larger producers are expected to produce better wines because of large scale advantages in both production and accumulation of knowledge. Note that Danish wine growers are very small as compared to other countries, where you may also expect that smaller growers produce excellent wine (e.g. garage producers). In Denmark this mechanism may be at work too, due to the fact that some micro producers especially non-commercial producers produce high quality wines simply because no economic considerations on time use and use of other resources spent in making the wines are really taken into consideration by this group.

² Due to the number of observations the data set includes both red and white wines.

$$(2) S = \alpha + \beta \cdot X + \gamma \cdot U + \delta \cdot V + \varepsilon$$

The grape sugar content, S (Oechsle) is of special interest because of the cool climate growing conditions. Furthermore higher content of natural sugar is an indicator of superior growing conditions and therefore the Oechsle measure is included as a separate factor in equation (1). Therefore the sugar content itself is of particular interest and in equation (2) the Oechsle measure is explained by grape varieties (X), field characteristics (U) and the length of the growing season (V).

4. Empirical results

The data used in the analysis comes from the annual harvest report of Danish wine growers 2007, which has been merged with the results from the Annual Danish wine Contest (2008). Table 1 gives means statistics for selected variables.

Table 1. Mean statistics for selected variables.

	Observations	Sample mean	Std. error, (Sample mean)	Std. error, (Overall)
Points at the Danish wine contest (max=20)	53	11.42	0.3258	2.372
Yield (kg/sqm)	53	0.561	0.047	0.347
Sugar content (oechsle)*	53	75.56	1.076	7.836
Experience (year)	53	7.283	0.764	5.565
Field Steepness (Degrees)	53	3.241	0.672	4.897

*Difference in weight between 1 liter grape juice and 1 liter of pure water (gram).

The average score was 11 among the 53 wines in the sample. This score corresponds to 'accepted with praise' which is the category just below 'bronze'. The overall standard error suggests that there is significant variation in the points in order to test the award model. The same is the case for the sugar content, which is measured by the standard Oechsle-figure and for experience and steepness of the field, all of them sample means significantly different from zero and with a notable standard error.

4.1 Empirical results - sugar

Prior to estimating equation (1) focus is put on the sugar content in the grapes because a quite important factor behind producing wines of superior quality is the sugar content of the grapes at harvest, i.e. the Oechsle figure. Higher sugar content in the grapes means better opportunities for optimal macuration and it will give stronger wines, which is the basic challenge for producers in Denmark to produce. Naturally, compared to the traditional wine countries it is relatively difficult to produce full matured grapes with high natural sugar content in Denmark. Furthermore, until now Danish produced wines are not really suitable for storing and therefore the acidity of the wines is relatively less important than in the classical wine countries where high sugar content and a correct balance between sugar and acid in the grapes is the prerequisite for producing full bodied and at the same time long-lasting wines. Table 2 gives an impression of the important factors for the sugar content.

The model, which includes the significant factors after using an elimination technique, gives a quite satisfactory degree of explanation, i.e. more than 50%. Furthermore, in accordance with prior knowledge it is easier to obtain a higher sugar content in the grapes by using Rondo (red wine), which is the preferred grape in Denmark and it seems that Solaris (green), which partly comes from the German grape Merzling. Solaris is known for early maturing, which of course is necessary for a high content of sugar. Oppositely, Phoenix is a tricky and demanding green grape in the muskat tradition which for the moment hardly seems to be suitable for the growing conditions in Denmark unless the local growing conditions allow a late harvest.

Table 2. Regression models of the sugar content of grapes (Oechsle) in award winning vines, 2008.

	Model 1	Model 2
Constant	1.342 (1.330)	1.014 (1.409)
Grape: Rondo	0.054* (0.024)	0.044** (0.025)
Grape: Solaris	0.165* (0.042)	0.157* (0.044)
Grape: Phoenix	-0.302* (0.077)	-0.311* (0.082)
Soil: sand	0.143* (0.055)	
Yield per m ²	-0.047* (0.022)	-0.046** (0.024)
Growing season (length)	0.675* (0.311)	0.754* (0.329)
R^2	0.56	0.51
Observations	53	53

* indicates significance at the 5 per cent level, ** at the 10 per cent level.

Naturally, the length of the growing season is of importance (note that this variable is reported for each field at the producer's level in the harvest report). And furthermore low yield gives higher sugar, which is of course not surprising and in accordance with experience in the old wine countries.

Finally, the model shows that sandy soil in itself results in higher sugar contents. However, soil conditions are correlated with the growing season and therefore the model is presented without 'sand' included in column 2. As expected the parameter for 'length of growing season' increases as compared to column 1, where soil type is included.

4.2 Empirical results - awards

According to the discussion earlier the chances of winning an award at the wine contest depends on several groups of explanatory factors. First of all grape varieties must be included, next producer experience, thirdly wine fields characteristics and finally the natural content of sugar assumable is an appropriate indicator of the basic quality of the grapes.

Table 3 gives the results of various specifications of equation (1).³ Column 1 presents the simple model just including the content of grape sugar at harvest, which clearly has a significant and positive influence on the number of points. Thus a 1 point increase in the Oecle measure assumable results in a 0.5% increase in the points granted. Column 2 brings in producers and grape characteristics. Being a commercial grower and having more experience has a positive influence on points though this influence is not significant. As expected Rondo grapes gives an additional chance – besides the higher sugar content – of winning awards at the contest, while this extra effect is non-existent for Solaris. On the other hand using Phoenix grapes enhances the chances for more points, which is an indicator of the potential (taste) of this grape. Finally, it should be noticed that the isolated influence of the Oecle increases when including grape characteristics into the model, which of course is an indicator of collinearity between these variable. Still, instrumenting the sugar variable does not seem to have a noteworthy influence on the results.

Focussing on field characteristics in columns 3 and 4 there seems to be no extra effect on the number from the type of soil points – besides the indirect influence via sugar content. Of course taste differences based on terroir are expected to affect the number of points, but in order to isolate this influence more detailed information on the soil is needed.

³ In the experimental phase of the computations the sugar content was instrumented by use of equation (2), however with mixed results.

Table 3. Regression models of awards at the Danish wine contest 2008 (Log of points, 53 wines).

	Model 1	Model 2	Model 3	Model 4
Constant	0.1370 (1.102)	-1.428 (1.282)	-1.563 (1.394)	1.899 (1.156)
Sugar (in grape at harvest)	0.527* (0.255)	0.846* (0.295)	0.885* (0.321)	0.948* (0.311)
Experience (year of establishing the oldest field of the vineyard)		0.060 (0.041)	0.070 (0.053)	0.110* (0.055)
Commercial producer		0.077 (0.053)	0.071 (0.053)	0.071 (0.059)
Grape: Rondo (red)		0.121* (0.057)	0.133* (0.063)	0.198* (0,068)
Grape: Solaris (green)		-0.099 (0.110)	-0.084 (0.118)	-0.005 (0.120)
Grape: Phoenix (green)		0.470* (0.221)	0.510* (0.240)	0.602* (0.235)
Soil: Sand			0.060 (0.166)	-0.303 (0.200)
Soil: Mixed			-0.073 (0.127)	-0.151 (0.129)
Soil: Clay			-0.042 (0.132)	-0.143 (0.137)
Field slope (degrees)				0.016* (0.008)
R^2	0.06	0.18	0.18	0.20
Observations	53	53	53	53

* indicates significance at the 5 per cent level.

According to the experiments field direction and the steepness of field did not have any significant influence on the Oecle figure due to the fact that these characteristics are partly included in the yield and length of the growing season. However, field slope does affect the number of points granted at the annual contest itself. Thus steeper wine fields result in wines of better quality, which of course is a priori expected.

Finally it should be noted that producer size does not affect quality (not shown),

which indicates that e.g. learning effects caused by large scale production for the moment seem not to be present. But the experience of the grower is correctly signed (positive) and significant in the full model (column 4) indicating that longer experience tends to increase the wine quality. Thus, at this stage of wine production in Denmark unobservable characteristics of fields and producers are important. This is partly reflected in the overall degree of explanation. Including more explanatory variables adds to the R^2 ending up with 0.20 for the full model.

5. Conclusion

Denmark is an emerging nation of wine production. Climate changes and innovation has already made it possible to produce wines in cool climate areas with relatively short growing seasons. Moreover the future global heating and the development of new varieties is expected to be even more favourable to Danish wine production. By now the number of commercial wine growers in Denmark is around 80 and the Association of Danish Wine Growers now counts more than 1400 members. Furthermore Denmark has been accepted as a commercial wine producing nation within the European Union.

Consequently, this paper first gives a description of wine production in Denmark. Based on a rich micro data for Danish wine growers we furthermore address the question whether vineyard characteristics are important for the quality of the wine and/or whether individual characteristics of the growers are important. Wine quality is approximated by the awards obtained at the annual Danish wine contest. Thus, estimation of a hedonic model for points at the contest suggest that sugar content, steeper fields, choice of grape variety and experience of the growers affect the number of points granted to the wine at the annual Danish Wine Contest positively. Still unobservables count for 80 percent of the variation in the granted awards, which of course is non-surprising in a new born wine industry like the Danish.

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