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"TESTED QUALITY IN THE GLASS": WINE QUALITY CERTIFICATION IN GERMANY

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"TESTED QUALITY IN THE GLASS": WINE QUALITY CERTIFICATION IN GERMANY

by

Henrich Brunke⁽¹⁾, James T. Lapsley⁽²⁾, Rolf A.E. Mueller⁽¹⁾ and Ludwig Tauscher⁽³⁾

Abstract

Wine is mostly sold in closed bottles that prevent buyers from inspecting their contents. This practice turns wine into an experience good which buyers are unable to assess at the time of purchase. In order to reduce buyers' information gaps, wine sellers provide information about the wine on one or several labels attached to the bottle. Wine buyers' problem then is to interpret this information and to assess its veracity. Institutional arrangements have emerged in Germany, as in other wine producing countries, that standardize communication between wine sellers and buyers, and that reduce the risk of wine buyers being misled by the information provided by the sellers. Core elements of the institutions are (i) verifiable wine quality categories or grades, (ii) wine examination by independent experts and certification of the information items provided by the wine bottler, and (iii) rules for the content and form of labeling information. Wines that satisfy all legal requirements for a quality wine are deemed to be "Tested Quality in the Glass". They are recognizable by a number that is issued for each wine that has passed examination; the number must be printed on the label. The objectives of this study are three: (i) to provide an English-language description of the German wine quality certification system, together with a summary of its legal basis; (ii) to describe an alternative private wine certification system that has been grafted onto the public system, and (iii) to encourage readers to think about how datafication of wine and digitization of wine certification may transform the "Tested Quality in the Glass" system. The study is of interest to all wine experts and scholars with an interest in wine certification, especially of German wines.

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1 INTRODUCTION

1.1 Motivation

Wines made from the grapes of *Vitis vinifera* vary widely in quality. Some wines are superb "bottled poetry" (Lapsley 1996), others are just a bland alcoholic drink, and most are somewhere in the middle of the huge quality range. Whatever their quality, most wines are sold in tightly closed bottles, many of them dark-colored, hiding their contents from the view of potential buyers. Selling wine in closed bottles prevents buyers from inspecting the wine and turns it into an experience good whose quality buyers are able to assess only after the wine has been bought in the bottle, like the proverbial pig in the poke.

By preventing the inspection of wine, selling wine in bottles increases the purchase risk and therefore the transaction costs for buyers. There are mainly three ways of reducing this transaction cost. One is to allow buyers to taste the wine prior to purchase. This is, however, not practical where sellers offer many wines to many buyers, such as in supermarkets, or when wine is sold online. Moreover, from the point of view of buyers, most retail outlets for wine offer more wines than is advisable for any one buyer to attempt to taste. Or buyers resort to repeat purchases in short intervals so that the experience of the wine bought today is the inspection of the wine that will be bought tomorrow. In a market with a highly differentiated product, such as wine, this strategy for reducing transaction costs comes, however, at the cost of foregoing the enjoyment of variety. The third and dominant means for reducing wine buyers' transaction cost is to substitute information about the wine for the knowledge that buyers cannot acquire directly by tasting the wine prior to purchasing it. This information is usually provided by the wine producer and printed in highly condensed form on the labels on a bottle.

When a wine buyer acquires his or her beliefs about a wine from information provided by the wine producer rather than from directly sizing up the wine with his or her own senses, false beliefs about the wine may result. The reasons are several. First, the message capacity of a label glued on a bottle is strictly limited and not all information about a wine's desired attributes can be communicated through the label. Second, wine is valued for its flavor. But flavor is notoriously difficult to describe (Lehrer 1983; Shepherd 2012) and describing a wine's flavor satisfactorily within the limited message capacity provided by a label is well-nigh impossible. Third, a wine producer may tell the truth about the wine, lie about it, or may provide bamboozling bullshit (Frankfurt 2005). The buyer, however, may be unable to ascertain the veracity of the information provided on the label. Hence, the provision of information by the producer transforms the risk of assessing the desired attributes of an untried wine into a risk of assessing the veracity of unchecked information about a wine. There is no reason to believe that the risks of buying a wine on account of the information put on the label are consistently lower than the risks of purchasing an unlabeled bottle and the provision of quality information by wine producers may therefore not reduce the transactions costs to buyers.

Where information deficiencies cause substantial transaction costs, institutional arrangements that ameliorate the deficiencies are likely to come about, either spontaneously, by entrepreneurial initiative, or through government's powers to coerce and to nudge. In wine markets such institutional arrangements abound. For example, wines that are categorized according to attributes valued by consumers may alleviate sellers' burden of describing them and buyers' burden to identify the wines they want to buy. Moreover, governments have regulated the design and content of wine labels, essentially defining the syntax and semantics of this medium. And some commercial wine

riters, such as Robert Parker (McCoy 2005) or the "Wine Spectator" have developed the provision of highly condensed, standardized information about the quality of wine into a thriving business.

In this study we are concerned with the institutional arrangements for ameliorating deficiencies in the provision of information about wine "quality" that are in place in Germany, and where "quality" refers to a bundle of attributes that are believed to determine a wine's enjoyment by wine drinkers. These arrangements, which, as we will see, are fairly complex, have been conveniently labeled for marketing purposes as "Tested Quality in the Glass" to distinguish them from comparable arrangements in France where the key information about a wine's quality is its "terroir", that is its geographical origin.

The German system for ameliorating information deficiencies was introduced by law in 1971 and it has withstood the vagaries of the legislative and regulatory urges of the EU bureaucracy whose norms dominate national wine laws and regulations. The main elements of the system are three:

- (i) definition of verifiable quality categories for German wine;
- (ii) testing of the wines by a panel of independent experts and certification of quality levels specified by the wine bottler; and
- (iii) regulations concerning the contents and terms of labeling information.

These elements are combined with well-defined wine regions and sites where grapes for wine production may be grown. Taken together, information disclosure, certification, and specified wine regions constitute a comprehensive wine quality assurance system.

Given the proven practicality and administrative resilience of the German wine quality assurance system, one could argue that this complex system is just fine and best be left alone. There is, however, no reason for complacency. For one, the quality categories of the system are currently challenged by an alternative grading system that has been designed and implemented by the Verband der Prädikatsweingüter (VDP), an association of some two hundred wine estates that tend to offer higher priced wines. Moreover, in the 40 years since its inception, the science and technology of wine analysis have changed significantly with the advance of digital technology allowing much more comprehensive and more accurate datafication of wine. This technology, we will argue, is near certain to transform the technology of wine testing and certification too.

1.2 Objectives

With this study we pursue three objectives: We want

- (i) to provide an English-language description of the German wine quality certification system, together with a summary of its legal basis;
- (ii) to describe an alternative private wine certification system that is grafted onto the public system, and
- (iii) to encourage readers to think about how datafication of wine and digitization of wine certification may transform the "Tested Quality in the Glass" system.

1.3 Outline

We have organized this paper into eight sections. After the introduction we describe in section 2 the wine quality grading and certification system in Germany. This overview should be of interest to all who want to know how the Germany wine industry makes sure that the wine inside of a bottle holds what is promised by the label on the bottle. In section 3 we characterize the significance of the official grades in terms of volumes of wine produced and in terms of prices paid for wines of different grades. “Tested Quality in the Glass” (TQG) is mandated by law and section 4 provides an outline of the legal framework that defines the system and determines its boundaries. In section 5 we describe the administrative organization of the wine testing and certification process as a decision making organization. In this description we rely heavily on the theory of administrative behavior that Herbert Simon (1997). In section 6 we present and assess the quality pyramid which the Verband der Prädikatsweingüter (VDP) has installed as an alternative to the public wine grades. Whilst the VDP attempts to emulate the French terroir-based notion of wine quality, datafication of wine attributes and digitization of wine certification are likely to transform the established grading and certification system. How this transformation is likely to come about is the topic of section 7. Each section closes with takeaways. Section 8 collects the section takeaways.

2 "TESTED QUALITY IN THE GLASS": WHAT YOU SEE, AND WHAT YOU DON'T SEE

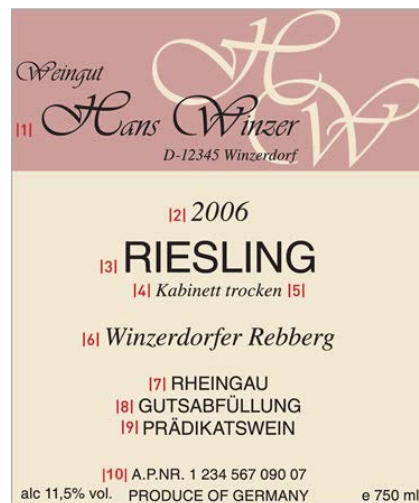
"Tested Quality in the Glass" is a wine certification system that attempts to provide wine buyers with information about certain characteristics of a wine, and to assure buyers of the validity of that information. In spite of the rapid advances in digital information technology, the information on the characteristics of a wine is still provided on a printed label that is stuck onto the bottle. The validity of that information is assured by a complex process that involves physical and chemical analysis, and organoleptic examination. In this section we first explain the content of a German wine label. Then we describe the process that assures the validity of that information.

2.1 What you see: The information content of a wine label

The label, sometimes there are more than one, on the wine bottle is the main medium through which a wine producer communicates with anonymous buyers. European and German wine laws regulate in excruciating detail the obligatory and the voluntary information content of wine labels, and the information that must not be put on a label. We know of no study that has analyzed empirically whether wine buyers actually understand in full the meaning of the terms used for describing a wine's quality and many of the terms that are used on a label may either be meaningless for buyers, or worse, may have some other meaning for buyers than the one intended by the seller.

To give structure to our discussion of the content of a wine label we take a stylized specimen label provided by the U.S.-office of the German Wine Institute (DWI):

Figure 2-1: Example of a label for a German wine



Source: <http://www.germanwineusa.com/press-trade/read-wine-label.html>

This label shows:

- [1] the name of the wine bottler;
- [2] the vintage;
- [3] the grape variety;
- [4] the "Prädikat" or quality grade the wine;
- [5] the wine style;
- [6] the location and vineyard site where the grapes have been grown;
- [7] the wine region where the grapes have been grown and where the wine has been vinified;
- [8] the type of bottling;

- [9] the quality category of the wine;
- [10] the "Amtliche Prüfnummer" (A.P. Nr.) of the wine; and
- [11] auxiliary information, such as the alcohol content and the volume of the bottle (not numbered in the label above).

Not shown in the specimen label is a warning, printed on most labels, that the wine contains sulfites.

The terms that are used on a wine label to describe a wine are legally defined terms and may not convey the same meaning as in common language. For example, "Spätlese", translated literally, means "late picking"; a wine of "Spätlese"-grade, however, is not necessarily a wine made of grapes that have been picked late in the harvest season, but is instead a wine of a certain level of ripeness, where ripeness is defined in term of must weight – i.e. the sugar concentration - of the grapes at harvest. We therefore need to explain the terms that are used on a wine label.

We now turn to the information content of the items that appear on a label, albeit in a different order as they are listed above.

2.1.1 The A.P. Nr. ("Amtliche Prüfnummer")

The inconspicuous and cryptic A.P. Nr. is that item on a wine label that carries the most information. A.P. Nr. is short for "Amtliche Prüfnummer", which means official testing number. The A.P. Nr. is not a number in the sense of arithmetic but in the sense of a telephone number. Like a telephone number, the A.P. Nr. is an identifier, but one with a defined structure of digits. Take the example of the A.P. Nr. on the label in Fig. 2-1. This number is:

1 234 567 090 07

where each group of digits has a defined meaning:

- 1st digit: identification number of the agency that has issued this A.P. Nr.;
- 1st group of 3 digits: identification number of the location of the wine's bottler;
- 2nd group of 3 digits: identification number of the bottler of the wine;
- 3rd group of 3 digits: serial number of the wine submitted for testing i by the bottler in the year when the A.P. Nr. has been assigned;
- final group of 2 digits: year when the A.P. Nr. has been assigned.

We do not know whether the example A.P. Nr. is a true one. But we can take a true one from a true bottle - regrettably empty - of 2012 Nahe Riesling "Unplugged" by Weingut Tesch, Langenlonsheim: A.P. Nr. 7 738 166 19 13. The single-digit number 7 identifies the testing center at Bad Kreuznach as the agency that has issued this A.P. Nr. The next three digits 738 identify Langenlonsheim as the location of the enterprise that has bottled the wine. The following three digits 166 identify Weingut Tesch as the bottler of the wine. The next two-digit number tells us that this wine was the 19th application for an A.P. Nr. filed by Tesch in the calendar year of the application. The last two digits of the A.P. Nr. represent the last two digits of the calendar year when the application has been filed. Note that the wine in the example is from the 2012 vintage, which is shown on the label, but the wine has been tested and assigned an A.P. Nr. in 2013.

Beyond the information that can be obtained by parsing an A.P. Nr., the presence of an A.P. Nr. in itself conveys the important information that

- the wine is a quality wine, as defined by EU and German laws;
- the wine has passed analytic and organoleptic testing;
- the wine has been found free of wine faults, and

- the claims on the label have been validated.

From an administrative and legal point of view the A.P. Nr. is the item that links each bottle of German quality wine to the legally defined testing procedure for quality wine.

2.1.2 Wine region

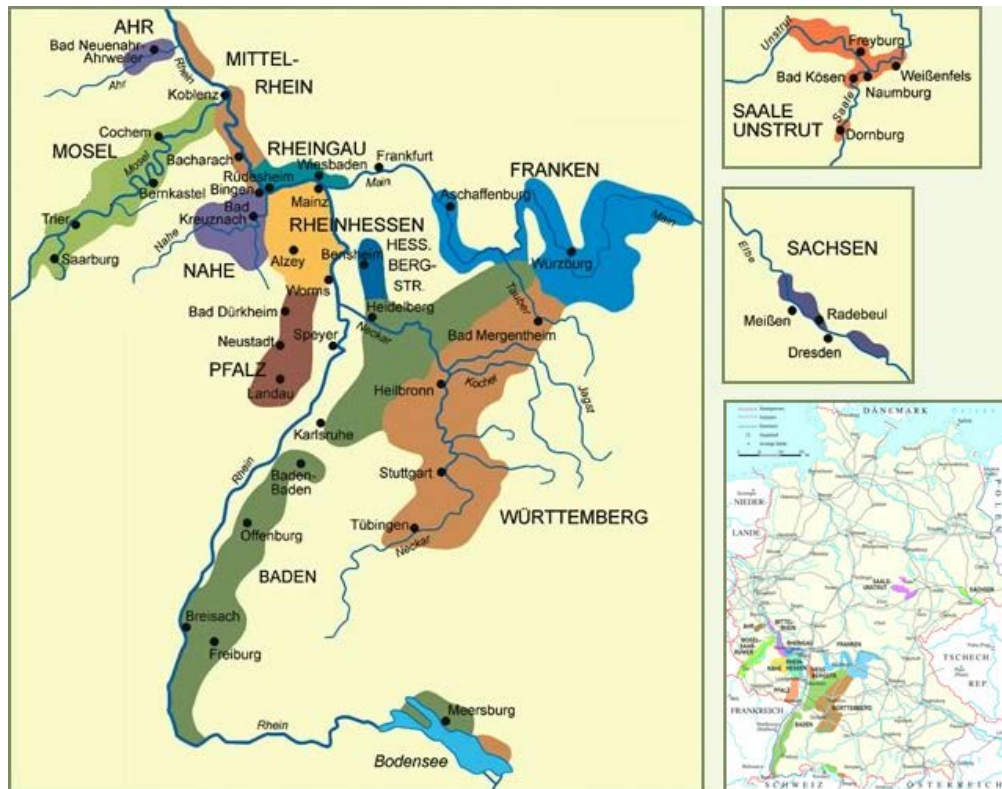
Wine is, to our knowledge, the only agricultural crop in Germany that may be grown for commercial purposes only within certain areas determined by the state. By German law, grapevine production is limited to two categories of geographic areas: wine regions ("Gebiete") and zones ("Bereiche"). There are 13 wine regions where quality wines ("Qualitätswein" and "Prädikatswein" grades) may be produced, and 26 zones where "Deutscher Wein" and "Landwein" grades may be produced. The regions for quality wine and for "Landwein" may be coextensive, as is the case for the quality wine region "Nahe" and the region "Nahegauer Landwein"; in contrast, there is no quality wine region in Germany's northernmost state, but there is a region "Schleswig-Holsteinischer Landwein". The grades "Landwein" and "Deutscher Wein" do not concern us here because wines of neither grade are tested and they are not considered to be "Tested Quality in the Glass".

Most of the national vineyard area of some 101,000 ha, or roughly 250,000 ac, is located within the 13 designated wine-growing regions and only a minute share (~ 100 ha) of the national vineyard area lies outside the designated wine regions. The wine regions are, with the exception of Saale-Unstrut and Sachsen, located in the warmer south and south-west of Germany and there they hug the valleys of the Rhine, the Mosel, the Main, the Neckar, and the valleys of some of their smaller tributaries, such as the Ahr, the Nahe, and the Saar (see Fig. 2-2). All of Germany's wine growing regions, with the exception of the Baden wine region, belong to EU wine zone A, the coolest wine zone in the EU. Baden belongs to zone B, the second coolest wine zone, which also comprises Slovakia, Austria, and the northern wine regions of France, such as Alsace and Champagne.

An implicit reason for demarcating wine regions is the belief that grapevines from within the wine regions produce wine that is of higher quality than wine from grapevines grown outside the wine regions. The belief is justified by the interaction of climate with the grapevine's inefficient conversion of solar radiation.

The intensity of solar radiation that arrives at a horizontal surface decreases considerably with geographic latitude. Whereas a flat surface on the equator receives 13.2 giga joules per annum [GJ/a] of solar radiation, the radiation received drops to 9.0 GJ/a, at 50° latitude, equivalent to a drop by one third (Aschenfelter and Storchmann 2010). Incidentally, 50° latitude is exactly the latitude of Mainz, and approximately that of the large and important German wine regions, Rheinhessen, Mosel, Nahe, and Rheingau. The drop in solar radiation at higher latitudes may, however, be compensated in part when the surface slopes at 45° degrees toward the south. In the German wine regions vineyards with such steep slopes and southern orientation are the distinctive "Steillagen" (steep sites) along river banks.

Figure 2-2: Map of Germany's thirteen wine regions



Source: <http://www.germanwineusa.com/press-trade/wine-regions.html>

The production of wine involves two biological processes: first, the grapevine converts solar radiation into sugar that is stored inside the berries, and then yeasts ferment the sugar into alcohol thereby turning juice into wine. Grapevines are, compared to other plants, fairly inefficient converters of solar energy into biomass. *Vitis vinifera* is a C3-plant, a group of plants whose photosynthetic efficiency tends to be about one-third lower than that of C4-plants (Monteith 1978). Moreover, even among the C3-plants grapevines rank low as radiation converters. Citing studies by others, Aschenfelter and Storchmann (2010, p. 334) report a radiation use efficiency of 0.7 for Merlot compared to a radiation use efficiency of 1.8 for maize. Because some white grapevine varieties that are widely grown in Germany, such as Müller-Thurgau, Weißer Burgunder (Pinot blanc), and Riesling, require smaller degree-sums for ripening than Merlot (Stock et al. 2006 p. 92 Table 27), their radiation use efficiency is probably somewhat higher than that of Merlot, but still much lower than that of many field crops and vegetables.

Given the low radiation received in Germany and the poor use that grapevines make of solar radiation, grapevines grown in Germany are at the limit of their physiological requirements for producing ripe grapes, and at the limit of their competitiveness with other crops that make better use of low solar radiation. As a consequence, grapevine production in Germany is largely limited to particularly warm and sunny locations, and there the best vineyards are those with a steep inclination and an exposure towards the south so that they can act as radiation collectors for the grapevines (Aschenfelter and Storchmann 2010). The biological and climatic conditions of grapevine cultivation help explain where wine may be profitably produced in Germany. Biology and climate are, however, insufficient to explain why wine regions in Germany are demarcated by the state.

By federal law, wine quality testing is a state matter. It is therefore important to know the states to which the wine-growing regions belong. We have listed the states and their wine regions in the following table:

Table 2-1: States with wine testing agencies and the associated wine regions

State with testing agency	Wine region
Rheinland-Pfalz	Ahr, Mittelrhein, Mosel, Nahe, Pfalz, Rheinhessen
Baden-Württemberg	Baden, Württemberg
Bayern	Franken
Hessen	Rheingau, Hessische Bergstrasse
Sachsen-Anhalt	Saale-Unstrut
Sachsen	Sachsen
Nordrhein-Westfalen	small section of the Mittelrhein
Saarland	small section of the Mosel

Source: DWI (2015a)

2.1.3 Vintage, variety, and vineyard

Vintage, variety, and vineyard are believed to contribute to the specific characteristics of a wine. They also help to distinguish one wine from another. Moreover, the declaration of the three Vs on a label constrains a wine maker's freedom to blend wine from different vintages, varieties, and vineyards. In particular, a wine with a vintage on the label must not contain more than 15 percent of wine from another vintage, and the same is true for the variety and the vineyard, if they are declared on the label. The percentages may not be accumulated; this means that a wine with the vintage, variety, and vineyard declared on the label may not contain more than 15 percent of wine that is either from a different vintage, a different variety, or different vineyard, or any combination thereof.

The variety of a quality wine must be a *vitis vinifera* variety from quite long lists of varieties that have been approved by each of the wine-growing states for the wine regions in its jurisdiction. The lists do not seem to unduly constrain vintners' choice of grape variety and several varieties that are new to Germany, such as Cabernet sauvignon, Tempranillo, and Sauvignon blanc, have appeared in German vineyards. The lists contain synonyms for varieties that have fallen out of wine consumers' favor. For example, "Grauburgunder" (Pinot gris) is currently more fashionable than the synonymous "Ruländer", and there are wine consumers who seem to prefer a "Rivaner" to a "Müller-Thurgau" from the same grapevine.

The vineyards in Germany are either "Grosslagen" (collective sites), or "Einzellagen" (individual sites). Collective sites are, as the name suggests, sites that collect individual sites under one composite name, which usually consists of the name of a location (village, township) with a good reputation for its wines and a component chosen for whatever reason. Examples are "Bernkasteler Badstube" and "Oppenheimer Krötenbrunnen", where both Bernkastel and Oppenheim are well-known wine locations. This arrangement allows wine marketers to sell under the name of a well-known location wines from one or several vineyards with no particular reputation but which happen to be located within the "Grosslage". This practice is bemoaned by some critics and wine authors, such as Jancis Robinson (2006; entry "Grosslage"). The number of "Einzellagen", more than 2,500 in total, certainly exceeds the number that most wine consumers are prepared to remember. Moreover, because

several vintners may operate plots within an "Einzellage", and because a vintner may grow more than one variety in any one plot, the large number of "Einzellagen" is the foundation for the high level of apparent product differentiation of German wines.

2.1.4 Wine quality grades

Describing the quality of a complex product, such as fine wine, is a challenge, particularly if the description has to both fit on a label and grip buyers' attention. Some describers of wine quality have minimized the number of symbols required for their description and describe the quality of a wine with a simple number: 93 Parker Points, 95 Points "Wine Spectator", 3 Gambero Rosso, and such like as we find in wine catalogues and on wine web sites. Perhaps describing wine quality with a simple number does justice to the quality of many wines, and perhaps this is indeed all that many wine consumers want to know about a wine: country of origin, color, and the level of quality as measured by points from an arbitrary scale with uncertain origin and idiosyncratic intervals.

As indicated by the wine label in Figure 2-1, the German wine industry may provide more detailed information on the quality of a wine, information that is validated by an elaborate system of wine grading, disclosure of wine quality information, information certification, and wine testing. The system was introduced in 1971, it went through several minor modifications to accommodate EU regulations, but emerged with its basic principles intact (for details of the legal evolution see Section 4). The fundamental principle of the system is to reduce the information required for describing a wine's quality by defining wine grades. The official grades for German wine are:

"Deutscher Wein"	"Kabinett"
"Landwein"	"Spätlese"
"Qualitätswein"	"Auslese"
	"Beerenauslese" (BA)
	"Eiswein"
	"Trockenbeerenauslese" (TBA)

"Deutscher Wein" is the lowest grade and "Trockenbeerenauslese" is the highest. Some of the names of the grades, such as "Kabinett", "Spätlese", and "Auslese" have more emotional appeal than descriptive value; others, in particular "Beerenauslese" (berry selection), "Eiswein" (ice wine), and "Trockenbeerenauslese" (dry berry selection) actually describe an attribute of the wine that determines its quality. Why the lowest grade "Deutscher Wein" (German wine) has been given a name that is identical with the term that denotes all of German wine is difficult to rationalize from a marketing perspective. It is to be hoped that wines of this grade are not mistaken by the uninitiated to represent German wines of any grade.

The grades have six properties:

- (1) any wine produced in Germany is assigned to one of the nine grades;
- (2) the grades are based on a combination of geographic origin, and observable wine attributes;
- (3) the grades are defined by minimum requirements on some attributes; the minimum requirements may vary between wine regions and grape varieties;
- (4) the grades, with the exception of "Eiswein", form a hierarchy such that a wine of a higher grade meets most of the criteria required for the lower grade;
- (5) given its attributes, a wine does not need to be given the highest grade possible but may be marketed under a lower grade, and
- (6) when wines of different grades are blended, the blended wine is given the grade of the wine with the lowest grade, irrespective of the lowest graded wine's share in the blend.

The grades are usually grouped into four bins which are listed in Table 2-2 together with their geographic indications. The lowest two grades, "Deutscher Wein" and "Landwein", jointly account for less than five per cent of national wine production. These two grades do not concern us here any further because wines of these grades are not quality tested. The PDO-category comprises the grades "Qualitätswein" and the "Prädikat"-grades group with six grades starting from "Kabinett" and upwards. "Qualitätswein" and all "Prädikat"-grades meet the requirements of the PDO-category, in particular,

- (1) the grapes from which the wines have been vinified originate in one of the 13 specified wine regions of Germany and they have been vinified in that region;
- (2) the grapes are of a *vitis vinifera* variety that has been approved for that specific wine region;
- (3) the grape yield does not exceed the limit specified for the region (see Tab. 2-4);
- (4) the alcohol content does not fall below the minimum specified for the region;
- (5) the wine has passed quality testing and has been assigned an "Amtliche Prüfnummer" (A.P. Nr.).

Wine of the grades "Qualitätswein" and "Prädikat" also met the criteria that the EU had introduced in the 1970s for the quality category "quality wine produced in specified regions (psr)"; this category was in used until 2011 when German wine regulations were adapted to the EU-classification based on geographic origin (see also Section 4).

Table 2-2: Quality grades and quality testing of German wines

German wine grade	Geographical Indication	Quality testing	Minimum natural sugar content, must ⁽³⁾		Share in national wine production, (2013) [%]
			[°Oe]	[°Bx] ⁽⁴⁾	
"Deutscher Wein"	None	no	44-50	11.0-12.4	Σ: 3.8
"Landwein"	PGI ⁽¹⁾	no	47-55	11.7-13.6	
"Qualitätswein"	PDO ⁽²⁾	yes	55-72	13.6-17.5	75.9
"Prädikat"-grades (6)	PDO ⁽²⁾	yes	70-150	17.1-34.3	Σ: 20.3

Source: BMEL (2014); DWI (2015b);

(1): EU-category "Protected Geographic Indication";

(2): EU-category "Protected Designation of Origin";

(3): The ranges result from different limits for white and red must, and from different values for different specified wine regions;

(4): Conversion of °Oechsle into °Brix with VinoCalc by Jonathan Musther, <http://www.musther.net/vinocalc.html>; Nov. 2015.

In Table 2-3 we have collected the similarities and differences between the grades with respect to six important binary wine attributes. The most important difference between a "Qualitätswein" and any of the six Prädikat-grades certainly is that a "Qualitätswein" may be chaptalized whereas chaptalization is prohibited for all "Prädikat"-grades.

Table 2-3: Similarities and differences between "Qualitätswein" and "Prädikat"-grade wines

Characteristic	"Qualitätswein"	"Prädikat"-grades
Quality tested	Yes	yes
Grapes from specified region	Yes	yes
Grapes vinified in specified region	Yes	yes
Only <i>vitis vinifera</i> varieties	Yes	yes
Oak chips permitted	Yes	no
Chaptalization permitted	Yes	no

In Table 2-4 we compare variable characteristics of "Qualitätswein" and the "Prädikat"-grades. Again, the grades are located at different levels on a gradient of minimum must weights, where must weight is an indicator for ripeness of the grapes: the grapes of a "Kabinett" wine of a specific variety and region have a higher must weight than the grapes of "Qualitätswein" of the same variety and region, a "Spätlese" has a higher must weight than a "Kabinett", and so on, all the way up to the "Trockenbeerenauslese". Note that the ranges of the minimum values in Tab 2-4 result from the aggregation of different minimum values for white and red grapes, and different minima in different specified wine regions.

The gradient of ripeness, measured in terms of minimum must weight, on which the wines from "Qualitätswein" to "Trockenbeerenauslese" are strung out, does not translate into an equivalent gradient of minimum natural alcohol content. The "Qualitätswein" category has slightly lower minimum natural alcohol content requirements than the "Prädikat"-wines "Kabinett", "Spätlese", and "Auslese". Then the gradient breaks and the alcohol contents for "Prädikat"-wines "Beerenauslese", "Trockenbeerenauslese", and "Eiswein" drops to 5.5% minimum natural alcohol. In these sweet desert wines much of the sugar in the must is not fermented to alcohol, and some wines of grades "Beerenauslese", "Trockenbeerenauslese," and "Eiswein" are marketed with alcohol contents below 7%, the threshold below which wine would not be legally recognized as such by U.S. wine law.

In addition to the seven PDO-wine grades that are listed in Table 2-4, there are three grades, which have been grafted onto the quality grading system after 1971, when the grading system was introduced. These are the quality grades "Classic", "Riesling-Hochgewächs", and "Selection", which are differentiated from the Prädikat-grades in fine gradations. Blessed is the consumer who can remember all the details of these add-on categories when deciding at the point of purchase which bottle to buy.

Table 2-4: Variable characteristics of "Qualitätswein" and of the "Prädikat"-grades

Quality category	Grapes and must							Vinification			Wine	
	Natural minimum must weight ⁽¹⁾ / natural min. alc. content				Max. yield	Hand picking required	Berry condition at harvest	Must enrichment allowed	Volatile acid	Max. sulfur content ⁽⁴⁾	Minimum natural alcohol content	Maximum alcohol content
	[°Oe]	[°Bx]	[Vol. %]	[hl/ha]					[meq/l]	[mgSO ₂ /l]	[Vol. %]	[Vol. %]
Qualitätswein bestimmter Anbau- gebiete (QbA)	w: 55 - 72 r: 55 - 72	w: 13.5-17.5 r: 13.5-17.5	w: 6.7-9.4 r: 6.7-9.4	80 - 125	no	n. s. ⁽⁶⁾		Zone A: 3 Vol. % Zone B: 2 Vol.% (3)	w: 18 r: 20	w-dry: 200 w-non-dry: 250 r-dry: 150 r-non-dry: 200	Zone A: 7.0 ^(3,5) Zone B: 8.0 ⁽³⁾	15.0
Prädikatswein												
Kabinett	w: 70 - 85 r: 73 - 85	w: 17.1-20.5 r: 17.7-20.5	w: 9.1-11.4 r: 9.5-11.4	80 - 125	no	n. s. ⁽⁶⁾		no	w: 18 r: 20	w-dry: 200 w-non-dry: 250 r-dry: 150 r-non-dry: 200	Zone A: 9.5 ^(3,5) Zone B: 10.0 ⁽³⁾	n. s. ⁽⁶⁾
Spätlese	w: 78 - 92 r: 80 - 95	w: 18.9-22.0 r: 19.3-22.7	w: 10.3-12.5 r: 10.6-13.0	80 - 125	no	fully ripe		no	w: 18 r: 20	r-dry: 150 w-dry: 200 non-dry: 300	Zone A: 9.5 ^(3,5) Zone B: 10.0 ⁽³⁾	n. s. ⁽⁶⁾
Auslese	w: 85 - 105 r: 88 -105	w: 20.5-24.9 r: 21.1-24.9	w: 11.4-14.5 r: 11.9-14.5	80 - 125	no (yes) ⁽²⁾	individually selected fully ripe		no	w: 18 r: 20	r-dry: 150 w-dry: 200 non-dry: 350	Zone A: 9.5 ^(3,5) Zone B: 10.0 ⁽³⁾	n. s. ⁽⁶⁾
Beerenauslese (BA)	w: 110-128 r: 110-128	w: 26.0- 29.8 r: 26.0-29.8	w: 15.3-18.1 r: 15.3-18.1	80 - 125	yes	selected fully ripe & botrytized		no	30	non-dry: 400	5.5	n. s. ⁽⁶⁾
Eiswein	w: 110-128 r: 110-128	w: 26.0- 29.8 r: 26.0-29.8	w: 15.3-18.1 r: 15.3-18.1	80 - 125	no (yes) ⁽²⁾	harvest at max. -7°C		no	30	non-dry: 400	5.5	n. s. ⁽⁶⁾
Trockenbeerenauslese (TBA)	w: 150 r: 150	w: 34.3 r: 34.3	w: 21.5-22.1 r: 21.5-22.1	80 - 125	yes	over-ripe & botrytized		no	35	non-dry: 400	5.5	n. s. ⁽⁶⁾

Sources: Blau and Nickenig (2015); BMEL (2014); DWI (2015a);

(1): Conversion of °Oechsle into Brix with VinoCalc by Jonathan Musther, <http://www.musther.net/vinocalc.html>; Nov. 2015;

(2): Federal law does not require hand picking of grapes for Auslese and Eiswein but State law may prescribe hand picking of Auslese and Eiswein grapes;

(3): Zones as determined by the EU Commission; Zone A in Germany: All wine-growing regions with the exception of Baden; Zone B in Germany: Baden;

(4): Max. permissible total sulfur content depends on sugar (glucose + fructose) content of the wine; "dry": < 5 g sugar/l; "non-dry": > 5 g sugar /l;

(5): In some areas of the Mosel, Mittelrhen, Ahr and Saale-Unstrut regions reduced to 6.0 % for QbA-wines and to 9.0% for Prädikat-wines;

(6): not specified.

The attribute "Classic" may be used for a single-variety "Qualitätswein" whose variety is typical for the wine region, such as Riesling from the Mosel or Rheingau wine regions, and which meets three criteria: (i) the must weight is higher by 6 or 7 °Oe (1.54 or 1.8 °Bx) than the minimum must weight required for a "Qualitätswein" of the same grape variety and wine region, but falls short of the minimum requirements for a "Kabinett"-wine; for example the minimum must weight for a Mosel Riesling "Qualitätswein" is 55 °Oe (13.56 °Bx), 61 °Oe (14.97 °Bx) for a Mosel Riesling "Classic", and 73 °Oe (17.74 °Bx) for a Mosel Riesling "Kabinett"; (ii) the total alcohol content is at least 12%, (11.5% for "Classic" from the Mosel) (the total alcohol content is the sum of the actual alcohol content plus the potential alcohol content that would obtain from converting the residual sugar of the wine into alcohol). Finally, (iii) the residual sugar content of the wine must not exceed 15 g/l and may be no higher than double the total acidity, measured in terms of grams of total acid per liter [g/l], of the wine. The varieties that may be used for "Classic"-wines are specified for the wine regions and the names used for the varieties are regulated. In particular, the variety names "Müller-Thurgau" and "Ruländer" are prohibited for "Classic"-grade wines and synonyms such as "Rivaner" or "Grauburgunder" must be used instead (LWK-RP 2011a). Apparently, the drafters of the statute that introduced the "Classic"-category considered changing the variety name as sufficient for differentiating a wine in the perception of consumers. Whether such national naming rules are conducive for the protection of consumers from error, which EU legislation wants to promote, is a question that we cannot pursue here.

The attribute "Hochgewächs" may be used for Riesling-wines that meet three requirements: (i) all the requirements of a "Qualitätswein"; (ii) their must weight is 7 °Oe (1.8 °Bx) higher than the minimum must weight of a Riesling "Qualitätswein" from the same region, and (iii) the wine has been awarded at least three of five points in the mandatory quality test, which is described later in this section. In some sense, a "Hochgewächs" is a Riesling "Classic" that has been rated above average.

The requirements for a "Selection"-wine are more stringent than those for a "Classic"-wine. Like a "Classic"-wine, a "Selection"-wine must meet the requirements of a "Qualitätswein". Moreover, the minimum must weight for most varieties in wine regions of Rheinland-Pfalz are in the range of 88-90 °Oe (21.13-21.57 °Bx) and thus similar to the minimum must weight requirements for "Spätlese"-wines from these regions. Different from "Spätlese"-wines, however, "Selection"-wines must have been harvested by hand from an "Einzellage", and the maximum wine yield is limited to 60 hl/ha (~ 4 t/ac grape yield). The style of a "Selection"-wine must be equivalent to a dry wine with regard to its content of residual sugar and total acidity, but the wine may not be called "trocken" on the label nor must "Selection" be used in connection with the declaration of a "Prädikat". "Selection"-wine must be cellared until September 1 in the year after the grape harvest (LWK-RP 2011a).

2.1.5 Wine style

The taste of a wine is determined by many compounds but for its standardized description on a label only four terms are legally defined: the wine may be described as "trocken" (dry), "halbtrocken" (off-dry), "feinherb" (dryish), "lieblich" (mild), and "süss" (sweet). The definitions are of two kinds: "lieblich," and "süss" are defined by reference to the residual sugar content of the wine alone (see Tab. 2-5). For the styles "trocken" or "halbtrocken" one of two criteria may be used: either a range of absolute levels of residual sugar, or a range that depends on a combination of residual sugar content and total acidity content. With either criterion a certain tolerance is permitted (Blau and Nickenig 2015).

For example, a wine with less than 4 ± 1 g/l residual sugar content is a dry wine. However, a wine with 8 ± 1 g/l residual sugar may also be declared as a dry one if its total acidity is, for example, 6 g/l because then, according to the formula in Tab. 2-5: $8 \pm 1 < \min \{9; 6+2\}$; if the acidity of that wine were as low as 4 g/l, the wine would not be deemed "trocken" because then its residual sugar content would exceed the limit given by $\min \{9; 4+2\}$; the wine would then have to be declared as being "halbtrocken".

Table 2-5: Residual sugar content and wine style

Wine style		Criteria (either... or) ⁽¹⁾	
<i>German</i>	<i>English</i>	Residual sugar content [g/l]	Residual sugar content in relation to total acidity [g/l]
trocken	dry	≤ 4	$\leq \min \{9; \text{total acidity} + 2\}$
halbtrocken	off-dry	$> 4 - 12$	$> 9 - \min \{18; \text{total acidity} + 10\}$
lieblich	mild	$> 18 - 45$	-
süß	sweet	> 45	-

Data source: Blau and Nickenig (2015);

(1): all sugar content values apply with a tolerance of ± 1 g/l.

2.1.6 The bottler

Making wine involves three distinct processes, each with an impact on the qualities of the final product and each requiring distinct skills: the growing and harvesting of the vine grapes, the vinification of the grapes into wine, and the blending of wines into the wine that is finally bottled, cellared, and sold. For most wines several agents - persons or organizations - are involved in grape growing, vinification, blending, and bottling but the label on the bottle names only one: the bottler of the wine. The bottler is defined by Article 56 of EU Regulation (EC) No 607/2009 as the agent "carrying out bottling or having bottling carried out on their behalf". This implies, if a winery A contracts with bottler B to bottle winery A's wine, the winery A is shown on the label as the bottler and not the bottler B who actually filled the wine into the bottles. The term "bottling", in turn, is defined by that Article as "putting the product concerned in containers of a capacity not exceeding 60 litres for subsequent sale". Hence bottling implies that the bottler intends to offer the bottled wine for sale.

The language of the label distinguishes several types of bottlers, such as the simple, unadorned "Abfüller" or bottler, the "Kellerei" or winery, the "Weingut" or wine estate whose wine maker has gone through oenological training, or the "Schloss", i.e. an old building in which the bottler resides and which has been recognized as a "Schloss" by the authorities (Blau and Nickenig 2015).

2.1.6 Type of bottling

The semantic of the wine label makes a distinction between different types of bottlings according to the origin of the grapes from which the wine was made, and according to the type of bottler. If the grapes were produced by the same agent who bottled the wine, the wine is an "Erzeugerabfüllung" (producer bottling). Moreover, in the name of an "Erzeugerabfüllung," the type of bottler may be indicated; thus we may have a "Gutsabfüllung" (estate bottling) if a "Weingut" (estate) has bottled a wine from grapes that it has produced. In contrast, a wine from a "Weingut" is not a "Gutsabfüllung"

if the grapes were produced by vine growers other than the Weingut; in such cases the name of the Weingut may appear on the label together with the term "Abfüller" (Blau and Nickenig 2015).

When the bottler is a winery that blends and bottles wines that have been produced – but not bottled – by other winemakers, this winery is the bottler of the wines it brings to market. If this winery also operates some vineyards, it may label as an "Erzeugerabfüllung" those wines it has vinified from grapes grown in vineyards operated by it.

Vintner co-operatives do not usually grow grapes but they vinify and bottle wine vinified from grapes produced by their members. Are they the "Erzeuger" of a wine or only its "Abfüller"? The law regards them as the "Erzeuger" of wines that have been produced from grapes grown by one or several of the co-operative's members.

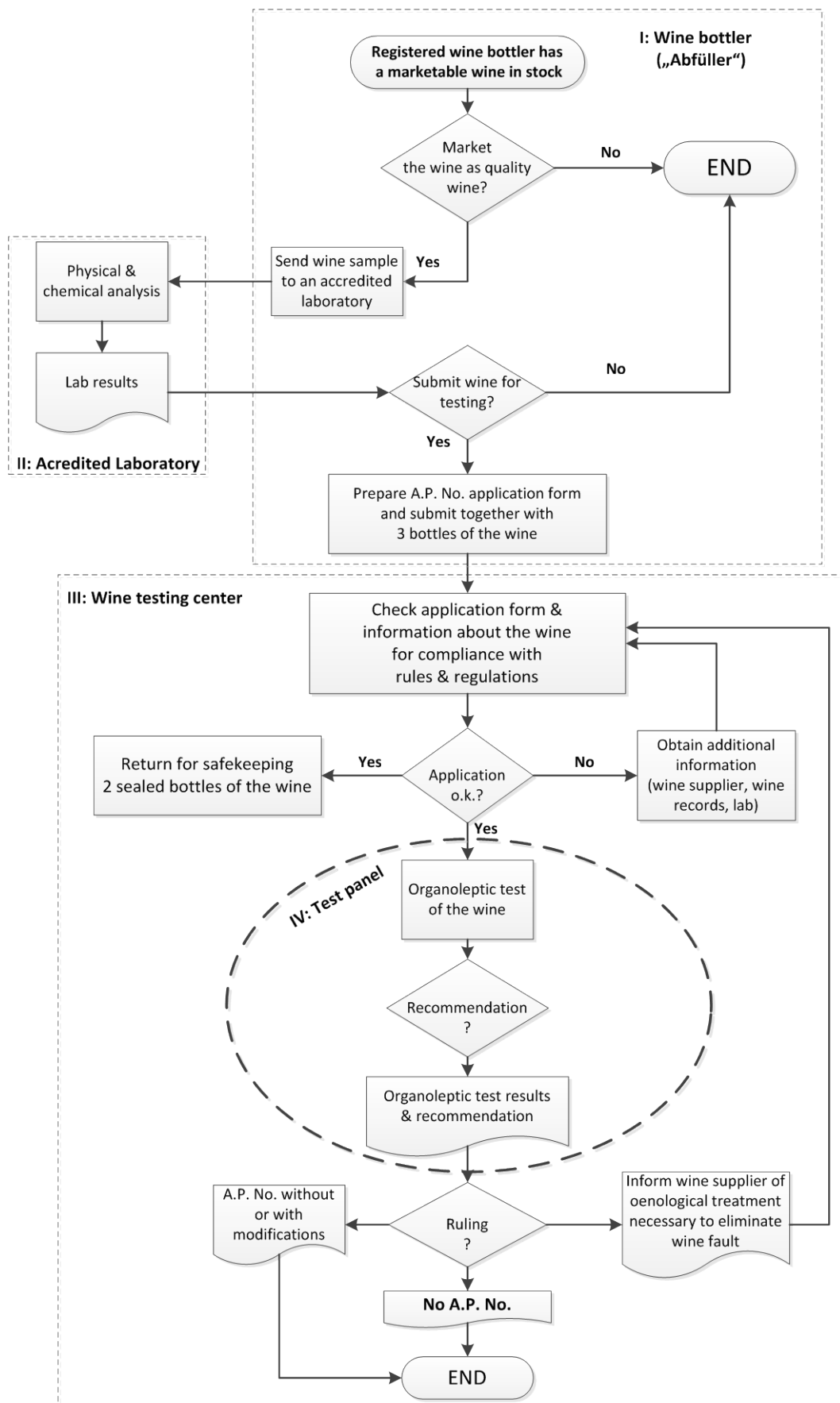
2.2 What you don't see: The A.P. Nr. assignment process

The label on a bottle of wine is the interface that connects the consumer of a bottle of German quality wine with the quality assurance system. Printing information on a label is easy because paper, as they say, is patient. Assuring that the information on a label is valid requires, however, the coordinated efforts of skilled specialists, and of rules that are enforced. Whereas the information on a label was the subject of Section 2.1, we now turn to the process that assures the validity of the information on the label of a bottle of German quality wine.

Because of some idiosyncrasies of the German legal system, the individual states have some discretion in designing details of their testing system for quality wine. We do not intend to parade here the systems seven wine-growing states of Germany have put in place. For concreteness we refer to the procedures that are employed by the Chamber of Agriculture in Rheinland-Pfalz (LWK-RLP), which is the agency mandated with testing quality wine for the six of Germany's 13 wine regions located in the state of Rheinland-Pfalz (see Tab. 2-1). In 2012 and 2013, the wines tested by the six test centers of the LWK-RLP represented, by volume of the tested wines, 66 percent of all quality wines tested in Germany in that two-year period (DWI 2015b). The details of the procedures may vary between states, but the key elements are the same in all states: declaration of the quality grade by the bottler, wine analysis by a laboratory, blind organoleptic testing by a panel of qualified examiners, rating of the wine on a 5-point scale, and assignment of an A.P. Nr. for wines that have passed the test.

Before we enter into the details of the testing and validation process, the flowchart in Figure 2-3 provides an overview of the process. In this flowchart an oval denotes a terminator of the process, a rhombus stands for a decision, a rectangle symbolizes a process, a rectangle with the lower edge replaced by a wave indicates a document, and the arrows indicate the sequence in which things happen.

Figure 2-3 Flowchart of the A.P. Nr. assignment process



The process starts when a bottler has wine that is ready for bottling and for selling. The bottler must decide the grade under which the wine should be sold: if the wine is to be sold as a non-quality wine, then the wine does not need an A.P. Nr. and no tests are required. If the wine is deemed to be of quality wine grade, the wine will need to be analyzed for certain physical, chemical, and microbiological properties by a laboratory that has been accredited by the state.

With the lab report in hand, the bottler proceeds to apply for an A.P. Nr. For this, the bottler needs to submit three bottles of the wine for which he requests an A.P. Nr. and an application form. Among many other things the bottler must declare on the form the specific details about the wine which shall be put on the label, e.g. the grade, style, vineyards, etc.

The testing agency then checks the application for completeness and consistency. If the agency is satisfied with the application, the wine is entered into an organoleptic analysis where the wine is tasted blind by a panel of certified, independent wine examiners who rate the wine on a scale from 0-5.

The wine testing agency summarizes the examiners' reports and decides whether the wine is assigned an A.P. Nr., or not. The applicant is notified of the result, and, if not satisfied with the result, may object to the ruling by the testing agency.

With the overall process in mind, we may now turn to the details of certification procedure.

2.2.1 Filing an application for an A.P. Nr.

An applicant for an A.P. N. must submit to the wine testing agency (i) a filled in and signed application form, and (ii) three specimen bottles of the wine for which an A.P. Nr. is requested.

Of the three specimen bottles, one is used for the organoleptic test and two are sealed and returned to the bottler for safe-keeping for two years. (Figure 2-4 shows an employee of the LWK-RLP testing center at Alzey sealing two specimen bottles of a wine.) The sealed bottles are kept in case they are needed to settle disputes over the testing agency's ruling about the wine. A wine that has not yet been bottled may also be submitted for an A.P. Nr. but once such a "barrel wine" has been assigned an A.P. Nr. it must be bottled within a certain period.

Figure 2-4: Sealing of specimen bottles of wine submitted for an A.P. Nr.



Source: L. Tauscher, LWK-RLP, Alzey.

The key document in the disclosure and certification process is the application form for the A.P. Nr. Explanations for the form are available online from LWK-RLP (2011b). The form comprises eight sets of information:

- 1) Bottler identification and A.P. Nr. elements;
- 2) wine description;
- 3) wine analysis results;
- 4) wine number and volume;
- 5) organoleptic test result (to be filled in by the laboratory);
- 6) sugar and alcohol content;
- 7) source of the grapes and composition of the wine;
- 8) confirmation of truthful disclosure and consent to the inspection of winery records.

We now turn in sequence to the information items which the bottler must supply in their application for an A.P. Number for a wine.

2.2.1.1 Bottler identification and A.P.Nr.-elements

Applicants must provide their name and address information, and their enterprise number. The enterprise number is a unique identifier of the bottler. Such a number is assigned by the LWK-RLP to all wine producers, wine estates, wineries, or wine commission traders.

The applicant must also fill in elements of the A.P. Nr. that the wine will be given if approved by the certification authority. The A.P. Nr. consists of four components as explained in Section 2.1.

2.2.1.2 Wine description

The wine is described in the application form in terms of nine items. If the wine passes testing and is awarded its A.P. Nr., the items must be shown on the label as specified in the application form:

- 1) vintage;
- 2) location and vineyard;
- 3) grape variety/ies;
- 4) Riesling-Hochgewächs (yes/no);
- 5) quality grade ("Qualitätswein" or one of the six "Prädikat"-grades);
- 6) type of bottling (producer bottled, estate bottled, winery bottled);
- 7) wine type (e.g. sparkling, red, or rose wine; "Weissherbst", "Rotling");
- 8) wine style (dry, off-dry, mild, sweet, "Classic", "Selection");
- 9) additional declarations.

Bottlers have several choices for declaring the geographic origin of their wine: they may declare:

- the names of the location, wine region, and site;
- the name of the location alone without declaration of the site;
- the "Bereich" (district) instead of the "Ortsname" (location), or
- the name of the wine region only.

Applicants have some discretion over the declaration of the quality grade. In particular, they may understate the quality grade, but they may not overstate it. Thus, an applicant may declare his or her wine to be a "Qualitätswein" when the wine actually is of "Kabinett" grade, and bottlers may understate the "Prädikat"-grade of the wine for which they seek an A.P. Nr. The practice of understating the quality grade of their wines is particularly wide spread among members of the VDP, a voluntary association of wine estates that has developed a wine quality grading system that has replaced the "Prädikat"-grades with their own quality grades for dry wines (see section 6).

2.2.1.3 Wine number and volume

Another set of data concerns some wine bookkeeping issues, such as whether the wine that is submitted for quality testing has already been bottled and how much of it has been bottled, when the bottling was done, and whether the wine has been sweetened and by how much.

Most importantly, in this section of the form the applicant must provide the wine number which identifies the wine in the wine records of the bottler.

2.2.1.4 Sugar and alcohol content

The must weight is the main criterion for grading German wines and chaptalization is permitted for "Qualitätswein" but not for "Prädikat"-grade wines. Applicants therefore must declare the must weight of the natural alcohol content of the wine for which they want an A.P. Nr. In addition, applicants must disclose in the application form by how much the wine has been enriched, and how the enrichment is measured either in terms of sugar or percent alcohol.

2.2.1.5 Source of the grapes and composition of the wine

The source of the grapes from which a wine has been vinified is decisive for whether the wine may be called an "Erzeugerabfüllung", "Gutsabfüllung", or "Schlossabfüllung", or whether the bottler is a simple, unadorned "Abfüller". The applicant therefore needs to disclose whether all of the grapes from which the wine has been produced were produced by the applicant or whether some or all of the grapes have been purchased.

In addition, the applicant must describe the composition of the wine in terms of vintage, geographic origin, and grape varieties.

2.2.1.6 Confirmation of truthful disclosure and consent to the inspection of winery records

Finally, the applicant declares with his or her signature on the application form that

- the described wine has been produced in compliance with the relevant laws and regulations;
- all required entries have been made in the winery records and winery records are open to inspection by the certification authority (see section 2.2.3.3);
- the submitted wine sample is an average sample which reflects the actual composition and condition of the bottled wine, and
- all disclosures have been made to the best knowledge and beliefs.

2.2.2 Laboratory analysis

The bottler must report on the application form the results of a chemical analysis of the wine. The analysis must have been performed by a government-certified laboratory and the results may not be older than three months. In particular, the bottler must report:

- 1) total alcohol content [g/l or %vol];
- 2) actual alcohol content [g/l or %vol];
- 3) total extract content [g/l];
- 4) sugar free extract content [g/l];
- 5) fermentable sugar content [g/l];
- 6) total acid content [g/l];
- 7) free sulfurous acid [mg/l];
- 8) total sulfurous acid [mg/l], and
- 9) relative density.

2.2.3 Checking the A.P. Nr. application

In disclosing the details about a wine submitted for quality certification some bottlers may err and some may lie. How can the certification authority detect errors and lies in the disclosed information? There are three methods that the certification authority may employ for validating the information disclosed on the form: Consistency checks, plausibility checks, and comparison of the data entered into the form with data from other sources. Such a source is the winery records that, by law, bottlers must keep.

Certification authorities routinely scrutinize the consistency and plausibility of the data on the application form as part of the certification procedure. Comparison of the data disclosed by a bottler with the bottler's winery records is much more costly to perform and it is not routinely done.

2.2.3.1 Consistency checks

There are many opportunities for cross-checking the data on an A.P. Nr.-application form and we do not intend to list them all. Two are obvious.

Mutually exclusive claims are candidates for cross-checking. For example, a wine cannot be one with a "Prädikat"-grade and be a "Selection"-wine at the same time; nor can a wine be an "Erzeugerabfüllung" and have been made from grapes or wines that the bottler has purchased from grape growers and wineries.

Moreover, the various quantitative limits with regard to sugar content, alcohol content, and total acidity are opportunities for cross-checking the disclosed data for errors and willful misrepresentations. For example, a wine from a must with a weight of 60 °Oe (14.74 °Bx) cannot be a "Spätlese", and a wine for which the analytic results by the laboratory indicate a residual sugar content of more than 9+1 g/l may not be called "trocken", irrespective of its total acidity.

2.2.3.2 Plausibility checks

Most staff of the certification authority are trained oenologists and all have accumulated much experience from the many wines that pass through the individual certification centers each year. Such staff can be expected to detect cases of implausible claims made by applicants. For example, in most years red "Prädikat"-wines from Rheinhessen would be met with suspicion, as would a Riesling "Auslese" from Franken.

2.2.3.3 Comparison with winery records

Detection of implausible and inconsistent disclosures is proof of error but not of lying. The certification authority may, however, detect lies by inspecting the winery records of a bottler. By law, any enterprise involved in the production and trade with wine must maintain a "Weinbuchführung," or winery records, which is a set of interlinked records that document key resources, activities, substances, and changes in stock of wine and intermediate wine products employed by a wine enterprise (Schandelmaier 2013).

Key elements of the winery records are the list of vineyards, the "Herbstbuch," or harvest record, the "Weinbuch," or wine record, and the "Stoffbuch," or substances record (Schandelmaier 2013). The vineyard list specifies the details of the vineyards operated by a winery, in particular, the vineyards' identification numbers in the land register, their exact size, the names of the respective "Einzellagen" (individual sites) and "Grosslagen" (collective sites). The harvest record is updated daily throughout

the grape harvesting period with data on the mass of grapes or the volume of must harvested from a particular vineyard on a particular day, and the must weight of the grapes harvested. In the "Weinbuch" the winemaker records all activities performed with each individual wine, and all changes in the stock of each wine that the winemakers has produced or purchased. Most importantly for tracing a wine, each wine is given a unique number; this is also the number that must be reported as the wine's number in the A.P. Nr.-application form. The substances record, finally, records the stocks and uses of non-wine substances that have been used by the winery as wine additives or vinification agents.

If kept correctly and truthfully, the winery records allow the production of a wine to be traced from the grapes that leave the vineyard to the bottles leaving the cellar. Even if the bottler has not produced the wine, and even if the producer has made the wine from purchased grapes, the wine records of the enterprises involved in its creation allow the wine to be traced to the vineyard where its grapes were harvested. In principle, the certification authority may therefore validate each item disclosed on the A.P. Nr.-application form by comparison with an entry in the records of the winery, or even several wineries, that have been involved in the creation of a wine. The effort required for such a validation is, however, considerable and militates against routine inspection of wine records.

2.2.3.4 Validating the type of bottler

The certification authority may validate the type of bottler using a bottler register that it maintains. In the state of Rheinland-Pfalz any wine bottler must register with the certification authority in order to obtain an enterprise identification number. In the application for an identification number the applicant must declare the dominant type of his or her enterprise, choosing from a list of 11 options. This list comprises, among others, the options "Weinbau/Weingut" (wine estate), "Winzergenossenschaft" (vintner cooperative), "Anerkannter Erzeugergemeinschaft" (approved producer group), "Weinhandel/Weinkellerei" (wine trader/winery), and "Kommissionär" (commission trader). The enterprise identification number must then be declared in the application for an A.P. Nr. when a wine is submitted for quality testing. Comparing the enterprise number in the application for an A.P. Nr. with the entry in the enterprise registry allows the wine testing center to verify the type of bottler.

2.2.4 Organoleptic test

Wines that aspire to become "Tested Quality in the Glass" must pass an organoleptic or sensory test. The number of wines that pass through this "eye of the needle" (Fuchß 2011) is considerable: the chamber of agriculture, which is mandated to conduct the tests in the state of Rheinland-Pfalz, examines about 120,000 wines each year. As the wine regions of Rheinland-Pfalz account for about two-thirds of German wine production, an estimated 180,000 wines are tested in Germany in each year. Whether this "eye of the needle" is narrow or wide is difficult to say. A rejection rate in the low single-digit percentage range suggests that German wine defies by a wide margin Sturgeon's law which holds that 90 percent of everything is crap (Dennett 2013). Moreover, re-submission of a rejected wine is permitted and the probability that a wine is eventually assigned an A.P. Nr. is likely to increase with each submission, albeit by a declining rate. We do not have any evidence, however, that applicants actually consider such probabilities when deciding to resubmit a rejected wine. Simple economic reasoning suggests that bottlers may have little or no incentive to re-submit a rejected wine for testing. A bottler of a wine that has not passed examination has nothing to gain from re-submitting that wine for testing if the testing procedure discriminates reliably between

quality and non-quality wines. The bottler has, however, to put up with the time delay associated with re-submitting a wine for testing, and he or she has to bear the expense of filing anew an application for an A.P. Nr.

For our description of the organoleptic testing protocol we relied on several sources. Blau and Nickenig (2015) and DWI (2012) provide useful short accounts of the test procedure. A detailed account of the organoleptic testing procedure has been supplied by staff of the LWK-RLP (Lambrich, n.d). Moreover, one of the co-authors (RAEM) has participated in 2012 in an organoleptic training course conducted by the Alzey wine testing center of LWK-RLP (disclosure: RAEM did not pass the final test). Finally, one co-author (LT) is the director in charge of the Alzey wine testing center.

2.2.4.1 Responsibility for wine testing

German PDO-wines are examined at regional testing centers. In some states, such as Hessen (Rheingau and Hessische Bergstrasse), and Bavaria (Franken), the wine testing centers are operated by government agencies. Other states have delegated wine testing to producer organization. In Rheinland-Pfalz (Rheinhessen, Pfalz, Mosel, Nahe, Mittelrhein, Ahr), Nordrhein-Westfalen (Mittelrhein) and Saarland (Mosel), wine testing centers are operated by the chambers of agriculture (Landwirtschaftskammer) of the respective states, and in Baden-Württemberg (Baden, Württemberg) the vintners association of the state is in charge of wine testing.

In Rheinland-Pfalz the Chamber of Agriculture operates six testing centers - three for the Mosel, Mittelrhein, and Ahr regions, and one center each for the wine regions Rheinhessen, Pfalz, and Nahe. The chief administrator of a testing center is responsible for the proper execution of sensory wine testing. This responsibility involves:

- training and examination of wine examiners;
- accepting and processing applications for A.P. Nr.;
- assembling panels of wine examiners;
- arranging wines into suitable test rounds and preparing lists of wines to be tested;
- supervising wine testing rounds by examiners;
- aggregating the points allocated by wine examiners into a single quality number for a tested wine;
- deciding the overall test result, and
- informing applicants about the test results.

2.2.4.2 Wine examiners

The organoleptic tests of wines are performed by independent wine examiners. The examiners are drawn from the wine industry, wine administration, wine extension service, or may be wine consumers with an interest in wine testing.

To be eligible for accreditation as a wine examiner by a testing center, examiners must have undergone a three-day training course in wine tasting and testing, and they must have passed an examination of their wine tasting and testing skills. Wine examiners have a 3-year tenure which may be extended twice. There is a preference for wine examiners below the age of 65 because the ability to taste wines tends to decrease with age.

The wine testing center employs the services of examiners at its discretion and wine examiners have no entitlement for the employment of their services. Examiners are not paid a wage for their services but their expenses are reimbursed and they receive a small allowance.

2.2.4.3 Test panel and testing procedure

The administrator of the testing center organizes testing sessions in which wines are tested by an examination panel. For regular tests that do not include reviews of previous tests, a panel of 4 examiners is assembled of whom at least 3 must be present during the session. Such a panel may test at most sixty different wines on a single day. Review panels consist of 6 examiners of whom at least 4 must be present.

Testing center staff arrange for a blind tasting by the examiners. In particular,

- bottles are fully covered by a bottle-burka so that no information is revealed about the bottler or the wine;
- the wines that are to be tested in a session are sorted by color, quality grade, and residual sugar; red wines are tested first, and sweet desert wines last;
- examination lists of the wines that are to be tested are prepared; the lists specify for each wine of a testing session the quality grade, wine region or district, type of wine, vintage, and variety;
- the lists are given to the examiners who obtain no further information about the wines that they test;
- examiners are assigned to visually separated booths with six wine tasting glasses in each booth (see Fig. 2-5); examiners are instructed not to communicate with each other during tasting;
- wines are poured in rounds of six wines per round and examiners taste and grade the wines;
- a representative of the testing center supervises the tasting.

Testing sessions tend to be intense and relatively short. A session with up to sixty wines may not take much longer than an hour.

The photographs of Figure 2-5 show organoleptic testing sessions in progress. In the left panel we see a container of wines ready for testing, with all bottles neatly covered with identical bottle-burkas. In the background the testing supervisor is pouring wine to an examiner. The examiners are separated by solid panels (right panel). The two gentlemen on the left panel who are not separated from each other are not examiners; they are L. Tauscher (far left) introducing J.T. Lapsley (2nd from left) to the organoleptic wine testing protocol during a session in February 2015.

2.2.4.4 Test criteria and wine evaluation

A wine is tested by each of the examiners in two steps: First, the "sensory preconditions" are assessed, and then, provided the wine has passed this assessment, its "sensory test attributes" are evaluated and the wine's quality number is determined.

Figure 2-5: Examiners at work at the LWK-RLP wine testing center at Alzey, Rheinhessen



Sources: R.A.E. Mueller (left panel) and L. Tauscher, LWK-RLP, Alzey (right panel).

For a still wine, assessment of the sensory preconditions involves checking five characteristics and a yes-or-no decision by each examiner:

- 1) *Is the wine typical for the wine region or district?* If not, the wine is rejected.
- 2) *Is the wine typical for its specific grade?* If the decision is "no" there are three options:
 - (a) a "Prädikat"-wine with a grade other than "Kabinett" may be downgraded by several grades, down to "Qualitätswein";
 - (b) a "Kabinett"-grade wine may not be downgraded;
 - (c) a "Qualitätswein" may be downgraded to the "Landwein"-grade;
- 3) *Is the wine typical for its variety?* If not, the wine is treated as one without a designated variety.
- 4) *Has the wine its typical color?* If not, the wine is rejected.
- 5) *Is the wine clear (not cloudy or opaque)?* If not, the wine is rejected.

After checking the sensory preconditions of a wine and recording the results in the examination sheet an examiner then continues with the evaluation of the wine's smell, taste, and harmony. The term "harmony" describes "the interaction between smell, taste, and sensory preconditions".

Examiners must express and record their judgment of the three wine attributes in terms of points from a 0 to 5 point scale with 0.5 point intervals. The numbers mean:

Table 2-4: Meaning of the points from the 5-point scale

Point range	Meaning
0.0	the wine smells disgusting and tasting it cannot reasonably be expected from an examiner
0.5 - 1,0	not satisfactory; the wine is rejected because of one or several wine faults
≥ 1.5	wine is fault-free
1,5 - 2.0	Satisfactory
2.5 - 3.0	Good
3.5 - 4.0	very good
4.5 – 5.0	Excellent

The points awarded for "harmony" must not be more than 1 point higher than the maximum points given for either smell or taste. From the points for each of the three attributes a wine's quality number is calculated as the simple average of the points for the three attributes.

More formally, for an examiner $k = 1, \dots, 4$ who evaluates a wine for the three attributes $i = 1, \dots, 3$, where $3 := \text{"Harmony"}$, the constraint on the maximum number of points p for harmony is:
 $p(3,k) \leq \max [5.0; \max \{p(1,k), p(2,k)\} + 1]$. A wine's quality number awarded by examiner k is calculated as: $Q(k) = 1/3 \sum(i) p(i,k)$.

Wine examiners are trained to recognize and instructed to report on their wine examination list the presence of one or several wine faults from a set of faults which includes:

- [1] untypical aging UTA (2-aminoacetophenon)
- [2] "Böckser" or "foul eggs"-taint (H_2S ; ethylmercaptan)
- [3] oxidation (acetaldehyde)
- [4] cork taint, (TCA, 2,4,6-trichloranisole)
- [5] volatile acidity (acetic acid)
- [6] acetone- or "glue"-taint (ethyl acetate)
- [7] butter-taint (diacetyl)
- [8] geranium-taint (2-ethoxy-3,5-hexadiene)
- [9] bitter almond taint;
- [10] brettanomyces (4-ethylphenole)
- [11] sulfuric acid (SO_2).

An examiner who detects any one of these faults, or who finds a wine seriously lacking in some other important characteristic required from a quality wine, should evaluate the wine such that its quality number does not exceed 1.3 points. Moreover, wine examiners are held to record in the wine examination sheet:

- their decisions about the five sensory preconditions;
- the points given to a wine for its smell, taste, and harmony;
- the calculation of the quality number Q , and
- when one or several wine faults were found, a note identifying the fault(s).

2.2.5 Test result and report

At the end of a test session the examination sheets are collected and a quality number for the wine is calculated by the testing center. The quality number of a wine is calculated as the simple average of the quality numbers that the examiners have given to the wine. A wine has passed the sensory test and is awarded an A.P. Nr. if its quality number $Q \geq 1.5$, which means that the wine is free of faults.

Based on the sensory test results the chief administrator of the testing center informs the applicant of the wine's examination result. The administrator has four options:

- 1) approve the proposed quality grade and assign an A.P. Nr.;
- 2) reject the proposed quality grade and deny the wine an A.P. Nr.;
- 3) downgrade the wine to a lower quality grade, and
- 4) approve of the proposed quality grade, conditional to changes in the declaration of the wine's grape variety.

Wines that reach a quality number Q of 3.5 or higher are eligible for medals awarded by the Chamber of Agriculture; bronze medals are awarded to wines with quality numbers in the range $3.5 \leq Q < 4.0$, silver medals go to wines with quality numbers in the range $4.0 \leq Q < 4.5$, and gold medals, finally, are for wines with quality numbers of $Q \geq 4.5$. The medals may, but need not, be displayed on the bottles of the wines.

Applicants can expect to receive a test report within 3 weeks or 10 workdays after filing a complete application. A fast-track option is available. Applicants may object in writing to a test result. The objection must be filed within four weeks. After that period the same wine may be re-submitted for testing. There is no limit on the number of re-submissions but a rejected wine that is submitted anew incurs a testing fee.

2.3 Closing remarks

In this section we have described how the German wine certification system works and how the system assures consumers that they have "Tested Quality in the Glass". The complexity of the system is impressive and two questions come to mind: What is the significance – in terms of production and sales - of tested-quality wines in Germany and in its wine regions? And, to what extent are the different wine grades reflected in wine prices? The questions are addressed in the next section.

2.4 Section takeaways

- (1) German wines are classed into nine main grades; the most important criterion for the grades is the must weight of the grapes from which the wine was made;
- (2) the two lowest grades, viz. "Deutscher Wein" and "Landwein," are not considered to be quality wine; "Deutscher Wein" has no geographical indication; "Landwein" is wine with a "Protected Geographic Indication"(PGI);
- (3) the remaining higher grades are "Qualitätswein" and six "Prädikat"-grades ("Kabinett", "Spätlese", "Auslese", "Beerenauslese", "Eiswein", and "Trockenbeerenauslese"); all are wines with a "Protected Geographic Origin" (PGO);
- (4) the option to improve a wine through chaptalization discriminates between "Qualitätswein" and all of the "Prädikat"-grade wines: "Qualitätswein" may be chaptalized, "Prädikat"-grade wines may not;
- (5) German PGO-grade wines are produced from *vitis vinifera* varieties; varieties are officially approved for each of thirteen specified wine regions;
- (6) all German PGO-grade wines have an A.P. Nr. printed on the label; this number is evidence that the wine has been officially examined and is deemed to be "Tested Quality in the Glass";
- (7) "Tested Quality in the Glass" is an information certification technology: wine bottlers (estates, wineries, cooperatives, etc.) suggest the grade under which they intend to market a wine and they submit the wine at the time of bottling to a testing center for examination;
- (8) a wine's examination involves three activities: (i) chemical and physical analysis by a laboratory; (ii) review by the testing center of the plausibility and legality of the claims the bottler intends to make on the label, and (iii) sensory examination by a panel of trained experts;
- (9) wines are tested blind by the experts who check for wine faults and who rate each wine on a 0-5 point scale for its odor, flavor, and harmony;
- (10) testing center may lower the grade of a wine, but may not raise the grade above the one claimed by its bottler.

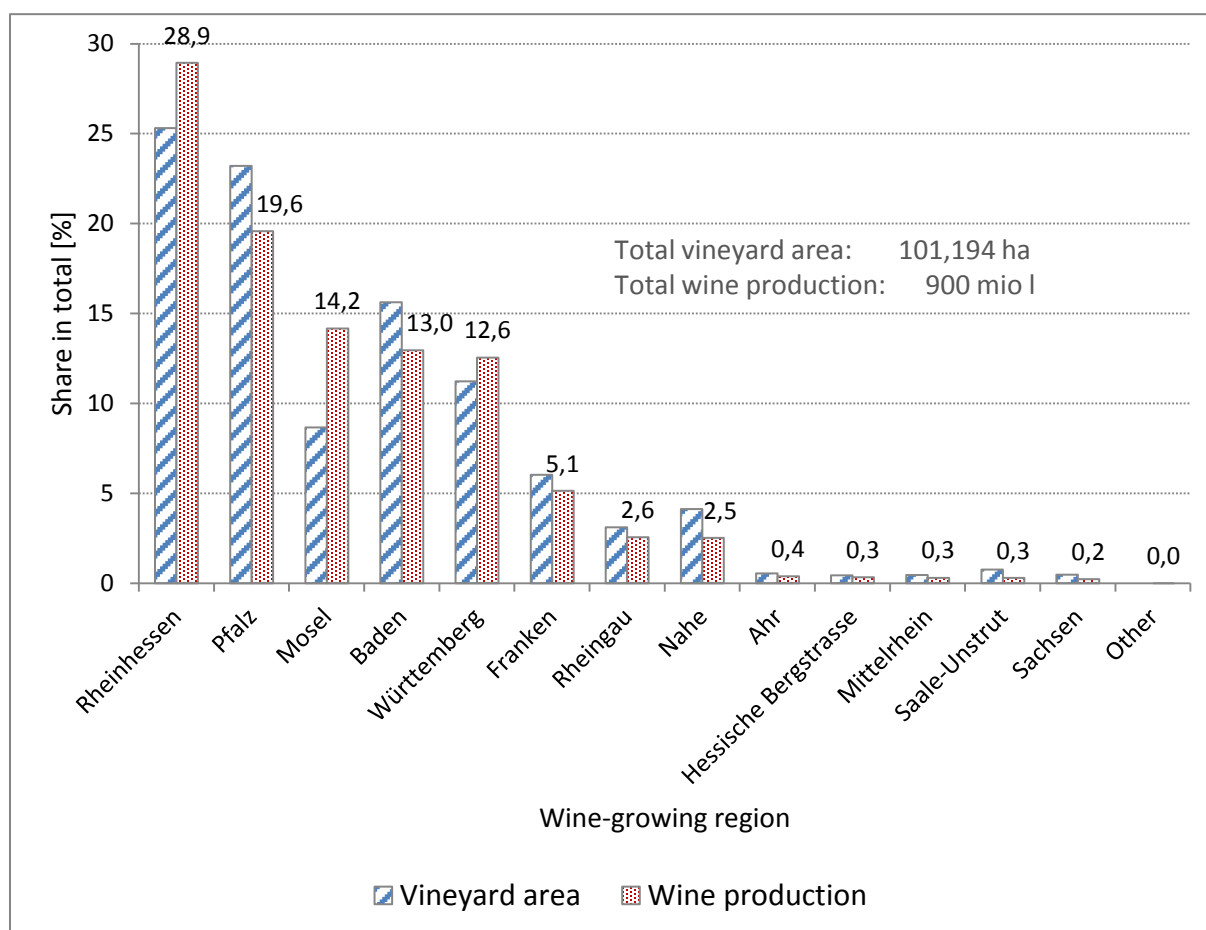
3 PRODUCTION, EXPORTS, AND PRICES OF GERMAN QUALITY WINES

3.1 Overview of wine production in Germany

3.1.1 Wine growing regions

In Germany, slightly more than 20,000 viticultural enterprises produced in 2012 about 900 mio l (100 mio cases) of wine from slightly more than 100,000 ha (247,000 acres) of vineyard area. At this level of production Germany was the world's 10th largest wine producer after South Africa (1bn l or 111 mio cases) and Portugal (610 mio l or 68 mio cases). Germany ranks 15th in the world in terms of vineyard area; it is one notch behind Greece (110,000 ha) and one before Brazil (91,000 ha). In Section 2 we have already introduced the 13 wine regions where PDO-grade wines may be grown. The size distribution of the wine-growing regions, both in terms of vineyard area and in terms of volume of wine produced, is shown in Fig. 3-1.

Figure 3-1: Shares in total vineyard area and in wine production of Germany's wine-growing regions, 2012



Source: DWI (2013). Deutscher Wein Statistik 2013/2014.

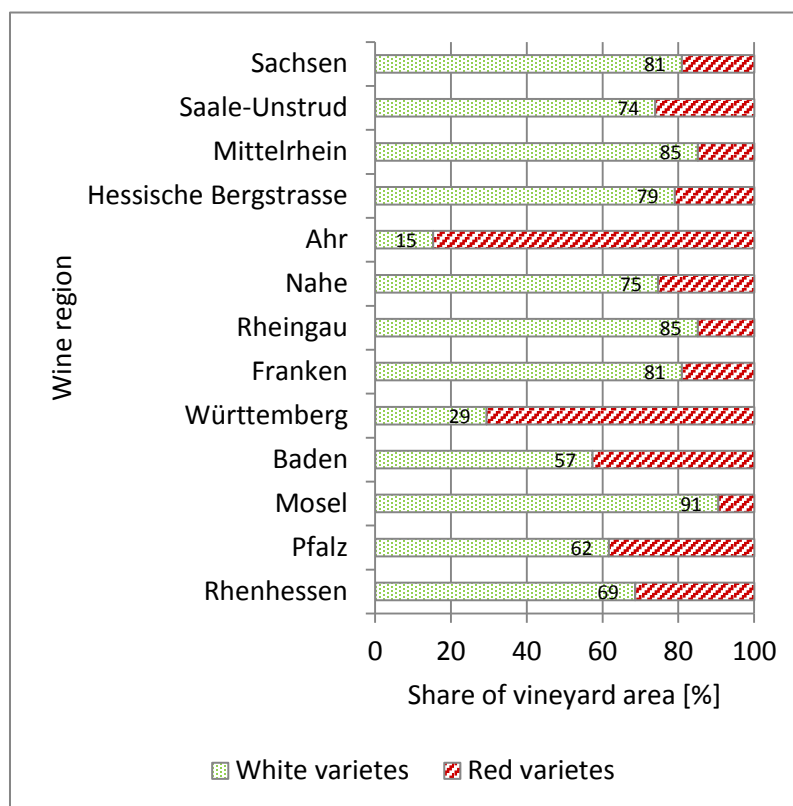
On the basis of their vineyard areas, the wine regions can be divided into three groups (see Fig 3-1): Regions of the first group, comprising Baden, Pfalz, Rheinhessen, and Württemberg, all have large vineyard areas in excess of 10,000 ha (24,700 acres). A second group of mid-sized regions has vineyard areas in the 4-digit hectare range; these are the regions Franken, Mosel, Nahe, and Rheingau. Finally, there are five small wine regions with fewer than 1,000 ha (2,470 acres) of

vineyard area; these are the regions Ahr, Hessische Bergstrasse, Mittelrhein, Saale-Unstrut, and Sachsen.

3.1.2 White and red wines

The annual temperature-sum of the climate in Germany is more favorable for white wines than for red ones. Nevertheless, the area under red varieties has increased from about 25 percent of total vineyard area in Germany in 2000 to about 36 percent in 2012 (DWI 2013). The shares of vineyard area under white and red varieties vary considerably. The Ahr and Württemberg regions have particularly high shares of their vineyard areas under red varieties, whereas white grapes occupy 85 percent or more of vineyard area along the Mosel and on the banks of the Rhine in the Rheingau and Mittelrhein regions.

Figure 3-2: Proportion of vineyard area under red and white varieties, by wine region, 2012



Source: DWI (2013). Deutsche Wein Statistik, 2013/14.

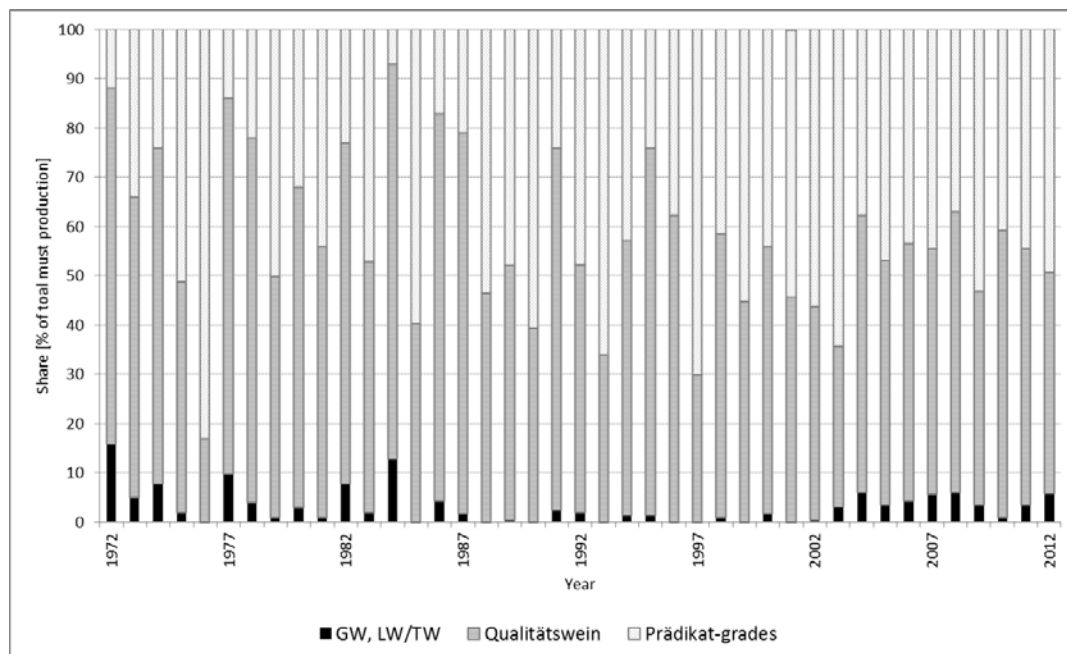
3.2 Production shares of the quality categories

Time series data on the shares of must suitable for three wine quality categories, i.e. for wines below "Qualitätswein", for "Qualitätswein" and for the "Prädikat"-grade wines have been published by the German Wine Institute (DWI) for the period 1972 to 2012 and are shown in Fig. 3-3. Two characteristics of the data series need to be mentioned. The quality categories of this series are not identical to the grades used for distinguishing German wines. Grades are based on a set of characteristics (see Tab. 2-4) and they are verified in an elaborate testing procedure. The quality categories in the series shown in Fig. 3-3, in contrast, are based only on one characteristic, the weight of the must, and they are reported by wine producers soon after the winegrape harvest. At that time the vinification of many wines is not yet complete, their quality grades are still unknown, and few, if

any, wines from the new harvest have been bottled and quality-tested. The quality categories reported in the statistical series of must production are therefore qualified with the term "geeignet für" (suitable for) by the German statistical office which is the source of the data published by DWI. Because the grade for which a must is suitable cannot improve after harvest, and because wine makers may choose for various reasons to market the finished wine under a lower than the highest possible grade, the volumes of must of a potential grade tend to exceed the volumes of wines that are eventually marketed with that grade. Moreover, the series straddles two different eras of EU quality schemes: the past era when wine quality was defined in terms of wine factors, and the current era when quality grading is based on geographic origin. For reasons that we explain in Section 4, the distinction is of no practical concern for the grades "Qualitätswein" and the "Prädikat"-grades but it has affected the grades below "Qualitätswein", which used to be either "Grundwein" (GW), "Tafelwein" (TW), "Landwein" (LW). These grades account, however, for only a small proportion (~ 3.3 percent on average) of total must production and in no year did their share exceed 16 percent.

Grape must suitable for "Qualitätswein" dominates national must production with a share of 54.5 percent on average during the 41 year period. The shares of must suitable for "Prädikat"-grade wines range from a low of 7 percent of national must production to a high of 83 percent, with an average of 42.1 percent. Poor years for wine production were the years 1972 and 1984; in these years the shares of must that were deemed unsuitable for quality wines were particularly high (16 and 13 percent, respectively) and the shares of must suitable for "Prädikat"-grades were particularly low (12 and 7 percent, respectively).

Figure 3-3: Development of the shares of must suitable for "Deutscher Wein/Landwein" and equivalent grades, for "Qualitätswein", and for wines of "Prädikat"-grades, Germany, 1972-2012.



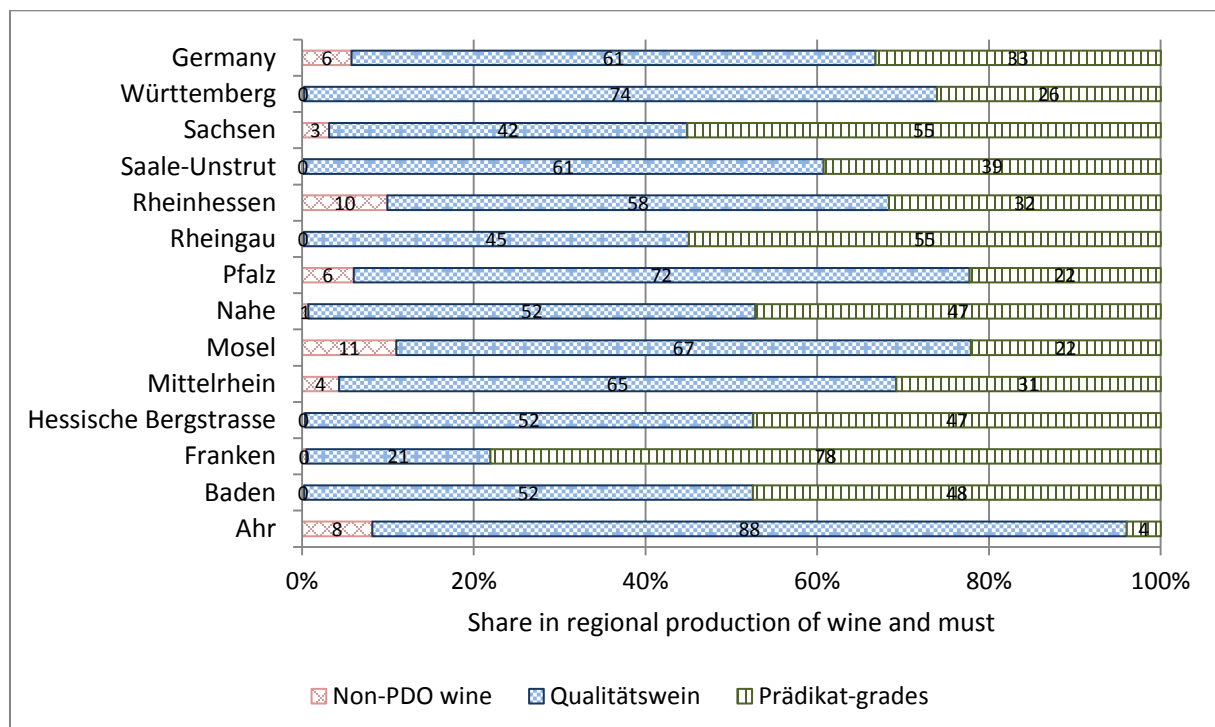
Source: DWI (2013). Deutscher Wein Statistik, 2013/14.

3.3 Regional variation of wine quality

In Figure 3-4 we examine for the year 2012 the variation across wine regions in the shares of wine quality categories in regional wine production. The data are again based on reports that wine producers have to submit on or before January 15 of each year. There are three data issues that we need to address here. First, the volume of wine produced always tends to be slightly lower (- 0.8 percent in 2012) than the volume of must produced because of losses during vinification. Second, for data on the volume of wine produced the statistical office does not use the qualifier "suitable for" in connection with the terms "Qualitätswein" and "Prädikatswein". The absence of the qualifier "suitable for" should, however, not be taken as an indication that the data refer to volumes of quality-tested wines because early in January most wines still await bottling and testing. Finally, in 2012, as in other years, there are considerable differences between the volumes and the shares of must (Fig. 3-3) and the volumes and shares of wine suitable for "Qualitätswein" and for "Prädikatswein"(Fig 3-4). We do not have a plausible explanation for the differences; inquiries in November 2015 at DWI (Mr. Abele), the Deutsche Weinbauverband (Dr. Rückrich), and the German statistical office DESTATIS (Dr. Gurrath) did not resolve the issue.

The shares of the quality categories vary considerably across wine regions. Some of the variation in the shares of "Landwein", "Qualitätswein" and the "Prädikat"-category wines is certainly due to the variation in regional weather. But there are also some systematic effects. For example, the Ahr region always has a low share of "Prädikat"-category wines because this region has specialized in the production of red wines which, under the climate conditions of the Ahr region, nearly always benefit from sugar-enrichment and therefore do not qualify for "Prädikat"-grades.

Figure 3-4: Shares of wine quality categories in regional wine production, 2012

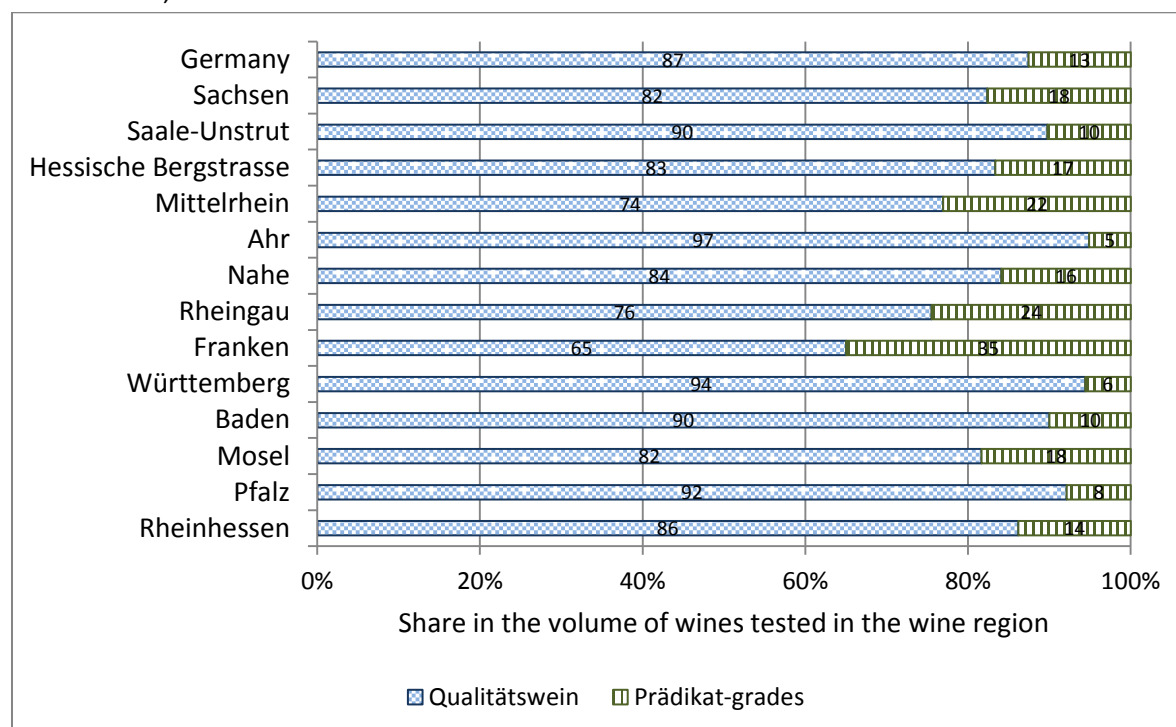


Source: DWI (2013). Deutscher Wein Statistik, 2013/14.

The quality categories used for the data of Fig. 3-4 and Fig. 3-5 may be regarded as potential quality grades because they are based on the weight (~ sugar content) of the must alone and they do not consider any of the other criteria for determining the grade of a quality-tested wine. There is,

however, no strict correlation between must weight and the other criteria that determine a wine's grade. A wine that exceeds the minimum must weight for a certain quality grade may, or may not, actually meet the all the criteria for this grade. For this reason, and for reasons based on wine bottlers' marketing strategies, the volume of wine that is potentially suitable for a certain grade is highly unlikely to equal the actual volume of wine that is marketed with that grade. Similarly, the shares of the wines with a potential grade in total wine production are unlikely to equal the shares of wines that are actually marketed with that grade. Thus, the volume of wine that meets the requirements of the potential grades "Qualitätswein" and "Prädikatswein" is significantly higher than the volume of wine that have fulfilled their potential: In 2012, of the 849.4 mio. l (94.4 mio. cases) of wine that were reported to be of potential "Qualitätswein" or "Prädikatswein" grade, only 755.5 mio l (83.9 mio cases), or 89 percent, were actually tested for their compliance with the requirements of these grades. Moreover, in all regions the shares of tested "Qualitätswein" are considerably higher than the shares of potential "Qualitätswein", whereas the shares of tested "Prädikat"-grade wines are significantly lower than the regional shares of potential "Prädikat"-grades. The differences in the shares corroborate the expectation that the classification of wine on the basis of their must weight is an imperfect predictor of their eventual grades, and that quality wine characteristics other than must weight significantly reduce the supply of "Prädikat"-grade wines. We hope this brief explanation sheds some light on the confusion that results from the specific use of the terms "Qualitätswein" and "Prädikatswein" in statistical publications, a use that deviates significantly from how the terms are defined by EU and national wine laws.

Figure 3-5: Regional shares of "Qualitätswein" and "Prädikat"-grade wines in total volume of quality-tested wines, 2012



Source: DWI (2013). Deutscher Wein Statistik, 2013/14.

In Fig. 3-6 we have plotted the regional shares of "Prädikat"-wines that have been tested by the official wine quality authorities in 2012. Nationally, "Kabinett" and "Spätlese" wines dominate the "Prädikat"-category and wines with the "Prädikat" "Auslese" and higher account for only about ten percent of all "Prädikat"-wines. Wine of "Auslese"-grade account for significant shares (> 10 percent)

of "Prädikat"-wine production in only three regions: Nahe, Rheinhessen, and Mosel. In 2012, "Kabinett"-wines dominated "Spätlese"-wines in most regions, but there are exceptions: In Rheinhessen, Mosel, Nahe, and Saale-Unstrut "Spätlese"-wines accounted in 2012 for a larger share of the regions' "Prädikat"-wines than the lower ranked "Kabinett"-wines.

Figure 3-6: Regional shares of individual "Prädikat"-grades in the volume of "Prädikat"-wines tested, 2012

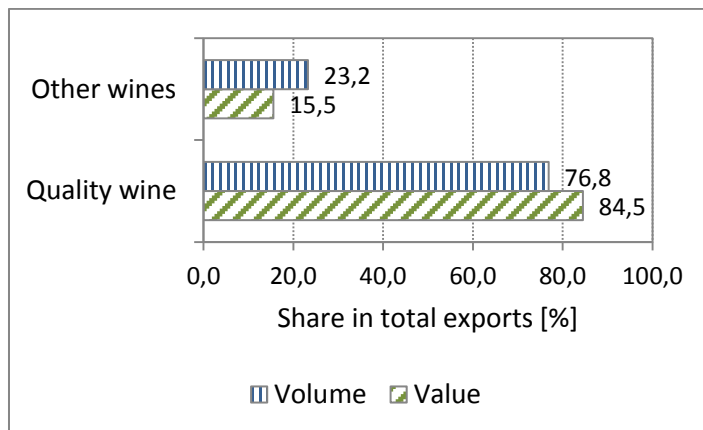


Source: DWI (2013). Deutscher Wein Statistik, 2013/14.

3.4 Quality of exported wines

Wines of the quality categories "Deutscher Wein" and "Landwein", which are not deemed quality wines, are, apparently, quite popular outside Germany. Whereas the "Landwein"-category accounted for only 5.8 percent of German wine production in 2012, the share of low-grade wines - which are mostly of the "Landwein"-grade - in Germany's wine exports was much larger: In 2011 and 2012 wines of grades below "Qualitätswein" accounted on average for 23.2 percent of Germany's wine exports in volume terms and for 15.5 percent of the value of Germany's wine exports.

Figure 3-7: Share of quality wines in total wine exports from Germany, 2011 and 2012



Source: DWI (2013. Deutscher Wein Statistik, 2013/14.

3.5 Wine quality grades and prices

The German wine quality grades that are in use today have been defined by law makers in the early 1970s. Whether the grades suit the hedonic preferences of today's wine consumers is not known. If they do reflect consumers' preferences, wines of higher quality categories ought to attract higher prices. We use price data from five sources to check empirically whether a positive relationship between wine quality grades and wine prices actually exists:

- (i) prices posted in idiosyncratically collected winemakers' price lists;
- (ii) mean retail and wholesale prices published by Schnabel and Storchmann (2010) for 1,105 wines offered by VDP-wine estates;
- (iii) price notations for bulk wine;
- (iv) prices for a "Prädikat"-suite of wines that meet *ceteris paribus* requirements, and
- (v) results from hedonic price analyses published in the wine economics literature, in particular, results published in Schamel (2003), Bentzen and Smith (2006), Rössel and Beckert (2012), and Frick and Simmons (2013).

3.5.1 Winemakers' price lists

A casual perusal of wine price lists from winemakers who adhere to the official German wine grading scheme suggests that prices of wines increase with the wines' grades, when other factors affecting price, in particular varietal, vintage, and appellation, are held constant. This is to say, winemakers price their "Kabinett" wine of a given varietal, vintage and vineyard higher than their "Qualitätswein", and they price their "Spätlese" of a given variety, vintage, and vineyard higher than their comparable "Kabinett", etc.

For illustration, we searched wine price lists from various wine estates for wines of the same varietal, vintage, and appellation that were offered in different quality grades and that would allow matched price comparisons. The lists that we searched were an idiosyncratic collection of wine price lists that one of the authors (Mueller) has accumulated from wine estates that sent him such lists.

The results of this exercise, which is in no way statistically representative, are shown in Tab. 3-1. They suggest that listed wine prices actually do increase with quality grade, sometimes only in a small way and sometimes considerably. We believe, we could have searched many more wine lists without finding any cases where a wine of a higher grade is offered at a lower price than a comparable wine of a lower grade. However, our observation from our lazy sample should not be taken as a reliable indicator of either the price differences or the price ratios for comparable wines of different grades. We advise against this because wine estates tend to maintain several price lists, one for consumers, one for restaurants, one for specialist wine merchants, etc. For obvious reasons, usually only the list with the highest prices, i.e. the list for consumers, is published and we have very little information on the prices asked from wine intermediaries. The only information we have is that provided by Wechsler and Gutzler (2015), two wine marketing experts. They suggest that prices for intermediaries are 25 to 30 percent lower than the prices for consumers buying direct at the cellar door. Moreover, when the quantity sold to an intermediary is high, the reduction on the direct sales prices may reach 50 percent. Finally, we do not know whether the stock-overs of the wines differed between the wines which would suggest that some wines on the list had been overpriced compared to others.

Table 3-1: Convenience sample of matched comparisons of winemakers' listed prices for white wines of different grades

Producer, year of winelist, and wine	QbA	Kabinett-QbA	Kabinett	Spätlese-Kabinett	Spätlese	Auslese-Spätlese	Auslese	BA-Auslese	BA	TBA-BA	TBA
	€/l	Δ%	€/l	Δ%	€/l	Δ%	€/l	Δ%	€/l	Δ%	€/l
Max Ferd. Richter, Mülheim, Mosel, 2014											
Brauneberger Juffer(-Sonnenuhr) ⁽²⁾ , Riesling, 2013	6,50 ⁽¹⁾	94,9	12,67	42,1	18,00	55,6	28,00	557,1	184,00	37,7	253,33
Graacher Domprobst, Riesling, 2013 ⁽³⁾	6,50 ⁽¹⁾	84,6	12,00	33,3	16,00	50,0	24,00				253,33
Veldenzer Elisenberg, Riesling, 2013 ⁽⁴⁾	6,50 ⁽¹⁾	94,9	12,67	26,3	16,00	41,7	22,67				
Wehlener Sonnenuhr, Riesling, 2013 ⁽⁵⁾	6,50 ⁽¹⁾	94,9	12,67	42,1	18,00				184,00		
Manz, Weinolsheim, Rheinhessen, 2015											
Oppenheimer Herrenberg, Riesling, 2013 ⁽⁶⁾	7,73				9,47	47,8	14,00	290,5	54,67	236,6	184,00
Gerhard Hauk, Maikammer, Pfalz, 2015											
Alsterweiler Kapellenberg, Riesling, 2013	4,00 ⁽⁷⁾	60,0	6,40	25,0	8,00	62,5	13,00				
Maikammer Mandelhöhe, Riesling, 2013	4,00	5,0	4,20								
Peter Stolleis, Gimmeldingen, Pfalz, 2015											
Gimmeldinger Meerspinne, Riesling, 2013	5,40	22,2	6,60								
Weissburgunder, 2013	6,60	18,2	7,80								
Staatsweingut mit Johannitergut, Neustadt, Pfalz, 2015											
Haardter Herrenletten, Riesling, 2013 ⁽⁸⁾	5,50				12,00	75,0	21,00	154,0	53,33		
Weinland Königsbach Neustadt, Pfalz, 2015											
Königsbacher Ölberg, Riesling, 2014 ⁽⁹⁾	4,70	17,7	5,53	33,8	7,40						

(1) QbA Riesling, 2011 vintage, without declared appellation;

(2) The Brauneberger Juffer-Sonnenuhr appellation is a 10 ha section in the center of the 35 ha B. Juffer appellation; the Kabinett- and BA-wines are from the B. Juffer, the others are from the B. Juffer-Sonnenuhr section;

(3) Kabinett: 2008 vintage; Spätlese: 2012 vintage; Auslese: 2012 vintage; TBA: 2007 vintage;

(4) Spätlese: 2011 vintage; Auslese: 2012 vintage;

(5) BA: 2011 vintage;

(6) 2014 QbA without declared appellation; BA: 2011 vintage;

(7) 2013 Riesling QbA without declared appellation;

(8) QbA without declared appellation; Spätlese: Rieslaner (Riesling x Silvaner);

(9) Spätlese: 2013 vintage.

3.5.2 Wholesale and retail prices of VDP-wines

Schnabel and Storchmann (2010) have collected retail and wholesale prices for 1,105 identical wines offered in the years 1993 to 2001 by VDP-wine estates from the Mosel, Rheingau, and Nahe wine regions. Wine estates that are members of the exclusive Verein der Prädikatsweingüter (VDP) claim to be high-quality producers and they tend to ask high prices for their wines (see section 6). The data for retail prices are prices that had been published in a wine guide. For identical wines, as identified

by means of the wines' A.P.-Numbers, prices asked at the wholesale level were obtained from a wine trade fair to which only wine intermediaries, but not final consumers, have access.

Inspection of the mean retail and wholesale prices for different grades in Table 3-2 provides support for our belief that a positive relationship between wine price and grade exists at all markets levels, the retail as well as at the wholesale level. Moreover, the VDP-price data suggest that the price premia of the grades increase considerably with the grade up to "Beerenauslese" (BA)-wines. The mean retail price for "Kabinett"-wines is only 2 percent higher than the mean price of "Qualitätswein" (QbA), and at the wholesale level the relative price difference between the two grades is less than 5 percent. The premium for the next higher grade increases to more than 50 percent for "Spätlese"-wines over "Kabinett"-wines, and to more than 400 percent for "Beerenauslese" (BA)-wines over "Auslese"-wines. The price jump from "Beerenauslese" (BA) to "Trockenbeerenauslese" (TBA) is about as large as that from "Spätlese" to "Auslese"-wines. Finally, we note that the relative differences between retail and wholesale prices are at around 40 percent higher for the wines of VDP-estates than the 25 to 30 percent that Wechsler and Gutzler (2015) report for that price difference.

Table 3-2: Mean retail and wholesale prices for VDP-wines of different grades, and relative differences of mean prices

Price type	Wine grade											
	All (1105)	QbA (198)	Kabinett - QbA	Kabinett (342)	Spätlese - Kabinett	Spätlese (408)	Auslese - Spätlese	Auslese (107)	BA - Aulese	BA (24)	TBA - BA	TBA (5)
	[€/l]	[€/l]	Δ %	[€/l]	Δ %	[€/l]	Δ %	[€/l]	Δ %	[€/l]	Δ %	[€/l]
Retail price [€/l]	22.05	8.76	2.1	8.95	55.4	13.91	132.7	32.36	426.5	170.36	142.4	412.88
Wholesale price [€/l]	15.29	6.32	4.6	6.61	51.8	10.04	115.3	21.61	442.3	117.21	119.2	256.99
Relative difference wholesale - retail price [Δ %]	-40.9	-37.1	n.a.	-34.8	n.a.	-37.1	n.a.	-44.3	n.a.	-41.6	n.a.	-50.3

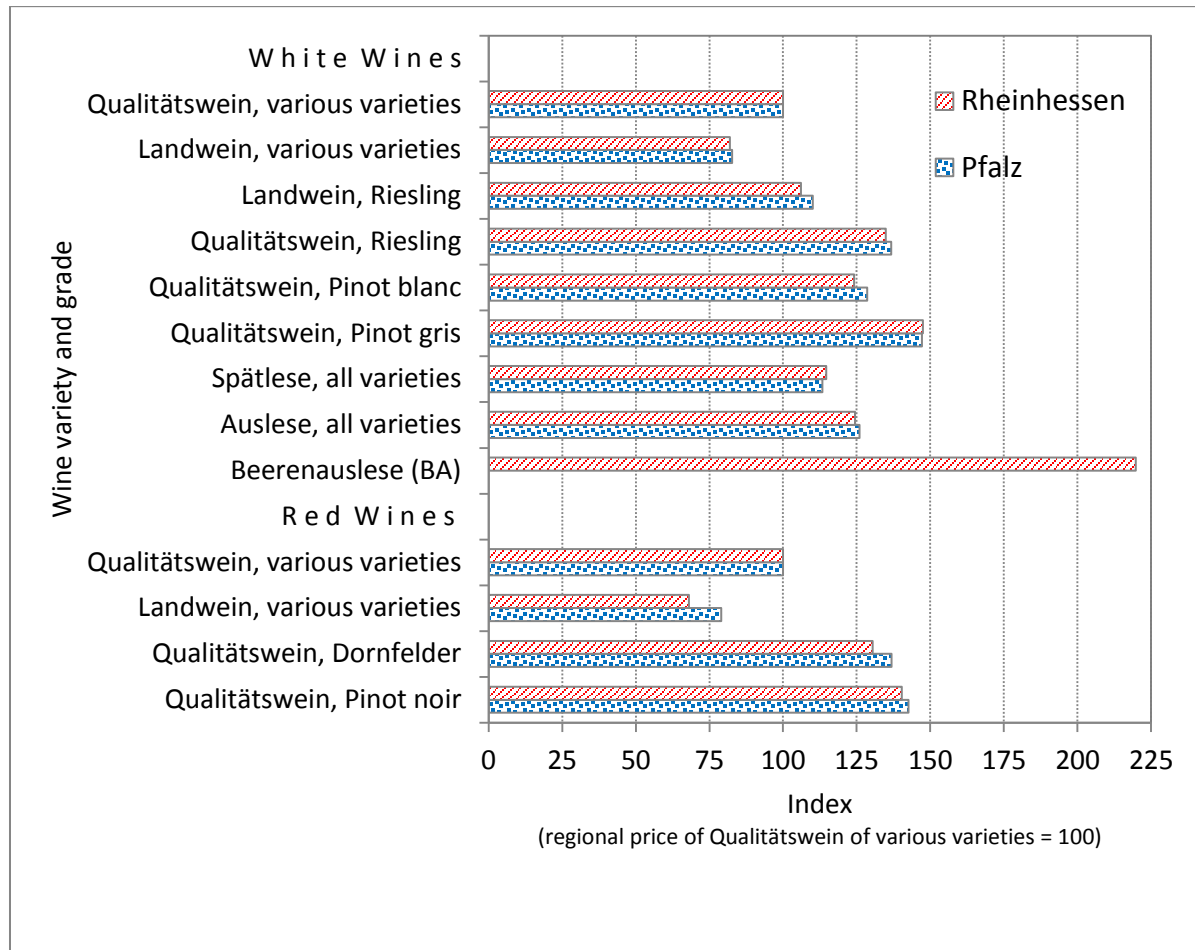
Source of the price data: Schnabel and Storchmann 2010.

3.5.3 Bulk wine prices

Statistics on bulk wine prices are available for major wine regions from two sources for the wine regions Mosel, Nahe, Rheinhessen, and Pfalz. One source is the bi-weekly trade journal "Weinwirtschaft," which also reports price notations for the Rheingau, and the other is Weinmarketing Rheinland-Pfalz, an agency of the wine administration of the state of Rheinland-Pfalz. Usable time series data were, however, available only for the Rheinhessen and Pfalz regions. As these are the largest wine producing regions in Germany, the price notations may be more than illustrative of the true but unknown price differences between the various wine grades. In Fig. 3-8 we compare monthly price notations for wine of various grades from the years 2011 to 2013.

The price notations for bulk wine confirm the impression that we have gained from the matched comparisons of winemakers' listed prices. In particular, Figure 3-8 conveys two messages: (i) winery-gate prices do increase with the grade of wines; e.g. "Qualitätswein" of various varieties is dearer than "Landwein" of various varieties, "Spätlese"-wine of various varieties is dearer than "Qualitätswein" of various varieties and, "Auslese"-wine, in turn, is dearer than "Spätlese"-wine. (ii) The price difference between the grades may be dominated by price differences between different varieties. Thus, the average prices for the grade "Landwein Riesling" during the period 2011 to 2013 were higher than the prices for "Qualitätswein" of all varieties, and prices of "Qualitätswein"-Riesling were higher than prices of higher graded "Spätlese"-wine with no variety declared.

Figure 3-8: Index of mean price notations for various white and red wines of different grades, Rheinhessen and Pfalz, 2011 - 2013



Data source: Database Weinmarketing RLP – Preisberichterstattung.

3.5.4 Price of ripeness

Ripeness of the grapes is one criterion for quality grading of German wines (see Tab. 2-4). Ripeness is measured in terms of the weight of the must from which the wine has been made. The units of must weight are degrees Oechsle (°Oe) in Germany, and degrees Brix (°Bx) in the USA. As we have shown in Section 2, ripeness is an important criterion for wines from Germany because of the country's marginal climate for growing grapes. Moreover, ripeness may be considered particularly important by some, only because it is measurable.

If the ripeness of the grapes from which a wine is made were the only characteristic that determined buyers' willingness to pay for a wine, and if consumers' marginal satisfaction from sweetness were constant or falling with the level of a wine's sweetness, then we would be led to expect that buyers' willingness to pay, and therefore the price, per degree Oechsle (or degree Brix) would be constant or falling. Prices of wine from different quality grades would then increase by no more than the increase in degrees Oechsle or degrees Brix.

Using the price notations for bulk wine that are publicly available from an online database maintained by the state of Rheinland-Pfalz (Weinmarketing Rheinland-Pfalz) we calculated the average and marginal prices for ripeness using bulk-wine prices in 2012 from the Rheinhessen and

Pfalz wine regions. In Table 3-3 we show the results for Rheinhessen; (the results for the Pfalz region are similar to those for Rheinhessen and are not shown here). From this table we see that the price for ripeness follows a U-shaped curve along the "Prädikat"-gradient: it is high at the lower and higher ends of the ripeness range but low in the middle of the ripeness range, i.e. for the "Prädikat"-wines "Spätlese" and "Auslese". The marginal price for a degree Oechsle in a liter of wine drops from 1.5 cent to about 0.4 cent only to increase to about 4 cent at the transition from "Auslese" to "Beerenauslese". We are therefore inclined to dismiss the idea that a wine's quality is solely determined by its level of ripeness – other characteristics determining quality are also at play.

Table 3-3: Prices and marginal prices of ripeness of Rheinhessen bulk wines of various varieties, 2012

Wine grade	Price bulk wine ⁽¹⁾ [€/l]	°Oechsle [°Oe]			°Brix [°Bx]		
		min °Oe ⁽²⁾	Price of ripeness [€/°Oe in 1 l]	Marginal price of ripeness [Δ€/Δ°Oe in 1 l]	min °Bx ⁽³⁾	Price of ripeness [€/°Bx in 1 l]	Marginal price of ripeness [Δ€/Δ°Bx in 1 l]
Landwein	0.6771	50	0.0135		12.38	0.0547	
QbA	0.8604	62	0.0139	0.0153	15.20	0.0566	0.0650
Spätlese	0.9708	90	0.0108	0.0039	21.57	0.0450	0.0173
Auslese	1.0432	100	0.0104	0.0072	23.78	0.0439	0.0328
Beerenauslese (BA)	1.8357	120	0.0153	0.0396	28.08	0.0654	0.1843

(1): Average prices calculated from monthly price notations for bulk wine of various varieties published by DLR-RP at <http://www.dlr.rlp.de/Internet/global/themen.nsf/0/5c724dc93286b510c125728f0033430a?OpenDocument>

(2): For Landwein: mean °Oe according to GWI; minimum Oechsle-values for Rheinhessen quality wines were obtained from tables published by DWI at <http://www.deutscheweine.de/Dozentenportal/Weinwissen/>. The values used here are those for white wines other than Riesling and Silvaner which have lower minimum Oechsle levels. Riesling: QbA 60; Spätlese 85; Auslese 95; Silvaner: Spätlese 85; Auslese 92.

(3): Oechsle-Brix conversions were obtained from the VinoCalc conversion calculator at <http://www.musther.net/vinocalc.html#sgconversion>

Data source: Database Weinmarketing RLP – Preisberichterstattung.

In contrast to the non-uniform wine prices per unit of ripeness across the "Prädikat"-grades that we observe for bulk wines, the VDP-price data assembled by Schnabel and Storchmann (2010) suggest that the price per unit of ripeness increases at an increasing rate with the "Prädikat"-grade. To explore this suggestion further, we assembled from the price list of Max Ferdinand Richter, a premium wine producer at Mülheim, Mosel, the prices of a suite of "Prädikat"-wines from the same variety, vineyard, and vintage. In particular, we took the cellar door prices for Brauneberger Mosel Riesling from the 2012 vintage for the "Prädikat"-grades "Kabinett", "Spätlese", "Auslese", and "Beerenauslese". The results, shown in Table 3-4, are much different from the results for the Rheinhessen bulk wines in Table 3-3 and similar to the ripeness-prices of the VDP-wines. The prices for ripeness for the Brauneberger Rieslings increase at an increasing rate over the four "Prädikat"-grades and they are much higher than the ripeness-prices of the Rheinhessen bulk wines: at the extreme, a degree Oechsle in a bottled "Beerenauslese" from the Mosel estate costs about 100 times as much as a degree Oechsle in a bulk "Beerenauslese" from Rheinhessen.

Table 3-4: Prices and marginal prices of ripeness for Brauneberger Mosel Riesling, 2012

Prädikat level	Cellar door price ⁽¹⁾ [€/0.75l]	°Oechsle [°Oe]			°Brix [°Bx]		
		min °Oe ⁽²⁾	Price of ripeness [€/°Oe in 1 l]	Marginal price of ripeness [Δ€/Δ°Oe in 1 l]	min °Bx ⁽³⁾	Price of ripeness [€/°Bx in 1 l]	Marginal price of ripeness [Δ€/Δ°Bx]
Kabinett	9,00	73	0,1644		17,74	0,6764	
Spätlese	12,00	80	0,2000	0,5714	19,33	0,8277	2,5157
Auslese	26,00	88	0,3939	2,3333	21,13	1,6406	10,3704
Beerenauslese (BA)	138,00	110	1,6727	6,7879	25,95	7,0906	30,9820

(1): Prices according to Weinliste 1/2014 of Weingut Max Ferd. Richter, D-54486 Mülheim/Mosel.

(2): Minimum Oechsle-values for Prädikat-wines from the Mosel were obtained from tables published by DWI at <http://www.deutscheweine.de/Dozentenportal/Weinwissen/>

(3): Oechsle-Brix conversions were obtained from the VinoCalc conversion calculator at <http://www.musther.net/vinocalc.html#sgconversion>

Source: Weingut Max Ferd. Richter, Mülheim, Mosel. Weinpreisliste 1/2014.

3.5.5 Evidence from econometric studies

Four econometric studies have investigated the impact of wine quality grades on wine prices using hedonic demand models. Of these studies, only the one by Schamel (2003) was focused on the price-quality relationship, whereas the remaining three by Bentzen and Smith (2006), Rössel and Beckert (2012), and Frick and Simmons (2013) were mainly interested in other determinants of wine prices and they used quality grades only as control variables in their estimation models. Neither data nor estimation methods are, however, concerned with the purpose that led to their inclusion in an econometric model. We may, therefore, as we do in Table 3-5, consider the estimates of the dummy variables for quality grades to be of equal informational weight.

Table 3-5: Estimates of the coefficients of dummy variables for wine quality characteristics from four hedonic demand models for German wine

Source	Result	No. of wines [N]	Independent variable	Reference category	QbA	Kabinett	Spätlese	Auslese	BA	TBA	Eiswein
Schamel 2003	Mean price [€/bottle]	4,141			5.73	4.62	6.41	10.16	19.21	34.68	33.34
	Dummy coeff. estimates		log(p) [€/bottle](1)	Spätlese	-0.348***	-0.286***	-	0.417***	1.087***	1.512***	1.59***
Bentzen & Smith, 2006	Dummy coeff. estimates, all countries	213	log(p) [€/bottle] (1)	Not Prädikat	-	n.s.s. ⁽²⁾	0.279***	0.42***	0.445***		1.405***
	Dummy coeff. estimates, DE	106	log(p) [€/bottle](1)	Not Prädikat	-	n.s.s. ⁽²⁾	0.252**	0.377***	n.s.s. ⁽²⁾		1.38***
	Dummy coeff. estimates, SE	30	log(p) [€/bottle](1)	Not Prädikat	-	n.s.s. ⁽²⁾	0.461***	0.545***	n.s.s. ⁽²⁾		n.s.s. ⁽²⁾
	Dummy coeff. estimates, NO	42	log(p) [€/bottle](1)	Not Prädikat	-	n.s.s. ⁽²⁾	0.337***	0.572***	n.s.s. ⁽²⁾		n.s.s. ⁽²⁾
	Dummy coeff. estimates, DK	35	log(p) [€/bottle](1)	Not Prädikat	-	n.s.s. ⁽²⁾	1.094***	0.357***	n.s.s. ⁽²⁾		1.094***
Rössel & Beckert, 2012	Estimates, model 5	1,890	log(p) [€/l]	QbA	-	-0.142**	+0.110**	+0.368**	+0.889**		
Frick & Simmons, 2013	Dummy coeff. estimates	1,303	ln(p) [€/bottle] (1)	Spätlese	-0.526***	-0.356***	-	0.747***	2.154***	2.926***	2.201***

*, **, ***: statistically significant at the 10%, 5%, and 1% level, respectively.

(1): Schamel, and Bentzen and Smith specify the wine prices in terms of Euro per bottle; bottle size can, however, vary; QbA-wines are often sold in 1 l, whereas 0.75 l bottles are typically used for Kabinett, Spätlese, and Auslese wines, and 0.5 l or 0.375 l bottles for wines in the BA ("Beerenauslese"), TBA ("Trockenbeerenauslese"), and Eiswein categories.

(2): Bentzen and Smith conducted step-wise regression analysis which included only variables whose estimated coefficients achieve at least a statistical significance level of 10%. For the variables with entry n.s.s. no estimates have been reported by Bentzen and Smith.

The empirical evidence in Table 3-5 on the impact of quality grades on price is easily summarized: In all cases except one, the coefficients for higher grades were higher than the coefficients for wines of a lower grade. The exception was "Auslese"-wines sold in Denmark.

We note four limitations of the econometric evidence. First, all price data used were data on listed prices, which may be different from transaction prices. Moreover, in three studies prices are given "per bottle" but the bottle size is not specified. "Kabinett", "Spätlese", and "Auslese"-wines are usually sold in bottles of 0.75 l volume, whereas "Qualitätswein" is often marketed in 1 l-bottles, and "Beerenauslese", "Trockenbeerenauslese", and "Eiswein" are most often sold in bottles of either 0.5 l

or 0.375 l volume. In addition, the wines included in the studies were samples drawn from either medal-winning wines, or were wines included in an up-market wine guide. The wines included in the studies are therefore not representative of all German quality wines offered for sale. Finally, the coverage of the German wine regions by the studies is uneven: Schamel (2003) and Bentzen and Smith (2006) cover all German wine regions, whereas Rössler and Beckert (2012) study wines from the Rheingau and Rheinhessen regions, and Frick and Simmons are exclusively concerned with wines from the Mosel region.

The limitations of the studies and their differences in approach and coverage advise us against interpreting the magnitudes of the estimated coefficients. Nevertheless, given that all the empirical evidence to which we have access shows positive relationships between wine prices and grades, we conclude that, *ceteris paribus*, German wines of higher quality grades fetch higher prices.

3.5.6 Summary: Non-uniform correspondence between quality grades and price

Four observations summarize our empirical evidence of the correspondence between wine quality grades and wine prices:

- 1) Wines of higher quality grades generally command higher prices than comparable wines of lower grades;
- 2) price premia for wines of higher grades are more pronounced for the higher "Prädikat"-grades than for the lower ones;
- 3) price premia for wine of higher grades are much more pronounced for premium wines than for bulk wines;
- 4) analysis of prices per degree Oechsle suggests three things. First, the prices of ripeness are positive for bulk wines as well as for premium wines. This suggests that the German grading scheme for wine is positively correlated with buyers' willingness to pay for wine of different degrees of ripeness. The relationship between degree of ripeness and buyers' willingness to pay appears to be different for bulk wines than for premium wines: the relationship is U-shaped for bulk wines and it increases non-linearly for premium wines. Whether the difference is due to differences in the types of wines or in the types of buyers – intermediaries in the case of bulk wines and consumers in the case of premium wines – we cannot say. Finally, our empirical basis for this suggestion is, however, extremely weak: One observation does not a conjecture make.

3.6 Takeaways

- (11) Germany is the world's 10th largest wine producer; slightly more than 20,000 viticultural enterprises produce about 900 mio l (100 mio cases) of wine annually from slightly more than 100,000 ha (247,000 acres) of vineyard area;
- (12) white wines dominate national wine production with a share of about two thirds of total volume;
- (13) PDO-grade wines dominate national wine production and, averaged over a 30 year period, jointly account for more than 95 percent of the total volume of wine produced;
- (14) of the PDO-grade wines, "Qualitätswein" accounts for more about 85 percent; the rest are wines of the several "Prädikat"-grades;
- (15) among the "Prädikat"-grades, the lowest two, viz. "Kabinett" and "Spätlese" account for more than 80 percent of the total volume of "Prädikat"-grade wines;

- (16) wine prices tend to increase with the wine's grade; the price premia increase with the wine grade, and grade premia tend to be higher for premium wines than for bulk wine.

4 The Legal Basis for "Tested Quality in the Glass"

The legal basis for "Tested Quality in the Glass" is slightly complicated because of the entanglement of German national and state legislation with EU community regulations. Legal scholars characterize the EU, and implicitly its predecessors as well, as an autonomous supranational organization "with its own sovereign rights and a legal order independent of the Member States, to which both the Member States themselves and their nationals are subject within the EU's area of competence" (Borchardt 2010). Agriculture was, and still is, one of the industries for which the Community has competence. Because wine was deemed an agricultural product, wine quality legislation also was, and still is, Community responsibility. The EEC and later the EC had, however, delegated back to the member states the specification of detailed rules concerning quality wine. Our delineation of the legal basis for wine quality testing in Germany therefore needs to consider both Community and German wine quality legislation.

Because of Germany's EU membership, three layers of norms govern wine testing: EU Regulations, that is EU-speak for legislative acts and regulations; German federal legislative acts and regulations; and legislative acts and regulations issued by the individual states of Germany. The three layers form a hierarchy of normative priority with Community Regulations at the top. These Regulations are acts that (i) apply in full in all Member States, (ii) apply directly and do not have to be transposed by the Member States into national laws, and they (iii) are binding in their entirety (Borchardt 2010). In short, Regulations are laws that apply throughout the Community. In addition, the governments of the German wine growing states have filed with the EU applications for PDO-status for "Qualitätswein" and "Prädikat"-grade from their wine regions. The documents specify the characteristics that PDO-grade wines from the wine regions are expected to have.

4.1 EU quality wine legislation

The EU has a well-deserved reputation for legislative activism and identifying the Regulations that are important for quality wine is no trivial matter. We searched two sources for legislative acts relevant for quality wine: the "Eur-Lex" data base, and a small selection of books and papers.

A search in the subdomain "Legislation" of the EU data base "Eur-Lex" (<http://eur-lex.europa.eu/>) for basic acts, excluding corrigenda, that have in their titles the text string "quality win*" and that are dated between January 1, 1960 and December 31, 2014 yielded a total of 52 documents of widely varying scope, length, and relevance. We decided not to screen the 52 documents for their relevance for quality wine examination. Instead we turned to other authors and a wine-legislation expert to identify EU legislative acts with import on EU quality wine. This exercise yielded a much shorter and more manageable list of 14 regulations to which we added one after inspection of the fourteen (see Table 4-1).

We screened each of the fifteen Regulations for four items: (i) the articles of European treaties on which the Regulation is based; (ii) the objectives of the Regulation, as stated in its "Whereas"-section; (iii) the rules that govern quality wine testing, as stated in the "Articles"-section, and (iv) whether the Regulation has been repealed, and if so, by which Regulation.

Tab. 4-1: Sources of EU Regulations concerned with quality wine testing

EU Regulation	Source							
	Klarmann 2001	Weinmann 2009	Rathke & Boch 2012	Meloni & Swinnen 2013	Gaeta & Corsinovi 2014	Blau & Nickenig 2015	Blau 2015	EU Commission
EEC Council Regulation No 24 (1962)	X	X						
Regulation (EEC) No 817/70	X	X		X				
Council Regulation (EEC) No 337/79		X		X	X			
Council Regulation (EEC) No 338/79								
Council Regulation (EEC) No 823/87	X			X	X			
Commission Regulation (EEC) No 2676/90	x							X
Commission Regulation (EC) No 761/1999								X
Council Regulation (EC) No 1493/1999	X	X		X	X			
Commission Regulation (EC) No 1607/2000		X			X			
Commission Regulation (EC) No 2729/2000								X
Council Regulation (EC) No 1234/2007			X		X	X		
Council Regulation (EC) No 479/2008			X	X	X	X		
Council Regulation (EC) No 491/2009								
Commission Regulation (EC) No 607/2009			X		X		X	
Regulation (EU) No 1308/2013					X	X	X	

Inspection of linkages between the Regulations reveals a cascade of Regulations enacted and repealed (see Table 4-2). The cascade begins in 1962 with Council Regulation No 24, a slim Regulation that contained nine articles and that fitted neatly on little more than two pages, the cascade ends with Regulation (EU) No 1308/2013, an obese Regulation that attempts to establish with 232 Articles and 14 annexes "a common organization of the markets in agricultural products". Wine is only one of the 24 agricultural product categories in whose markets the EU intervenes with this Regulation.

The evolution of Community Regulations concerned with quality wine is characterized by a near constancy of the objectives of the Regulations, and a switch from a concept of quality wine to one based on geographic origin.

4.1.1 Objectives of Community wine quality policy

Information on the objectives that a Community Regulation attempts to achieve comes from two sources: First, EU Regulations refer to articles in a Community Treaty as the primary source of Community law, and the objectives stated there are relevant for the Regulation; and, second, objectives and desirable activities are regularly stated in the "Whereas"-section of a Community Regulation, before the "Articles"-section.

Tab. 4.2: The cascade of Community Regulations concerned with quality wine

Community Regulation	In force/ repealed	Reference to Treaty
EEC Council Regulation No 24 on the progressive establishment of a common organisation of the market in wine (1962)	repealed by Reg. (EEC) No 337/79	Treaty establishing the European Economic Community, Art. 43
Regulation (EEC) No 817/70 of the Council of 28 April 1970 laying down special provisions relating to quality wines produced in specified regions	repealed by Reg. (EEC) No 338/79	dto.
Commission Regulation (EEC) No 2236/73 of 16 August 1973 prescribing certain rules for the tests to be carried out on wines which prima facie satisfy the requirements for designation as 'quality wines produced in specified regions'	repealed by Reg. (EC) 1607/2000	Treaty establishing the European Economic Community
Council Regulation (EEC) No 337/79 of 5 February 1979 on the common organization of the market in wine	repealed by Reg. (EEC) No 882/87	Treaty establishing the European Economic Community, Art. 43
Council Regulation (EEC) No 338/79 of 5 February 1979 laying down special provisions relating to quality wines produced in specific regions	repealed by Reg. (EEC) No 823/87	dto.
Council Regulation (EEC) No 823/87 of 16 March 1987 laying down special provisions relating to quality wines produced in specific regions	repealed by Reg. (EC) No 1493/99	dto.
Commission Regulation (EEC) No 2676/90 of 17 September 1990 determining Community methods for the analysis of wines	amended by Reg. (EC) No 761/1999; repealed by Reg. (EC) 606/2009	Treaty establishing the European Economic Community
Commission Regulation (EC) No 761/1999 of 12 April 1999 amending Regulation (EEC) No 2676/90 determining Community methods for the analysis of wines	in force	Treaty establishing the European Community
Council Regulation (EC) No 1493/1999 of 17 May 1999 on the common organisation of the market in wine	repealed by Reg. (EC) No 479/2008	Treaty establishing the European Community, Art. 36 & 37

Commission Regulation (EC) No 1607/2000 of 24 July 2000 laying down detailed rules for implementing Regulation (EC) No 1493/1999 on the common organisation of the market in wine, in particular the Title relating to quality wine produced in specified regions	repealed by Reg. (EU) No 607/2009	Treaty establishing the European Community
Council Regulation (EC) No 1234/2007 of 22 October 2007 establishing a common organisation of agricultural markets and on specific provisions for certain agricultural products (Single CMO Regulation)	repealed by Reg. (EU) No 1308/2013	Treaty establishing the European Community, Art. 36 & 37
Council Regulation (EC) No 479/2008 of 29 April 2008 on the common organisation of the market in wine, amending Regulations (EC) No 1493/1999, (EC) No 1782/2003, (EC) No 1290/2005, (EC) No 3/2008 and repealing Regulations (EEC) No 2392/86 and (EC) No 1493/1999	repealed by Reg. (EC) No 491/2009	dto.
Council Regulation (EC) No 491/2009 of 25 May 2009 amending Regulation (EC) No 1234/2007 establishing a common organisation of agricultural markets and on specific provisions for certain agricultural products (Single CMO Regulation)	in force	dto.
Commission Regulation (EC) No 607/2009 of 14 July 2009 laying down certain detailed rules for the implementation of Council Regulation (EC) No 479/2008 as regards protected designations of origin and geographical indications, traditional terms, labelling and presentation of certain wine sector products	in force	Treaty establishing the European Community
Regulation (EU) No 1308/2013 of the European Parliament and of the Council of 17 December 2013 establishing a common organization of the markets in agricultural products and repealing Council Regulations (EEC) No 922/72, (EEC) 234/79, (EC) No 1037/2001 and (EC) 1234/2007	in force	Treaty on the Functioning of the European Union, Art. 42(1) & 42(3)

The primary legal sources for the Regulations concerned with quality wine are the "Agriculture" sections of three Community treaties, viz. the Treaty of Rome of 1957, establishing the European Economic Community (TEEC), the Treaty of Maastricht of 1992, establishing the European Community (TEC), and the Lisbon Treaty of 2007 which includes the Treaty on the Functioning of the European Union (TFEU)). The wording of the respective article specifying the objectives of the common agricultural policy stands unchanged since the Treaty of Rome and only the number of the article changes (Article 39 in the TEEC, Article 33 in the TEC, and Article 39 again in the TFEU).

The agricultural policy objectives stated in the Treaties are wide ranging and fairly general. More than 50 years of Community policy have, however, provided much evidence of the objectives that actually guide agricultural policy. This evidence suggests that the one objective that dominates all others is income support for agricultural producers (Tangermann and von Crammon-Taubadel, 2013).

The clearest statement of the objectives of the Community wine policy was, to our knowledge, made in "Whereas" No. 2 of Regulation (EC) 1493/1999: "the aim of the common agricultural policy is to attain the objectives set out in Article 33 of the Treaty and in particular, in the wine sector, to stabilize markets and ensure a fair standard of living for the agricultural community concerned; these objectives may be attained by adjusting resources to needs, in particular through the pursuit of a policy for the adaptation of winegrowing potential and a quality policy;..." Hence, quality policy, like the rest of agricultural policy, may safely be regarded as state support for wine producers' incomes.

More on the intentions of Community wine policy can be learned from the "Whereas"-sections of the Regulations concerned with wine quality. The objectives most consistently cited in these Regulations are the desire to protect consumers from error and fraud, and to protect producers from unfair competition. Another desire that is frequently expressed, particularly in the Regulations enacted up to 1999, is the harmonization of wine quality requirements across member states. In addition, there are several objectives relative to wine producers, consumers, the wine industry, and wine markets that are expressed in one or two Regulations but that do not appear in others.

4.1.2 Switch in the quality concept: From quality factors to geographic origin

The evolution of Community legislation concerning quality wine may be divided into four periods (see Table 4-3). After a period of wine policy initiation that began with Regulation No 24, there followed a long period when Community wine policy was based on the notion of "quality wine psr" (produced in specified regions) and when quality was defined in terms of a wine's characteristics, which were called its "factors". During this phase Community Regulations concerned with quality wine were separate from Regulations concerned with the rest of the wine policy. This phase ended in 1999, when a transition period began with Regulation No 1493/1999, which established the Common Market Organization for wine. During this transition period, the Community also switched from a quality concept based on wine factors to one based on the geographic origin of a wine. In particular, the Commission introduced with Regulation No 479/2008 two new quality categories: "Protected Designation of Origin" (PDO), and "Protected Geographic Indication" (PGI); applied to wine, the PDO category replaced the older category "quality wine psr".

Tab. 4.3: Phases of EU regulations with import on quality wine

Phase	Period	Regulatory scope	Quality concept	
			Wine factors	PDO/PGI
Initiation	04/1962 - 03/1970	Wine market establishment	Reg. No 24 1962	
Quality wine regulation	4/1970 - 04/1999	Quality wine	Reg. No 817/70 Reg. No 2236/73 Reg. No 338/79 Reg. No 823/87 Reg. No 2376/90 Reg. No 761/1999	
Wine CMO	05/1999 - 04/2009	Wine market (Common Market Organisation - CMO)	Reg. No 1493/1999 Reg. No 1607/2000	Reg. No 479/2008 Reg. No 607/2009
Single CMO	05/2009 - to date	Agricultural markets (Single Common Market Organisation)		(Reg. No 1234/2007) Reg. No 491/2009 Reg. No 1308/2013

Another change in the Community regulations came in 2009 when Regulation 491/2009 integrated wine into the Single Common Market Organisation (Single CMO), which had been established two years earlier by Regulation No 1234/2007 but from which wine was exempt because wine policy was still under discussion at the time when that Regulation was decreed. In the current phase, i.e. the Single-CMO-phase, wine has lost the privilege of having a dedicated regulation and wine is now bundled into the Single CMO, together with much less differentiated and less valuable agricultural products such as pig meat and dried fodder.

The changes in the scope of the Regulations are of little concern to us. What matters here is the change in the quality concept from quality wine psr to wines of protected designations of origin (PDO). The practical consequences of the change are less radical than the change in terminology. In Tab. 4-4 we have juxtaposed the factors that were used for classifying wines as quality wines psr with the required descriptors for PDO-wines. The main differences are three: cultivation methods and minimum alcoholic strength are no longer required to distinguish a PDO-wine, and applicants for a PDO-wine must provide "details bearing out" that "the quality characteristics of the product are essentially or exclusively due to a particular geographical environment with its inherent natural and human factors" (Art 3 and Art 94, Reg. (EU) No 1308/2013). Presumably, the practice of granting PDO status to wines clarifies what exactly applicants have to provide to achieve this feat.

Like the old quality system, the new one based on geographic origin also requires that PDO wines must pass analytic and organoleptic testing. This requirement was introduced in 1970 by Article 11 of Regulation No 817/70 and it was upheld by Article 25 of Regulation 607/2009. Moreover, the new quality system – like the one that it replaced - leaves much room for the detailed specification of wine characteristics. This freedom has made possible that the old quality wine psr classification for German wines could be morphed into a PDO-classification.

Table 4-4: Quality wine psr factors and required PDO descriptors compared.

Quality wine psr factors ⁽¹⁾	Required PDO descriptors ⁽²⁾
-	Name that is to be protected
Demarcation of the area of production	Demarcation of the geographic region of origin
Vine varieties	Vine grape variety/-ies from which the wine is made
Wine-making methods	Specific oenological practices used to make the wine
Yield per hectare	Maximum yield per hectare
Analysis and assessment of organoleptic characteristics	Major analytic and organoleptic characteristics
Cultivation methods	-
Minimum alcoholic strength	-
-	Requirements by EU or national legislation, or by an PDO organization
-	Link between quality and characteristics to the geographical environment with its inherent natural and human factors

(1) Source: Art. 4(2), Reg. No 24 1962;

(2) Source: Art. 94(2), Reg. (EU) No 1308/2013.

4.1.3 Established administrative practice morphs into tradition

The transition in Germany from the old to the new quality regime was made possible by a legal construction that interprets as 'traditional', terminology that was introduced only forty years earlier by the German wine law of 1970. In particular, the terms distinguishing the various grades – "Prädikate" in German wine speak - have been retained under the new quality regime as traditional terms.

The legal construction was introduced with two Regulations, Regulation (EC) No 479/2008 and Regulation (EC) No 607/2009. The spaghetti-like entanglement of terms and cross-references that the EU has created within the limited space of two articles and an Appendix is worth citing verbatim. Article 54(1) of Regulation (EC) No 479/2008 defined traditional terms as follows,

"Traditional term shall mean a term traditionally used in Member States for products referred to in Article 33(1) to designate:

(a) that the product has a protected designation of origin or geographical indication under Community or Member State law;"

Article 33(1), in turn, defines the scope of designations of origin, geographical indications and traditional terms:

Rules relating to designations of origin, geographical indications and traditional terms laid down in Chapters IV and V shall apply to the products referred to in paragraphs 1, 3 to 6, 8, 9, 11, 15 and 16 of Annex IV."

Chapter IV contains the articles on the definition, procedures, and enforcement of designations of origin and geographical indications, whereas Chapter V comprises the articles concerned with "Traditional terms", including Article 54.

Annex IV of Reg. (EC) No 479/2008 then lists the categories of grapevine products, with wine being the No. 1 referred to in Article 33(1).

The traditional terms referred to in Article 54(1) of Regulation (EC) No 479/2008 were then listed in Annex XI, Part A of Regulation 607/2009. This list covered several countries, Germany among them. In particular, the terms "Qualitätswein" whether or not supplemented with "b.A." and the terms "Prädikatswein" ("Qualitätswein mit Prädikat"), supplemented by "Kabinett", "Spätlese", "Auslese", "Beerenauslese", "Trockenbeerenauslese", or "Eiswein" were recognized as traditional terms and afforded PDO-status.

The equivalent article in the most recent regulation is Article 112(a) of Regulation 1308/2013 and the recognized traditional terms are listed in the open E-BACCHUS database (<http://ec.europa.eu/agriculture/markets/wine/e-bacchus/>). As of November 2015, PDO-documents have been filed and approved for the thirteen quality wine regions of Germany.

4.2 German federal and state regulations

Quality wine testing in Germany is governed by two federal statutes and subsidiary administrative orders by the wine growing states. The two federal statutes are (Rathke and Boch 2012):

- (i) Weingesetz (WeinG) of 1994 last amended in 2014, and
- (ii) Weinverordnung (WeinVO) of 1995 last amended in 2015.

The "Weingesetz (WeinG)" is a piece of primary legislation that has been passed by the federal parliament, whereas the "Weinverordnung (WeinVO)" is secondary legislation issued by the Federal Ministry of Food and Agriculture. In relation to the WeinVO the WeinG is the authorizing statute. For the subjects of the statutes, the difference between a "Gesetz" as primary legislation and a "Verordnung" as secondary legislation is immaterial - both are binding.

We need not present here the administrative orders that the various states have issued in relation to quality wine testing. Instead, we are concerned here only with an administrative order of the state of Rheinland-Pfalz, which is the state with largest vineyard area and the largest wine production in Germany. The statute that regulates quality wine testing in Rheinland-Pfalz is the administrative order by the Ministry of Economics, Transport, Agriculture and Winegrowing for the "Conduct of Quality Tests for Wine, Aerated Wine, Liqueur Wine and Sparkling Wine and the Procedure for Downgrading" of July 3, 2003. The federal as well as the state-level statutes apply for all of the four wine product categories named in the title of this administrative order but we are only concerned here with still wine.

The existence of three statutes that jointly govern the conduct of quality wine testing might suggest that there is some logic in the division of the statute's scopes. If there actually was such a logic, it has escaped our attention. As there is no clear division in the scope of the statutes, we best describe their content jointly.

4.2.1 Contents of the statutes

The scope of the WeinG and WeinVO covers all of the wine industry and quality wine certification is only a small but significant part of the two statutes. Each of the two statutes is concerned with quality wine testing in their identically numbered and nearly identically titled sections 4. Moreover, the WeinVO specifies various details of wine testing and analysis in appendices, in addition to Section 4.

In the WeinG this Section 4 comprises § 16a to § 22a where § 18a has been dropped. The main concerns of the seven paragraphs of the WeinG are:

§ 16a: Refers to Article 94 Sec. 4 of Regulation (EU) No 1308/2013 - the Single Common Market Order - as corresponding EU legislation;

§ 17: an omnibus paragraph that identifies predicate wines, specifies minimum alcohol contents of quality and predicate wines, empowers the Ministry of Food and Agriculture to issue secondary legislation, and specifies areas of legislation delegated to wine growing states;

§ 19: decrees that wine can be sold as quality wine only if it has been assigned an A.P. Nr.;

§ 20: stipulates requirements for "Prädikatswein", in particular (a) the prohibition of enrichment, (b) the ripeness requirements for the grapes from which "Prädikatswein" of various grades are produced, and (c) the "Prädikat"-grades for which harvesting by hand of the grapes is obligatory;

§ 21: specifies several issues for which the Federal Ministry of Food and Agriculture is empowered to decree secondary legislation;

§ 22a: is concerned with annual controls of product specifications for wines with protected geographic origin or protected geographic indication.

Section 4 of the WeinVO consists of §§ 19 - 28a. Wine quality issues regulated by the WeinVO are:

§ 19: Defines with reference to Article 6 of Regulation (EU) No 607/2009 where quality wine may be produced;

§ 21: requires quality wine to be free of errors with regard to its appearance, odor and taste, in order to be assigned an A.P. Nr.;

§ 22: specifies eligibility for applying for an A.P. Nr., details of the application, and procedures related to rejection, withdrawal and objection to a rejection;

§ 23: requires that analytic test results accompany the application for an A.P. Nr. for a wine; the analysis must have been performed by a laboratory that has been accredited by the state;

Appendix 10: specifies the items required in an analytic test report;

§ 24: determines that wines that have been submitted for an A.P. Nr. undergo a sensory test which is conducted according to Appendix 9 of the WinVO; depending on the results of the sensory test the agency in charge of quality wine testing may assign the wine to a different quality category, require another or an additional analysis, or require additional relevant documentation. Moreover, the paragraph regulates the disposal of wines that have not been assigned an A.P. Nr.;

Appendix 9: section I specifies the items of an application for an A.P. Nr., and section II lists the sensory pre-conditions that a quality wine must meet, defines the 0-5 rating scales, tabulates the number of points allowed for the sensory test criteria odor, taste and harmony, and it defines the method for calculating the total number of points for a wine;

§ 25: determines the responsibility of the state agency concerned with quality testing and A.P. Nr. assignment;

§ 26: requires the concerned state agency to notify applicants of the test results within a set period and to assign the wine an A.P. Nr. according to a prescribed format;

§ 27: specifies conditions and procedures for revocation of an A.P. Nr.;

§ 28: contains sundry derogations.

The administrative order for the conduct of quality tests for wine by the state of Rheinland-Pfalz is a detailed to-do list for the agency in charge of conducting sensory tests of quality wines, as well as for the expert panels that actually examine the wines. The order takes as its legal basis Regulation (EC) No 1493/1999, Regulation (EG) No 1607/2000, WeinG, and WeinVO. It determines the Chamber of Agriculture of the state as the agency in charge for quality wine testing and the assignment of A.P. Nr. From all the statutes related to quality wine testing, this order is the most relevant for the practical conduct of quality wine testing; it is also written in remarkably clear language.

4.3 PDO-Application Documents for "Qualitätswein" and "Prädikatswein"

In order to obtain PDO-protection producer groups or, in exceptional cases, single producers must file an application with the EU Commission (Regulation (EU) No 1308/2013 Articles 92 – 111). True to EU administrative style, the format of the application and the procedure for granting PDO-status for wine is regulated in fine detail, down to the maximum number of symbols that may be used for the description of wines, oenological methods, etc. Such PDO-protection applications for "Qualitätswein" and "Prädikat"-grade wines were filed for each of the 13 specified quality wine regions by the governments of the states with specified wine regions.

We are no legal experts and we are unable to properly assess the legal status of the PDO-application documents. For practical matters, they do not seem to matter much at present because the documents reiterate the requirements and specifications for German quality wines that had already been defined in the various national German wine statutes. The elements in the PDO-applications that go beyond what is found in German wine statutes are verbal descriptions of the wines and statements in compliance with Article 118b, paragraph 1, letter a, number 1 of Regulation (EU) No 1234/2007 which defines as a requirement for a wine with a designation of origin, that "its quality and characteristics are essentially or exclusively due to a particular geographical environment with its inherent natural and human factors". The article is mute about which "inherent natural and human factors" the drafters of the Regulation had in mind. The lack of specificity of what information is required has, however, not prevented the applicants from duly filling in the forms with text. The result are descriptions of the geographical environments of the wine regions that would suit travel guides with aspiration somewhat above the ubiquitous guides for dummies. Moreover, the wines are described in the PDO-applications in the usual wine language that is rich in analogies but poor in precise terms. It is difficult to imagine wines that would be covered by the descriptions.

4.4 Tensions between German and Community wine legislation

When the former European Economic Community exercised its power to regulate wine quality with Regulation (EEC) No 817/70, the new regulation was not released into a legislative void. Rather, several of the then six member states had their own history and principles of wine legislation. These national statutes had either to be adapted to the new Community regulation, or they were simply superseded by it. Germany reacted to the new wine legislative environment with its "Weingesetz" of 1971. The remarkable achievement of this law was to design a new regime for quality wine regulation – the "Tested Quality in the Glass"-system – that carried over into the new European Economic Community principles of German wine quality legislation and which was, at the same time,

compatible with the new Community regulation. From the point of view of the German wine legislative tradition, there are, however, some indications that Community legislation related to wine quality tends to become increasingly alienated from the German tradition of regulating wine quality (Fuchß 2011).

Germany has had wine laws since 1892 when the first wine law was passed. Others followed in 1901, 1909, 1930, 1971 (Koch 1970), and the latest wine law is that of 1994. The first wine laws were mainly consumer protection laws; with the passage of time the laws were, however, increasingly concerned with broader economic aspects of the wine industry (Koch 1970). Much of the German idiosyncrasies of wine quality legislation dates back to the wine law of 1901. This law had introduced three innovations: (i) organoleptic testing of wine by "tongue appraisers", (ii) the wine category "Naturwein" (natural wine), and (iii) the prohibition to enrich "Naturwein" (Koch 1970). Two of these innovations were carried into the wine law of 1971, and one was dropped. The "tongue appraisers" became the organoleptic testing experts of the new wine law, and enrichment was prohibited for "Prädikat"-grade wines. The category "Naturwein", in contrast, was dropped. Perhaps legislators were not convinced that a drinkable wine could be produced by nature alone, and without any support from viti- and viniculture.

Because Community legislation allowed the member states considerable discretion in the design of their national standards for quality wine produced in specified regions, significant variation in the national standards emerged. Thus, Germany had its "Tested Quality in the Glass," whereas France continued its Appellation d'Origine Contrôlée (AOC)-system, which was copied as early as 1963 by Italy and later by Portugal (1986) and Spain (1996) too (Gaeta and Corsinovi 2014). Obviously, the German and the French systems for standardizing quality wines are fundamentally different. The German system considers in the award of a quality grade the geographic origin of a wine together with its observable individual characteristics. In France, in the AOC-system attributes quality to wines according to their geographic origin, largely without regard to the properties of the individual wines. To exaggerate, the quality level of a German wine is an indication of a wine's individual characteristics, whereas a wine's quality in France is like membership in a Hindu caste - inherited, immutable, and largely independent of its actual individual characteristics. What is, however, much more noteworthy than the differences in the quality assurance systems between northern and Mediterranean wine states is the Commission's forbearance over many years with that diversity. This is remarkable because the Commission usually tends to harmonize into oblivion differences between Member States when the differences are in its jurisdiction.

As we have said above, Community legislation on quality assurance underwent a paradigmatic change in 2008, when the wine factors were replaced by geographic origin. By this change, the EU system for distinguishing wine quality categories has become more similar to the French system and its notion of "terroir," and more removed from the German "Tested Quality in the Glass" system. In response to this change Germany saved its system by declaring it as a traditional one in. Whether this move will assure the viability of the German system in the long term is not obvious. Traditions have a tendency not to be amenable to technological change, trapping an industry in a technological cul-de-sac. The German system may have maneuvered itself into such a cul-de-sac if the decision to declare essential elements of its "Tested Quality in the Glass"-system turns out to constrain its future ability to adapt to innovations in either viniculture, or viticulture, or wine analytics.

4.5 Takeaways

- (1) Wine is deemed an agricultural product and the EU has competence over regulations that concern the wine industries of its member states;
- (2) three layers of legal norms govern wine testing in the EU: EU regulations, German federal legislative acts and regulations, and legislative acts and regulations of the wine growing states of Germany;
- (3) the objectives of EU regulations concerning wine are income support for wine producers, protection of consumers from error and fraud, protection of producers from unfair competition, and harmonization of wine quality requirements across member states;
- (4) from 1962 to 2000 EU wine quality policy was concerned with setting and enforcing criteria for "quality wine produced in specified regions"; with EU Regulation No 479/2008 the EU switched to two new quality categories (PDO and PGI) that are based on the geographic origin of wine;
- (5) PDO-wines must pass analytic and organoleptic testing;
- (6) PDO-wine testing in Germany is based on the Weingesetz (WeinG) of 1994, the secondary Weinverordnung (WeinVO) of 1995, and various administrative orders issued by the wine growing states;
- (7) the German grading system was adapted to the EU's quality system based on geographic origin by declaring the grades to be "traditional terms".

5 ORGANIZATION OF QUALITY WINE CERTIFICATION

5.1 Introduction

In this section we describe the organization of wine quality certification. We limit the description to the organization that is in place in Rheinland-Pfalz because this state is the largest wine producing state in Germany.

In the previous sections we have made no or only very light use of theory and models. But we now need some concepts and models for our description of the organization of wine certification. In particular, we make use of Simon's (1996) suggestion that artificial systems are purposefully designed interfaces between an inner and an outer environment, where the goals of the system provide the crucial link between the two environments. We first describe the system's goals and the outer environment. Then we describe the inner environment as a small network of agents. Finally, we outline how information that is generated through a sequence of observations, measurements, and decisions flows through the network to eventually produce a decision on the certification of a wine.

5.2 A network of agents

5.2.1 Purpose and external environment of the network

The apparent purposes of wine quality certification are determined or implicit by EU and national wine policy. There are four apparent purposes:

- (i) to validate the claims that a wine bottler makes about the quality characteristics of a wine;
- (ii) to enforce wine bottlers' compliance with labeling rules for Quality Wine;
- (iii) to signal to wine buyers the validity of the quality claims made on the wine label; this signal is the A.P. Nr. on the label, and
- (iv) to confirm the quality of German wines and enhance their reputation for high quality.

Conceivably, the system also serves some other undeclared purposes. For example, a purpose of the system may be to render the highly varied market supply of wine more "legible" for administrators by boxing the vast quality variation of wine into a relatively small number of quality categories. For our description we do not need to identify such undeclared purposes – if there are any.

5.2.2 Boundaries

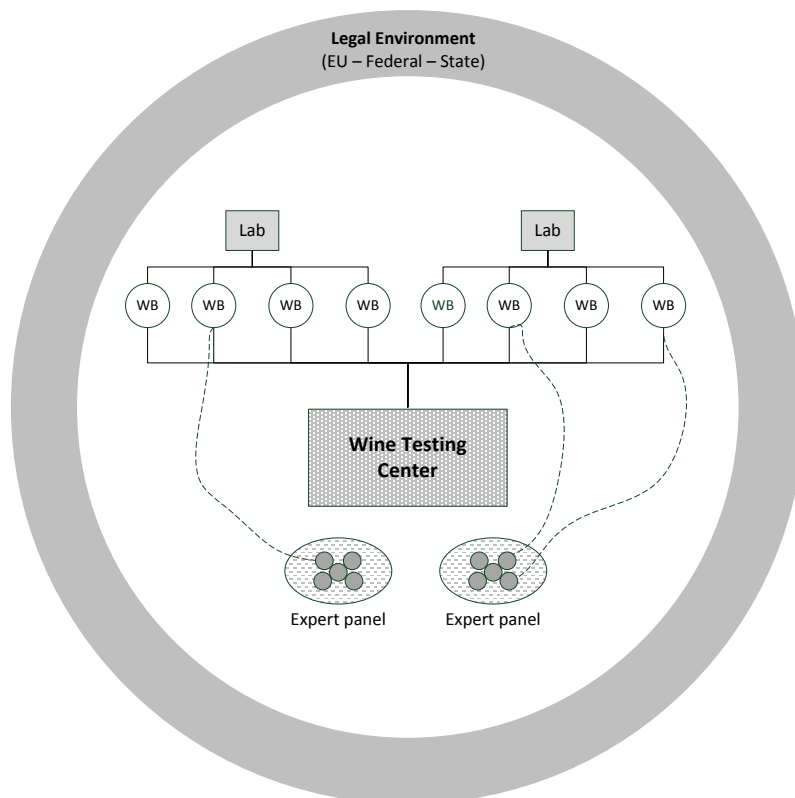
The wine certification system has two boundaries: the outer boundary of the system and an inner boundary that separates the outer from the inner environment. The outer boundary which separates the system from the rest of the world is given by the extension of the market for quality wines from Rheinland-Pfalz. The boundary can be defined in abstract terms but not in concrete, specific ones.

The boundary between the inner and the outer environment is best described by two locations along the wine supply chain. The first location is where a finished wine is ready for bottling or has already been bottled but not yet fitted with printed labels. At this point of the chain a wine enters the inner environment when it is sent by a wine bottler to a laboratory for analysis. The second location on the wine supply chain is reached when the Testing Center's issues a ruling about a wine and when the wine leaves the inner environment of the certification system.

5.2.3 The inner environment: a network of agents

The inner environment of the wine quality certification system is composed of various types of linked agents that form a network (see Fig 5-1).

Fig. 5-1 Overview of the organization of wine certification in Rheinland-Pfalz



There are four types of agents in this network:

- (i) wine bottlers (WB);
- (ii) laboratories (Lab);
- (iii) wine testing centers, and
- (iv) wine testing experts.

Wine bottlers comprise wine estates, wine cooperatives, and wineries that hold in stock wine that is ready for marketing (see Section 2.1.6). The differences in the size, the legal constitution, and the business models of the various types of bottlers are ignored here.

The laboratories analyze wines before they are submitted for testing. We can say little about the laboratories. Because they have been certified and registered by the Chamber of Agriculture of Rheinland-Pfalz, we are assured that the laboratories are equipped and able to perform the wine analyses according to EU regulations.

The Chamber of Agriculture of Rheinland-Pfalz is mandated by the state government to conduct tests for Quality Wine and the Chamber maintains six wine testing centers spread out over the state's five specified wine regions. A bottler who intends to sell a wine with a PDO-grade may submit the wine for testing to only one of the six centers.

The fourth and final type of agents are the wine tasting experts who actually perform the organoleptic wine examinations. The experts are drawn from various industry groups, such as vintners, wine estates, wine trade, and wine consumers. The experts have in common that they have been trained in wine tasting and in the testing protocol, and that they had their knowledge and tasting skills examined by a testing center of the Chamber of Agriculture.

All of the agents have links with agents and organizations in the outer environment: wine bottlers are part of the grape production industry or of the winery industry, or both; the laboratories are part of an industry for scientific services; the wine testing center is part of semi-autonomous public administration, and the wine tasting experts, finally, may be affiliated with other industries yet. This variability in outside affiliations of the agents is bound to enhance the diversity of tacit knowledge employed in the information production processes that we describe later in this section.

5.2.2 Linkages among the agents

The agents of the inner environment are connected to each other in various ways, and many of the linkages are irrelevant for the system to achieve its goals. For example, there are many connections between wine estates, e.g. family relations or vineyard leasing and tenancy relations, or wine estates and wineries who buy bulk wine from wine estates that may also bottle and sell some of their own wines. Such linkages are of no interest to us here. For the description of the organization of wine certification we are concerned with only three types of linkages among the agents:

- (i) the affiliation linkages that result from the fact that all agents are subject to the same EU, national, and state legal statutes that govern quality wine certification; in Fig 5-1 these linkages are not shown individually; they are indicated collectively by the ring that encircles the agents of the inner environment;
- (ii) information linkages between agents, and
- (iii) linkages that involve the transfer of wine samples.

The direct linkages between agents are indicated by the full lines in Fig 5-1. The individual linkages between the pairs of agents are listed in Table 5-1. Jointly, Fig. 5-1 and Tab. 5-1 are a description of the network that constitutes the inner environment of the wine certification system. The broken lines in Fig. 5-1 are not network linkages; they indicate that some wine bottlers may also serve as experts on tasting panels.

Table 5-1: Links among the agents of the network organization.

From column agent to row agent	Agent			
	Wine bottler	Laboratory	Testing Center	Expert panel
Wine bottler	-	wine sample	wine sample; analysis results; application form	-
Laboratory	analysis results	-		-
Testing Center	sample f. safekeeping; test result & A.P. Nr.	-	-	wine sample; tasting report form
Expert panel	-	-	filled in tasting report form	-

5.3 What the agents do

The purpose of organizing is to reap gains from specialization. To complete our description of the organization of wine certification we therefore need to describe the specialized activities that the agents perform. The activities are of two types. One is implied by the links between the agents and involves the communication - sending and receiving – of messages among agents, as indicated in Table 5-1. The other type involves the production and processing of information, in particular, generating data by observing and measuring wine attributes, and making decisions of various kinds. Before we describe the agents' specific activities, we briefly go over the substance of three generic activities, *viz.* observation, measurement, and decision making.

5.3.1 Observation

When we observe something we examine properties or attributes of the thing with one or several of our senses - sight, smell, taste, touch, and sound. The term 'observation' is sometimes used only for visual examinations but in science the term is used in its broader meaning (Bogen 2014). Often, the observations made are recorded as data that can be stored and used as information for various purposes, such as description of the thing that has been observed, for its categorization, or for decisions about its use.

Observations may be made with or without tools that enhance the senses, such as magnifying glasses or purpose-designed tasting glasses for wine, and they may or may not require the manipulation of the objects of observation in order to produce reliable data. Moreover, in order to enable observers to make non-trivial observations, they may have to be trained in requisite perceptual skills, and in the faculty to reliably translate their sensory perceptions into descriptive data.

Wine tasting, wine appreciation (Peynaud 1987), and sensory examination of wine (Amerine and Roessler 1976) are terms that denote the activity of making observations on a wine. Of these terms we prefer the last one because it best matches our definition of observation. The sensory examination of wine has evolved into a highly developed art which usually engages all human senses with the exception of sound. This art sustains specialists who routinely prepare a wine for examination, who are skilled in arranging the settings for sensory examinations, and, most importantly, who are experienced wine tasters. For reasons that are not yet fully understood, the ability of these wine experts to translate into intelligible data the full range of their sensory perceptions of a wine is, however, limited (Lehrer 1983; Shepherd 2012).

The limitation of expressing in natural language the sensory perceptions of a wine's complex attributes may have contributed to the development of various rating schemes that radically simplify the perception- translation task by prescribing a vocabulary consisting of a limited range of words or numbers. When numbers are used for coding the sensory perceptions of a wine, the resulting data are often used as if they were rational numbers, which they obviously are not.

5.3.2 Measurement

A measure is quantitative information about an attribute of something that has been measured according to some replicable procedure (for a discussion of various definitions of measurement see Ferris 2004). Often, measures are expressed in terms of numbers that may be stored and communicated without loss, be used as information inputs in decision making, and be processed according to certain rules, such as the rules of arithmetic.

In general, there are three methods for measuring something. Discrete attributes may be measured by counting, whereas for continuous attributes two different methods are usually employed, depending on whether the attribute can be observed directly by humans or not. Attributes that can be observed directly may be measured by comparing them with the same attributes of a unit of measurement. For example, we measure the volume of a wine container by comparing its volume with the volume of another container with a standardized volume. The other method of measuring quantitative attributes is to employ a calibrated measurement chain. In such chains, a sensor is put into contact with the attribute and produces some signal that depends on the state of the attribute. The signal is then converted into some information output that can be either understood by people, or be processed by intelligent machines (Perdijon 2001). Several sensors may be combined to produce information about an attribute. Finally, different measuring chains for different attributes may be contained within a single measurement instrument.

All of the measurable attributes of wine are continuous variables and many of the economically important attributes defy direct comparison with a unit of measurement. For instance, we may measure the volume of a bottle of wine by comparing it with the content of a standardized measure but we are unable to measure its sugar content in a similar manner. For this and many other physical and chemical attributes of wine, we need measurement chains that are implemented in measurement instruments.

5.3.3 Decision making

Making decisions is a mental activity that can be broken down into several elements. For Herbert Simon, who used the terms 'choice' and 'decision' interchangeably, "The problem of choice is one of describing consequences, evaluating them, and connecting them with behavior alternatives" (1997, p. 88). We adopt Simon's perspective on decision making and we define decision making as an activity by an intelligent agent who chooses from several feasible alternative actions the one that is expected to have the desirable consequences with respect to predetermined goals.

Simon (1997) thought of decision making as a sort of intellectual fabrication process that transforms various cognitive inputs in to an output, i.e. the selection from many of one or several actions. Simon (1997, p. 23) identified several inputs to a decision: "Any important decision is based on numerous facts (or suppositions of fact) as well as numerous values, side conditions, and constraints. We can think of all these facts and values as the premises of the final decision - the raw material inputs, so to speak, to an assembly process that ends with the decision itself" (p. 23). And he characterizes the

process as follows: "... the facts and values that enter into the decision-fabrication process, a process that involves fact-finding, design, analysis, reasoning, negotiation, all seasoned with large quantities of 'intuition' and even guessing" (Simon 1997, p. 24).

Simon spent much effort on contrasting bounded rationality, a term that he invented, with the conventional notion of full rationality. From the standpoint of the individual agent, Simon (1997, p. 323) distinguished three categories of the limits of rationality: "...he [the decision maker] is limited by his unconscious skills, habits, and reflexes; he is limited by his values and conceptions of purpose, which may diverge from the organizations goals; he is limited by the extent of his knowledge and information."

The recognition of bounded rationality provides scope for the division of labor among individual decision making agents. When decision making tasks are broken down into smaller tasks to suit agents' bounded rationality, the individual decision making processes become interdependent: the outcome of the decision of one agent becomes part of the decision premises of another. Moreover, when different agents specialize in making decisions of different kinds, there is scope for benefits from coordinating the decision making tasks of the specialists. Such coordination work often involves an additional, separate, kind of specialized decision making.

We have already identified the specialized decision making agents as well as the links along which agents communicate results of their observations, measurements and decisions to other agents who use this information as premises in their own decision making. But the question remains from where do the agents obtain the remainder of the decision premises, that is, the values, side conditions, and constraints? Some of the values and constraints are laid down in the various legislative documents that govern the wine certification process (see Section 4.1.1). This segment of the decision premises is binding for all agents and it is a strong formal tie among the agents of the certification network. Some elements of the decision premises may, however, simply be "in the air" of the external environment to which the agents are linked and from where they are somehow absorbed by the agents.

We have not observed systematically how the agents make their decisions, and even if we had, we would not know how exactly the agents process decision premises into decision outcomes. We may try, however, to infer the logical structures of the decisions that an agent has to make from the types of the explicit and observable decision premises of the decisions, and from the types of decision outputs. Or put differently, we ask, what type of decision making mechanism could possibly transform the types of given decision premises into the types of required decision making outcomes?

5.3.4 The agents' information activities

The agents' tasks that are of interest here are their information production activities which involve observation, measurement, and decision making. In Fig. 5-2, which is the slightly modified flowchart from Section 2, we have indicated these activities by shading them and we have numbered them consecutively in the order in which they are executed in the certification process. The activities are also listed in Table 5-2 together with their information inputs, outputs, and mechanisms that transform inputs into outputs. In this table some entries refer to observed items whereas others are assumptions or conjectures. In particular, because we do not have systematically collected empirical evidence of the values and interests of the agents, the entries in the column "Values & interests" are no more than plausible guesses.

Activity No. 1: The first information production activity is a measurement activity by a laboratory. The input to this activity is a wine sample that the laboratory receives from a wine bottler. On this sample the laboratory takes various measurements that are prescribed by law; moreover, the methods employed for measurement and the units of measurement are also prescribed by law. The laboratory reports back to the wine bottler the results of its analyses.

We do not have to search for long for the sources of specialization by the laboratories. The skills and the equipment required for analyzing wines and for measuring their chemical properties are certainly strong obvious sources for existence of specialized laboratory services.

Activity No. 2: Before a wine bottler files an application for an A.P. Nr. he or she ought to check the lab results whether the analytically measured properties of the wine, as reported by the laboratory, actually meet the requirements for the quality category that is to be specified in the A.P. Nr. application form. If the laboratory results indicate that the wine does not meet the required standards, the wine bottler may downgrade the quality category of the wine or decide not to market the wine as PDO-grade wine.

This decision by the wine bottler is readily modeled as an IF/THEN-rule with laboratory results as decision premises. Let $x(i)$ be the measurements of the wine's i -th attribute ($i = 1, \dots, n$) as reported by the laboratory, and $x_k(i)$ are the thresholds prescribed by law on attribute i for wines of quality category k . The wine bottler then must decide:

IF $\{x(1) \geq x_k(1) \text{ AND } x(2) \geq x_k(2) \dots \text{ AND } \dots x(n) \geq x_k(n)\}$
THEN {prepare an application form for category k -wine}
ELSE {don't prepare an application form for a category k -wine}.

The eventual output of this decision is a filled-in and submitted A.P. Nr. application form. This routine decision requires knowledge of the likely impact on demand for the wine when marketed with any of the quality categorizations that are feasible, given the laboratory results. Knowledge about a product's likely demand is idiosyncratic, entrepreneurial knowledge and the activity is specialized because of this unique knowledge input.

Figure 5-2: Specialized information production activities

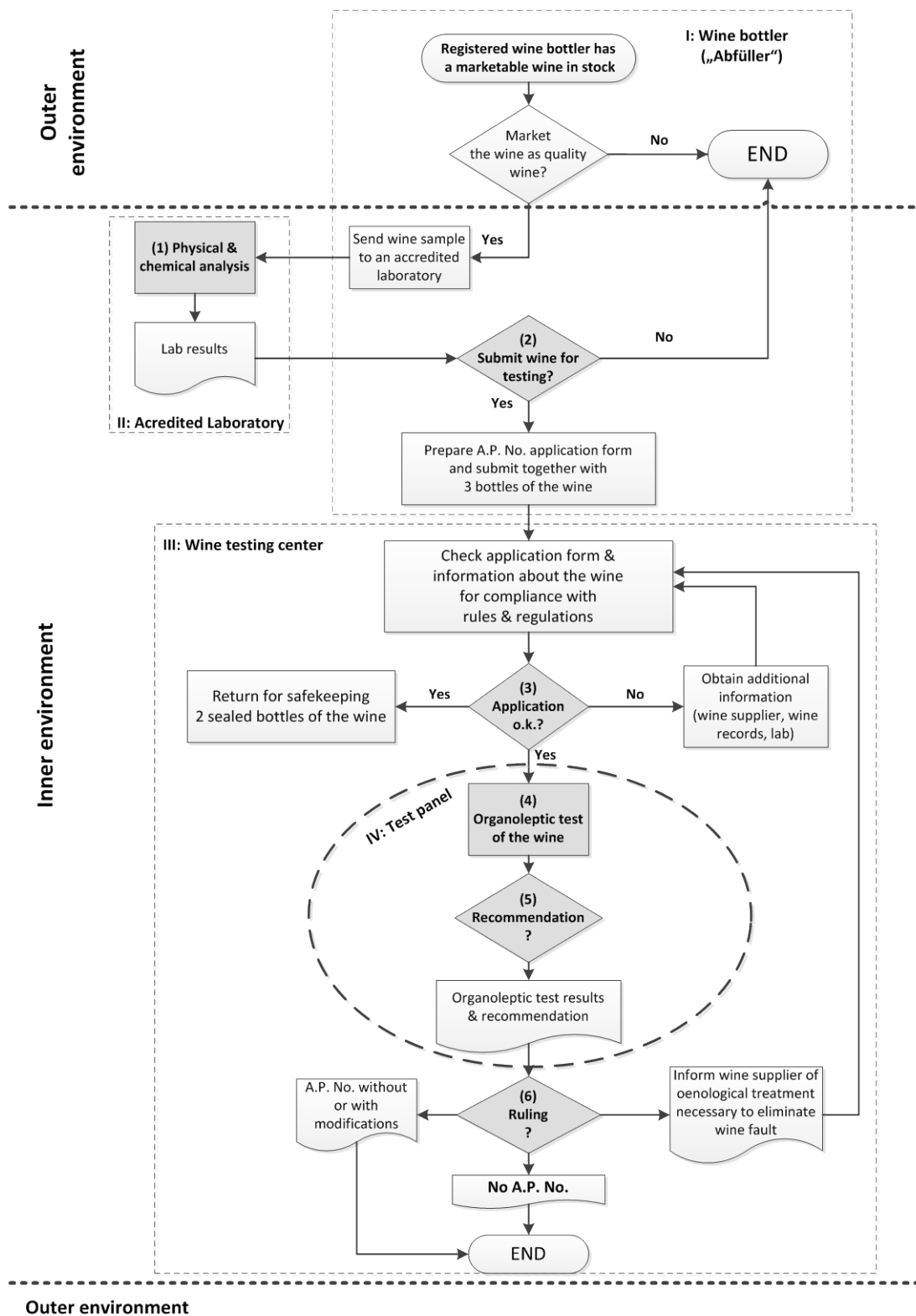


Table 5-2: Information production activities by the agents of Quality Wine certification in Rheinland-Pfalz.

Event No.	Agent	Activity	Activity premises			Mechanism	Information output
			Regulations & laws	Values & interests <i>(assumed)</i>	Case information		
1	laboratory	measurement	EU, federal & state statutes	professional values & profit	wine sample	Measurement chain	analysis report
2	wine bottler	decision making	"	peer values & wealth/profit	analysis report	IF/THEN	application form
3	testing center	decision making	"	professionalism & service for members	application form	IF/THEN	validated app. form
4	tasting panel member	observation & measurement & decision making	"	peer values & recognition	wine sample & tasting report form	black box; IF/THEN	filled in tasting report forms
5	tasting panel	decision making	"	peer values & recognition	short term memory & filled in tasting report forms	aggregation; Decision tree	aggregate quality no. & recommendation
6	testing center	decision making	"	professionalism & service for members	appl. form & wine sample & quality number & recommendation	Decision tree	test result & A.P. Nr. for approved wines

Activity No. 3: The testing center receives from the wine bottler three sample bottles of a wine that is to be tested together with an A.P. Nr. application form. Before the testing center processes a wine that has been submitted for testing, it checks the validity of the application. Checking a submission form is a routine activity which, conceptually, involves for all items $I = 1 \dots n$ on the form composite IF/TEHN-decisions of the kind:

IF {item(1) is filled in ... AND ... item(n) is filled in}	THEN {submission is complete};
IF {item(1) is plausible ... AND ... item(n) is plausible}	THEN {submission is plausible}
IF {submission is complete AND plausible}	THEN {accept submission as valid}
	ELSE {return submission to applicant}

The output of the decisions is a categorization of the application: it is either accepted as valid or rejected and returned to the applicant. This activity needs to be performed reliably but there are no reasons for specialization. Any robot that is able to read could be programmed to make the required decisions.

Activity No. 4: The experts of the organoleptic test panel are charged with three tasks that involve observations, subjective measurements, and decisions. Each of the test panel members receives from the test center a small quantity of the wine for tasting and a report form which indicates the category for which the wine has been submitted for testing. Based on the tasting each test panel member then has to make observations that are tied to simple IF/THEN-decisions:

- | | |
|--|---|
| 1. Is the wine suitable for tasting? | If "No": exclude from further testing; |
| 2. Is the wine typical for its specified region? | If "No": exclude from further testing; |
| 3. Is the wine typical for its quality category? | If "No": downgrade to a lower category; |
| 4. Is the wine typical for its variety? | If "No": accept but deny variety declaration; |
| 5. Is the wine typical for its color? | If "No": exclude from further testing; |
| 6. Is the wine clear (not clouded)? | |

Test panel members are held to record their decisions in the report form.

Following the yes-no decisions each panel member examines the wine for the presence of any of twelve wine errors and assigns points for each of the three wine quality characteristics, odor, taste, and harmony. For the assignment of points the experts are held to use a five-point scale, with its origin at zero and subdivisions of 0.5 points. There is an upper limit for the points that a wine may receive for its harmony. Let $p(o)$, $p(t)$, and $p(h)$ be the points that a panel member assigns to a wine for its odor, taste, and harmony, respectively. Then the number of points $p(h)$ that the expert may assign for the wine's harmony is given by:

$$p(h) \leq \max\{p(o), p(t)\} + 1.$$

Panel members record their observations and the points they assigned on the testing form and they calculate the quality number as the arithmetic mean of the points for the three wine quality characteristics.

This procedure may be regarded as a procedure for taking subjective measurements of the wine where the panel members use a common scale which has, however, not been rigorously calibrated among the members of a panel. However, some calibration may be achieved through training and examining the panel members, and through discussions among panel members. Such discussions

may occur after a testing session when the ratings for a wine varied significantly among the panel members.

We are unable to describe – far less to model – how panel members, or indeed any wine taster, translates his or her sensory experiences of the wine into a simple yes-no decision or into a number in the range from 0 to 5. It is well established that the tongue, the nose, the retronasal cavity, and certain sections of the brain are involved in wine tasting (see for example Shepherd 2015). But how these organs interact to translate the sensation induced by a wine into an utterance about the wine is a black box to us.

Examining wine is a demanding task that, as one of us has learned the hard way, requires substantial experience and natural talent in addition to formal training. Hence, personal knowledge, skills, and talent are the basis for specialized expertise in oenological examination of wine.

Activity No. 5: The organoleptic test results from the individual panel experts are collected by testing center staff, checked for their compliance with the requirements of the five-point system, and the wine's aggregate quality numbers is calculated from the points that the wine has received from the individual panel experts. Based on the aggregate quality number and the summary of the individual wine examination results, the panel then makes a decision about its recommendation for the classification of the wine. This decision is constrained by law to four options:

- 1) A.P. Nr. and approval of the suggested quality category and variety declaration;
- 2) A.P. Nr. and assignment of a quality category or a variety declaration different from the one state in the application;
- 3) deference of the decision for at least four weeks if the wine is not yet ready for testing;
- 4) an A.P. Nr. is denied.

This decision by the panel could be modeled as a decision tree. The decisions of the panel are passed on to testing center staff.

Activity No. 6: The final event involves the decision by the Testing Center about a wine. The key input into this decision is the record of the expert panel's recommendation for the wine, in addition to the application form and the wine sample. Again, the options available for this decision are defined by law. Three of the legal options are of no interest here because they involve the derogation of the wine to a non-quality wine. The one option that is relevant here concerns wines that have been rejected by the expert panel because of a wine fault. The Testing Center may grant such wines an A.P. Nr. if it believes that the fault can be corrected by some suitable oenological treatment.

The need for having a specialist make this decision has a single source: The power to issue a legal ruling on a wine, a power which the state of Rheinland-Pfalz has delegated exclusively to the Testing Centers of the Chamber of Agriculture.

5.4 Closing remark

In closing our description of the organization of wine certification we note an important implication of the sequence of the information production tasks. Wines that do not meet the minimum analytic requirements are eliminated from the testing procedure before they enter organoleptic testing. This implies a dominance of analytic examination criteria over organoleptic ones because a wine's organoleptic qualities are immaterial if it has not passed analytic muster and only when a wine has passed analytic examination are its organoleptic attributes taken into account.

5.5 Takeaways

- (1) Wine quality certification is organized as network with four types of agents: certification applicants (e.g. wine estates, wineries, co-operatives), laboratories, testing centers, and wine testing experts;
- (2) the agents are connected by affiliation linkages that obtain from the agents being subject to the same legal norms, by information linkages, and by linkages that involve the transfer of wine samples;
- (3) the legal form of the testing centers varies across states: in some state the testing centers are operated by the state, in others by the chamber of agriculture in the state, or by the wine producers' association in the state;
- (4) testing panels are managed by the testing centers; in their recommendations testing panels are independent of the testing centers; the panels' recommendations are binding for the testing centers.

6 THE QUALITY PYRAMID OF THE VDP

6.1 The VDP

The Verband Deutscher Prädikatsweingüter (VDP; "Association of German Prädikat Wine Estates") describes itself as "an elite group of some 200 quality-oriented German vintners who are committed to terroir-driven viticulture at the highest level" (VDP [a]). The members of the VDP, who are distributed over all German wine regions, account for about 2.6% of the national wine grape harvest, about 5% of the national vineyard area, and about 8% of the total value of German wine sales. VDP-vintners account for more than 10 percent of regional vineyard area in six of Germany's 13 wine regions, in particular, in the regions Rheingau, including the Hessische Bergstrasse, Franken, Sachsen and Saale-Unstrut, and the small Mittelrhein region. In the large wine producing regions of Rheinhessen, Pfalz, Baden, Württemberg, and Mosel the share of VDP-vintners in regional vineyard area ranges between 1.1 and 5.2 percent only (see Tab. 6-1).

Table 6-1: Regional distribution of VDP-wineries and their shares in regional vineyard areas

Regional VDP-branch	Wine producers		Vineyard area			
	VDP		Region		VDP	
	No	% of total VDP	ha	% of total	ha	% of Region
Rheinhessen	15	7.5	26,940	26.6	307	1.1
Pfalz	25	12.4	23,489	23.2	707	3.0
Baden	20	10.0	15,820	15.6	547	3.5
Württemberg	18	9.0	11,359	11.2	382	3.4
Mosel-Saar-Ruwer	32	15.9	8,787	8.7	457	5.2
Franken	28	13.9	6,111	6.0	854	14.0
Nahe & Ahr	15	7.5	4,708	4.6	291	6.2
Rheingau & Hessische Bergstrasse	39	19.4	3,134	3.1	1,245	39.7
Sachsen & Saale-Unstrut	4	2.0	481	0.5	92	19.1
Mittelrhein	5	2.5	459	0.5	57	12.4
Total	201	100.0	101,288	100.0	4,939	4.9

(1) Source: Calculated from data available at VDP [c].

The VDP has grown out of an earlier association, the "Verband Deutscher Naturweinversteigerer (VDNV), which was founded in 1910 to facilitate the auctioning of "Naturwein", i.e., "natural" wine that was not "improved" with sugar. The VDNV was transformed into VDP in 1971 when the German wine law of 1971 abolished the term "Naturwein" and replaced it with the term "Qualitätswein". At that time the VDNV had already shrunk to little more than 70 members and its dissolution seemed imminent (VDP [b]). Since then the exclusive VDP, new members are asked to join but may not join out of their own volition, has evolved into a club that provides its members with mainly three services: (i) a projection of the club and its members as an exclusive group of ecologically responsible vintners committed to producing terroir-wines of high quality, where quality is defined by the VDP itself; (ii) cooperative marketing and promotion activities, and (iii) development of a collective brand.

The collective VDP brand involves five elements: (i) a common identification symbol - the mildly Teutonic "grape eagle" ("Traubenadler") - which is shown on anything related to the VDP and which must be shown on the capsule of all VDP-wines (see Fig. 6-1); (ii) regular controls by the VDP of members' production processes and product quality; (iii) use of the VDP quality pyramid for classifying wines; (iv) commitment to list high prices, and (v) induction of vintners who add to the club's profile and clout and separation from members who do not meet the standards of the club. Here we are only concerned with the VDP quality pyramid which the VDP has developed since the year 2002 and which is compulsory for its members since the year 2012 (VDP [d]).

Fig. 6-1 The VDP "Traubenadler" (grape eagle)



Source: VDP (a)

6.2 The VDP quality pyramid

The VDP suggests that the roots of its wine classification scheme are to be found in certain deficiencies of the official classification scheme, in particular, the absence of a distinction between wines from specific vineyards ("Einzellagen") from those produced from grapes from a collective site ("Grosslage"), that wine of the Quality Wine (QW) category may be chaptalized, and that "There was no correlation between a quality category and style (taste profile)" (VDP [e]). In response to these deficiencies the VDP has specified several basic requirements for all wines marketed with the VDP-label, and the association distinguishes four quality levels which are, from the lowest to the highest quality level, VDP.Gutswein (regional wine), VDP.Ortswein (village wine), VDP.Erste Lage, and VDP.Grosse Lage. We are not aware that the VDP has provided English translations of the terms "Erste Lage" and "Grosse Lage" and we suggest the translations, "VDP premier vineyard wine", and "VDP-grand vineyard wine", respectively.

The VDP has specified a set of criteria that all wines sold with the grape eagle logo should meet, and several other criteria that are specific for the individual quality categories. In addition, the VDP prescribes for its members descriptors for wines of the different categories. We have assembled in Table 6-2 the criteria that the VDP uses to distinguish as wines of different qualities.

The requirements that all wines with the VDP label should meet are: (i) "ecological friendly and sustainable viticulture"; (ii) reduced yield of 75 hl/ha (~ 337 cases per acre) or less; (iii) use of traditional wine making techniques, and (iv) "must weights higher than the minimum prescribed by law" (VDP [d]). The VDP does not specify how the attributes "ecologically friendly" and "sustainable viticulture" are operationalized and which techniques are "traditional". Apparently, spraying of the nondegradable toxin copper sulphate (CuSO_4), as may be done by certified organic VDP vintners, is deemed "ecologically friendly". Moreover, the use of barrique barrels, which was considered in Germany until the early 1970s to produce "untypical" wines, has matured into a "traditional technique" in the eyes of the VDP. Finally, all VDP-wines should be at least "Quality Wine" according to the official quality scheme; this implies that all VDP-wines must have passed official quality testing and have been assigned an A.P.-Number.

Tab. 6-2: Criteria for the VDP wine quality categories.

VDP quality category	Criteria						
	Estate is a VDP member	Vineyard character- istics	Variety restrictions	Max. wine yield [hl/ha] ⁽¹⁾	Minimum grape ripeness at harvest	Harvesting by hand prescribed	Date of first sales
Gutswein	yes	good or excellent; belongs to the estate	none	75 (337)	not specified	No	not specified
Ortswein	yes	a village's best vineyards	none	75 (337)	not specified	No	not specified
Erste Lage	yes	first-class vineyard with distinctive characteristics	regional variety (additional restrictions in some regions)	60 (270)	Spätlese level	Yes	May, 1st, year after harvest
Grosse Lage	yes	terroir parcels within the very best vineyards in Germany	regional variety (additional restrictions in some regions)	50 (225)	Spätlese level	Yes	sweet: May 1st; dry: Sept. 1st; year after harvest; red: Sept. 1st, 2nd year after harvt

(1) No. of cases per acre in brackets.

Source: Assembled from VDP [d].

The differences between the criteria for wine of the "Gutswein" and "Ortswein" categories are small: the only difference is that a wine of the "Ortswein" category must have been produced from grapes that have been grown in a vineyard at a specific village, whereas the grapes for a wine in the "Gutswein"-category must have been grown in a vineyard that is operated by the VDP wine estate and located anywhere in a specified German wine region (see Tab. 6-3). The criteria for the remaining two quality categories, in contrast, are more demanding. Wine of both the "Erste Lage" and "Grosse Lage" categories must have been produced from grapes of varieties that are typical for the region and that have been grown in specified "Einzellagen"-vineyards, the maximum wine yields are further reduced for these categories, and the grapes must be harvested by hand at a stage of ripeness (sugar content of the must) that is the equivalent to grape for a wine in the official "Spätlese"-category. Moreover, there are precise restrictions on the first date of sales of the wines so that wines of the "Erste Lage" and "Grosse Lage" categories have had sufficient time to mature.

The VDP also uses different descriptors for its wines of different qualities (see Tab. 6-3). Wines of the "Erste Lage" and "Grosse Lage" categories are described by the VDP as "terroir wines" whereas wines of the "Gutswein" and "Ortswein" categories are not considered to be terroir wines. This distinction is expressed on the labels. Whereas "Erste Lage" wines and "Grosse Lage" wines show the names of vineyards on the label, the other wines do not. Moreover, the VDP prescribes that dry wines, with the exception of the wines from the lowest "Gutswein" category, may not be classified as a "Prädikat" wine, whereas sweet wines may have a "Prädikat". Thus, there may be no "Riesling Grosse Lage, Spätlese trocken", but there may well be a Riesling Gutswein, Kabinett trocken", and there may be, for example, a "Riesling Grosse Lage Auslese" if that wine is not a dry one.

The VDP likes to compare its quality levels with those that are in use in Burgundy. The "Grosse Lage" is regarded as being on par with "Grand Cru", "Erste Lage" is compared to "Premier Cru", "Ortswein" corresponds with "Village", and "Gutswein" is deemed comparable to "Bourgogne regional". We do not know whether the vintners in Burgundy appreciate the compliment.

6.3 The VDP quality system in relation to the official system

The VDP promotes its wine classification system as an alternative to the official system. This it is only in part but not in whole. The VDP system shuns the official "Prädikat" quality categories for its dry wines above the "Gutswein" categories. For the rest of its wines, i.e. for all sweet wines and for its wines of the "Gutswein" categories, a VDP-vintner may still use the "Prädikats". Moreover, and perhaps more importantly, all VDP-wines still have to pass the official wine testing procedure to be granted an A.P.-Number. Dry VDP-wines that are intended to be labeled without a Prädikat must, however, be entered into the testing procedure without any claims for a "Prädikat"; they then pass the testing procedure under the assumption that they are a simple "Qualitätswein" (QW) even though they may later be marketed as an expensive "Grosse Lage"-wine. The VDP-classification is therefore best characterized as a system that uses the official system and that provides an alternative classification for dry wines. Whether consumers are aware of the somewhat subtle differences between the official Prädikat-based quality hierarchy and that of the VDP is an open question.

Tab. 6-3: Descriptors for the VDP wine quality categories.

VDP quality category	Descriptors				
	Corresponding category in Burgundy	Terroir wine	Location information on the label	Permitted official "Prädikat"	
				Dry wines	Sweet wines
Gutswein	Bourgogne regional	no	wine region (e.g. "Pfalz", "Mosel")	QW; Kabinett, Spätlese	QW; all Prädikats
Ortswein	Village	no	name of the village of origin (e.g. "Forst")	QW	all Prädikats
Erste Lage	Premier Cru	yes	name of the vineyard (Einzellage)	QW	all Prädikats
Grosse Lage	Grand Cru	yes	name of the vineyard (Einzellage or some other name)	-	all Prädikats

Source: Assembled from VDP [d].

6.4 Takeaways

- (1) The VDP, a voluntary association of some 200 of the best wine estates in Germany, has developed a private wine grading scheme for dry wines;
- (2) the VDP grading scheme exemplifies the flexibility of the official scheme: (i) VDP wines are submitted for testing as "Qualitätswein" and, if certified, are assigned an A.P. Nr. like any German PDO-grade wine; (ii) for dry wines VDP estates use the VDP-grades in place of the official "Prädikat"-grades.

7 OUTLOOK: DIGITIZATION OF "TESTED QUALITY IN THE GLASS"

We have described in considerable detail how German quality wines are examined and certified, and we have quantified how much quality wine of various grades is produced in the thirteen specified wine regions; we have investigated how the wines are priced; we have forced our way through the thicket of legal statutes, we have scrutinized the organization of the certification system, and we have described a private grading system that has been grafted onto the official one. And now, what? - what use is the detailed knowledge of how "Tested Quality in the Glass" works?

First and foremost, the knowledge may enhance readers' utility from German PDO-wines because they can be assured that the label on a bottle describes the content with a minimum accuracy of 85 percent. Moreover, readers may impart this knowledge to others, enhancing their utility from German wines in turn. Second, empirical evidence suggests that the brains of people knowledgeable about wine, such as sommeliers, react differently to wine than the brains of wine amateurs (Castriota-Scanderberg et al. 2005), and wine experts appreciate wine differently than non-experts (Goldstein et al. 2011). This suggests that readers of our description may experience German wines differently from non-readers. If this is the case, we hope that our readers' experience is the more enjoyable. Third, the description details how the German state renders wine and wine quality 'legible', that is, how wine and wine quality are legally defined and how German and EU wine quality policy is made operational by the state's wine administration. This knowledge may help wine policy analysts to better understand German wine regulations and how they are administrated. Enhancing wine consumers' enjoyment of German wines and helping others to better understand German wine administration are useful endeavors, yet we probably could have achieved both with much lower demands on readers' attention and patience. We believe the most important use of our detailed description lies elsewhere.

The description led us to adopt a new perspective of the 'Tested Quality in the Glass' system, and this perspective, in turn, provides a basis for thinking about how the system may evolve in the future. In Section 5 we have described wine certification as a process that comprises several information-related tasks, such as measuring wine attributes, checking applications, and various decisions, all distributed over the agents who are linked in the certification network. Borrowing ideas from Arthur's (2009) "The Nature of Technology", we find that the network may be regarded as a complex technology for certifying wine. This technology, like all technologies, consists of various loosely-coupled sub-technologies where each sub-technology performs a certain sub-task. The technologies may be conventional ones, such as measurement equipment employed by laboratories, or non-conventional ones, such as the organizational routines of the testing center, and the wine examination by experts. What the certification technology and its essential sub-technologies have in common is that they involve the generation and processing of information. The overall technology produces, or doesn't produce, an A.P. Nr. from a sample of wine bottles that are accompanied by an application form. Some sub-technologies, in particular the laboratory and the wine examination experts, act as datafication technologies that produce data about wines. Several of the remaining technologies involve decisions based on established fixed rules and information that was produced by sub-technologies that were invoked earlier in the certification process. Moreover, at present much of the information that flows through the certification network is not digital nor are most of the essential sub-technologies.

Digitization is the most powerful force of creative destruction of our times. The force destroys technologies for the production and processing of analog data whilst it replaces them with digital ones. In addition, digitization has a knock-on effect. Because of huge cost and performance advantages of digital data technology over analog technology, digital technology encourages the datafication of anything. An impressive example of the knock-on effect is the huge increase in the harvesting, storage, and exploitation of digitized personal data by social networks, companies, and government agencies. Wine has been datafied to only a small extent until now, and wine data are often, perhaps even mostly, non-digital. We take it for granted that wine, the wine industry, and wine certification will not escape creative destruction through digitization. We believe the time is ripe for thinking through scenarios how digitization may transform wine certification.

In this section we sketch a scenario of the digitization of wine certification. Scenarios are invitations to reason about an unknown future. Our scenario of the digitization of wine certification must therefore not be mistaken as a prediction of what we think is likely to come to happen. Rather, it is a means for preparing the minds of those who are responsible for wine certification in Germany for the digitization of this area of their responsibility – a digitization which we believe is inevitable.

Speculations about the evolution of a technology are mostly worthless when they assume that the evolution starts from a blank slate. New technologies more often evolve from predecessor technologies and along bounded pathways. Our detailed description of wine certification allows us to tether our scenario to facts that we have described earlier in this paper: the reality of the present system that we have described in Section 2, the legal bounds described in Section 4, and the agents and their activities, or technologies, described in Section 5. What is missing are some important facts about digital information technology. We therefore highlight in the next section some broad trends in digital information technology, and we identify some broad categories of digital tools that are likely to contribute to the creative destruction of the analog certification system that we have described.

7.1 Opportunities and constraints on evolutionary change

More than sixty years of sustained evolutionary change of digital information technologies (IT) have created new industries, vaporized some old ones, and transformed many others. The transforming powers of IT are diverse and we will highlight only some that seem to be the most relevant for wine examination.

7.1.1 Technology

7.1.1.1 Super-exponential performance growth of computer hardware

Devices for storing, processing, and communicating digital data have experienced sustained performance growth described by growth laws that specify doubling times of relevant performance measures. Thus, data processing performance is said to follow "Moore's Law", "Kryder's Law" holds sway over doubling times of data storage capacity, and "Cooper's Law" specifies the doubling time of radio bandwidth (see Tab. 7-1). Expressed in performance per US\$, the functional performance measures have improved by 40 - 65 % p.a. since 1971, when the German wine law introduced "Tested Quality in the Glass" (Tab. 7-1). Closer inspection of functional performance time series

suggests, however, that performance growth is best described not by exponential growth functions with fixed doubling times, as the "Laws" suggest, but as super-exponential growth with decreasing doubling times (Nagy et al. 2011). Super-exponential growth functions have the ability to "shoot through the roof", i.e. they go to infinity. Infinite growth in computer performance is called a "singularity". The concept is as strange to us as the notion of the number zero was to medieval Europeans. Nagy et al. (2011), who determined the years for which such singularities are to be expected, seem to be uncomfortable with the specter of IT singularities: "Obviously, it is physically impossible to reach a singularity, indicating that before that hyperbolic growth must necessarily break down." And they add: "... the fitted curves are merely simplified descriptions of the trends in past performance and may not be predictive of future performance" (Nagy et al. 2011, p. 1362).

The implications of super-exponential growth in performance are mindboggling and it is difficult to imagine advances in hardware performance that are, in absolute terms, larger by factors of ten than anything we have seen until now. Fortunately for us, the wine industry is not in the cusp of rapid technological development and we can afford to be unconcerned about the day when the performance of digital devices equipment experience their respective singularities. It would be unwise, nevertheless, to ignore the continued accelerating rapid growth in the performance of digital equipment because the wine industry will not remain for long a tranquil island surrounded by perfect storms of digital creative destruction.

Tab 7-1: Measures of growth in computer hardware and communications performance

	IT function		
	Data processing	Data storage	Communication
Relevant "Law"	Moore	Kryder	Cooper
Performance measure	no. of transistors in an integrated circuit	areal density (bits stored per track, area or volume of storage device)	no. of conversations in the useable radio spectrum at one location
Expected doubling time	~24 months ⁽¹⁾	13 months ⁽²⁾	30 months ⁽³⁾
Performance measure	MIPS/US\$	Mbits/US\$	Kbps/mio US\$/km
Level at t	2.14E-07 (t=1968) ⁽⁴⁾	0.075 (t=1971) ⁽⁵⁾	49,910.24 (t=1970) ⁽⁵⁾
Level at T	5.32E+01 (T=2010) ⁽⁴⁾	1,142.9 (T=2004) ⁽⁵⁾	32,946,120,727 (T=2002) ⁽⁵⁾
Comp. growth rate in t to T	56.6% p.a.	65.0% p.a.	41.5% p.a.
Year of singularity (\pm SE) ⁽⁶⁾	2030 (\pm 12)	2029 (\pm 17)	2020 (\pm 14)

(1) Wikipedia "Moore's Law"

(2) <http://searchstorage.techtarget.com/definition/Kryders-Law>

(3) <http://www.arraycomm.com/technology/coopers-law/>

(4) Kurzweil 2012, Ch. 10, note 10

(5) Koh and Magee 2006

(6) Nagy et al. 2011

7.1.1.2 Shrinking size and falling weight of digital devices

As the performance of physical IT equipment grew super-exponentially, devices shrank, lost weight, and became mobile. Cutting-edge IT devices of the 1970s were of cabinet size, in the 1980s and 1990s they occupied the better part of a desk, then they moved to the lap, now they fill a shirt pocket, and soon they will sit on our noses. As they shrank in size and mass, they also became more mobile. Nobody moved their Vax-machines around, but many take their smartphones wherever they

go. Shrinking sizes have not impaired the functionalities of IT devices; rather, the opposite is true. When component technologies shrink in size and mass, the number of component combinations in a device of manageable size and mass increases exponentially according to the formula $2^N - N - 1$, where N is the number of single component technologies that can be fitted into a device (Arthur 2009, p. 173). The smartphone exemplifies the power of Arthur's formula. Whereas a mobile phone of old was a computer with a telephone, the smartphone, which is about 20 years younger, has added to this ensemble a number of component technologies, such as touch-sensitive color display, Wi-Fi radio, cameras, GPS-receiver, and so on. Moreover, smartphones have become the computer-platform for sensors that datafy a wide range of phenomena in which the sensors' buyers have some interest. Examples are the various sensors for functions of the body, such as the pulse rate or blood oxygen level, or a pocket-sized spectrometer for measuring the contents of food products.

7.1.1.3 Sensors: The end of ageusic and anosmic digital technology has come

Ageusia is the loss of taste functions of the tongue and anosmia is the loss of the sense of smell. Digital data technology was born with both impediments. We know of no evidence from the history of digital technology that suggests that any one of its leading developers and engineers had any interest in technologies for the conversion of flavor into bits, and for turning bits into flavor. Not even computer scientists and engineers who put the people at the center of their designs seemed to be concerned with flavor. For example, Markoff (2015, Kindle position 3322) writes about Alan Kay, the inventor of the dynabook, the ur-tablet computer, "Computing, he foresaw, would become a universal, overarching medium that would subsume speech, music, text, video, and communication." In short, digital IT was meant to be seen and to be heard, but it wasn't meant to tickle, smell, or taste. Evidence suggests, however, that sensors for datafying taste and odors are enabling digital devices to evolve a sense of flavor.

We are no specialists in chemical wine analysis and we do not claim to be in any way familiar with the field. Our reading of review papers on the state of the art in chemical wine analysis (Polaskova et al. 2008; Robinson et al 2014; Savage 2012) suggests that the arsenal of chemical wine analysis comprises five major classes of analytic methods, most with several sub-types: olfactometry, gas chromatography, mass spectrometry, nuclear magnetic resonance spectroscopy, and electronic noses and tongues. Specific methods from these classes are often combined in various ways and instruments for applying the methods are commercially available.

With the exception of human olfaction, which is handicapped by man's slow evolutionary change, the instruments for all types of methods appear to be subject to significant technological advance. We lack the expertise necessary to provide a useful account of these advances. Skimming a number of review papers suggested to us the following objectives of the technological advances in chemical analysis: (1) to enhance the breadth, sensitivity, and accuracy of measurements, (2) to make the methods and instruments easier (and less costly) to use inside the laboratory, in particular to automate analysis processes, and (3) to render the equipment for certain methods portable for use outside the laboratory by non-specialists. Moreover, innovations in chemical analysis equipment tend to be applied first in any one of the industries where demand for chemical analyses is large, in particular, in health, food, environmental monitoring, and security. The wine industry is far too small to sustain the development of new analytical methods and instruments; rather, such innovations

usually spill into the wine industry allowing this industry to free-ride on the innovations designed for industries with a larger, more attractive markets.

A recent innovative application of IT in wine flavor analysis suggests an imminent technological revolution that will bring taste and flavor to IT. One of these methods is ^1H nuclear magnetic resonance (^1H NMR) spectroscopy. The scientific basis for NMR was laid in the late 1940s. NMR systems for chemical analysis became available from commercial vendors in the 1960s but a search at Google Scholar shows no trace of NMR applications in chemical analysis of wine in the 1960s. Applications of the method to wine analysis appeared in the late 1980s and 1990s, when NMR analysis was well underway in the health industry, and more applications of the method to wine analysis were reported in the research literature in the early 2000s. By now ^1H NMR spectroscopy has been developed to a stage where it allows the automatic fingerprinting of wines (Godelmann et al 2013) and it is offered as a service by commercial wine laboratories (Pilz 2015). Also, E-tongues have been constructed whose sensors capture signals of tastes and e-noses capture signals of odors (Savage 2012), and both are capable of digitizing the signals received, and of storing and communicating the information thus generated. E-tongues and e-noses are, however, unable to convey that information to humans in a way that engages the flavor centers in the human brain. Whether and when the instruments will be endowed with an ability to transmit flavor experience, we cannot tell. Finally, enologists and IT-engineers have developed sensors and data analysis methods that allow wine makers to monitor continuously wine fermentation for compounds that determine wine taste, such as sugar, phenolics, and alcohol content (Lapsley and Mueller; Lapsley and Sumner). Apparently, it is possible to endow IT with the sense of taste, smell, and flavor. Whether the possibilities will become reality depends on the presence of entrepreneurs who perceive for such devices a market that is sufficiently large to encourage investment in adapting the technologies to wine and the wine industry.

7.1.2 Software tools

Software turns digital equipment into useful tools for tasks. Before we characterize software tools that are potentially useful for digitizing wine certification, we need to recollect the information tasks that jointly constitute wine certification. The tasks, as identified in Fig. 5-2, slightly aggregated and generalized, are:

- (1) routine information tasks, including information storage, retrieval and communication;
- (2) decision making and aggregating individual judgments;
- (3) taking measurements and processing of measurement data (e.g. lab analysis of the wine);
- (4) tasting and judging wine.

Software for routine information tasks is readily available for diverse computer systems. This software category has achieved high levels of usability, performance, reliability, and it would appear to be fully adequate for the tasks involved in wine certification. Moreover, software of this category is available at prices that are negligible for any organization. Software is also available, or can be easily programmed, for the routine decisions that need to be made during wine certification, as well as for aggregating the individual judgments about the wines into a collective one. Some measurement data require powerful statistical software for data classification and categorization.

Again, such software is readily commercially available, although the effective use of such software packages may require some training.

The most difficult task to solve with computer software is the tasting and judging of wine. We know of no study that has shown that tasting and judging of wine by humans can be replaced by some type of wine tasting robot. But even if robots may never become a perfect substitute for wine tasting and examination by human experts, this does not imply that software may not facilitate and perhaps augment wine tasting and examination by human experts. Actually, the widely publicized dispute between the econometrician Orley Ashenfelter and a phalanx of wine experts led by Robert Parker has convincingly shown that statistical data analysis may predict wine quality and prices more reliably and more accurately than experts whose method is to feed their mental prediction models with wine flavors rather than with data (Ayres 2007, pp. 1-6). If experts are outperformed by a standard statistical method applied to a relatively small data set, up-to-date machine learning algorithms that are trained with large volumes of data from several hundred thousands or millions of wine examinations that have been conducted in the past should be able to provide valuable support for experts charged with the difficult task of examining and rating many wines in rapid succession.

Software has greatly benefitted from super-exponentially growing hardware performance: growth in storage capacity helped to overcome space constraints of large software programs, and growth in CPU-speed helped to overcome the time constraint of large and complex software programs. What hasn't grown by much, if at all, is the human capacity to absorb and understand the information that complex and sophisticated software tends to produce and on which people should base their actions. Three approaches are available for resolving the human bottleneck. First, the task may be automated completely thereby eliminating humans from the task; this would violate German wine law which requires wines to be examined by panels of human experts. Second, the computer running the software could communicate the results directly to digital implants in the user's brain; for some time to come wine examination experts are unlikely to give their consent to this type of interaction. Third, smart interfaces link the computer with the human user; this would be legal and feasible - just talk to Siri on your iPhone, or to Google Now on your Android device. Hence, smart human-computer-interfaces are likely to be the technology of choice for breaking the human information absorption bottleneck.

7.1.3 Domains, bridges, and the Shannon Touch

Digital information technology (IT) is more than a heap of devices and software. Because all digital IT devices exploit the same physical phenomena - they represent data as binary digits and they process binary digits with switching circuits that implement Boole's logic - digital equipment and tools work by the same principles and they can interact with each other more easily than with non-digital devices. Digital IT nicely fits what Arthur (2009) calls a 'domain': it is a cluster of technology elements that "share a common theory" and that have some "shared and natural ability of components to work together" (Arthur 2009, p. 70).

Domains change over time and, "A change in domain is the main way in which technology progresses" (Arthur 2009, p.74). Change is, however, rarely abrupt and complete; rather, different domains of technologies that serve the same purpose often coexist. Thus, the change from older analog domain to the new digital domain is rarely complete in office information technology, where

digital computers, databases and email have coexisted with analog forms, folders, and files. When devices from different domains are used side-by-side, 'bridging technologies' are needed to enable the technology components from the different domains to cooperate with each other. Thus, the scanner is a bridging device between the analog world of forms and the digital world of files stored on a memory device, and the screen is a bridge between the digital computer and the brain of its user. Bridges tend to interrupt the 'natural' work flow of a domain, they reduce the performance of the technology ensemble, and they are as inconvenient as toll bridges.

In Greek mythology, King Midas turned everything that he touched into Gold. A similar, less miraculous, transformation can be observed when digital IT touches an older analog information technology. Examples of technologies that turned digital when touched by digital IT abound: books became e-books, music records became CDs and iPods, maps became GIS/GPS, movies moved from the drive-in theater to Netflix, and so on. We call the transforming power of digital IT the "Shannon Touch" in memory of Claude Shannon who was the first to automate the processing of binary data according to Boole's logic (Hillis 1998).

The 'Shannon Touch' has three sources: the super-exponential performance growth of digital IT equipment, the network externalities that accrue when two or more pieces of digital equipment are harnessed together in a technology assembly, and the bridges between domains. Super-exponential performance growth assures that digital IT becomes increasingly attractive for potential adopters. The network externalities fuel the epidemic spread of digital IT and the elimination of old domains eliminates the toll bridges. The "Shannon Touch" can be expected to be also at work when sensors are converted from analog to digital and when such sensors are connected to digital data equipment. Thus, as nearly all high-performance data storage and processing is digital, sensors will sooner or later be converted into digital ones.

7.1.4 Pragmatic constraints

7.1.4.1 EU and German wine regulations

The most important pragmatic constraint that we take into account in our scenario are the EU and German wine regulations, which we assume to remain in force unchanged. This assumption is justified on two grounds. First, EU wine regulations concerning quality wine have undergone considerable change with the replacement of the older system based on quality criteria by the new one based on geographic origin of a wine. There is no evidence that the EU is about to change the essence of the current policy on wine quality. Second, the resilience of German quality wine regulations is assured: the laws and regulations are, with some adaptations, in place since 1971, and they have survived significant changes in EU regulations. We are confident that the German laws and regulations will also survive unscathed the creative destruction of conventional wine certification by digitization.

7.1.4.2 Continuation of organizational structure

The current organizational forms of quality wine certification in Germany have been in place for decades. There is no evidence that the governments of the quality wine producing states have any intentions to reorganize wine certification. Our second pragmatic constraint therefore is the

continuation for some time to come of the current organization of quality wine certification in the states, and particularly in Rheinland-Pfalz. Historical evidence suggests, that organizations that change their internal information processing technologies eventually also change their organization routines (or non-physical information processing technologies). And when both the physical and the non-physical technologies have changed, the structure of the organization or the overarching information processing technology are also changed to better accommodate the constituent component technologies. This change, which seems to be inevitable, is, however, beyond our purview.

7.1.4.3 Augment people - don't aim to replace them

A debate of many years divides into two camps computer scientists, some philosophers, and a very few economists. In one camp are the proponents of Artificial Intelligence (AI) who expect computers to replace human intelligence in many cognitive tasks. The other camp is populated by the believers in Intelligent Augmentation (IA), who hold that computers are best used as complements for the human mind (Markoff 2015). Due to cost and performance limits of computers the debate was somewhat academic in the past. The super-exponential growth in computer performance has changed this. When IBM's Deep Blue super-computer beat world chess champion Kasparov in 1997 and when IBM's Watson computer beat in 2011 the world's leading human players in the "Jeopardy!" quiz show (Markoff 2015), AI obviously was no longer a wil-o'-the-wisp in the eyes of some exceedingly farsighted computer scientists. And when ordinary chess players, with a bit of help from affordable computers and off-the-shelf chess software regularly managed to beat chess grandmasters in so-called freestyle chess, this form of IA was considered by some to be "a model that high earners will be emulating in years and decades to come" (Cowen 2013, p. 68).

We do not intend to enter the debate about the pros and cons of AI versus IA. We believe, however, that IA has two important advantages. First, its demands on computer performance and software sophistication are lower than that of AI. This advantage is, however, likely to melt away with super-exponential performance growth of digital equipment and with machine learning. The other advantage is more robust. IA, we submit, is likely to encounter much less luddite opposition than AI. This is likely to be a significant advantage for the chances of IA technologies being adopted, compared to the chances of AI adoption, particularly when labor interests have a say in an organization's technology adoption decisions.

7.2 An evolutionary path towards digitization

It is difficult to think about a scenario without a foil, a framework, a storyline. Our storyline for the creative destruction of the wine certification technology is the following: Technological change is not planned by anyone agent in the network but it evolves. This evolution is fed by the rapid and accelerating expansion of the digital domain outside the wine industry. Technological entrepreneurs from the wine industry tap into the digital domain and introduce digital technologies in their businesses in order to exploit some benefits from digital technology. Some innovations of this kind require new bridges to the older information technology used by the certification network; the bridges are inconvenient and may cause avoidable costs. Some of the agents may put pressure on the network to change its technology such that the bridges between their own new digital technology and the networks old analog technology become unnecessary. When this happens, digital

IT has penetrated the network and Shannon's Touch may do its work towards a full conversion of the network to digital technology.

Because no single entrepreneur can affect the conversion of the network, we need to specify for our scenario a conversion path with several phases. In total, we have five phases in mind:

- 1) lobbying for digitization by A.P. Nr. applicants;
- 2) digital document flow in the Testing Center;
- 3) digital data services by the laboratories;
- 4) intelligent augmentation (IA) of wine testing experts, and
- 5) intelligent augmentation (IA) of testing center management.

For each phase we need to specify:

- (i) which type of agent is likely to act as the entrepreneur initiating the phase;
- (ii) which conventional technology will be replaced by new digital technology;
- (iii) how the new digital technology collaborates with the remaining conventional technologies, and
- (iv) which new potential network effects ('Shannon Touch') may arise from the new digital technology.

We present our scenario in future tense. We do this in order to avoid the tedious complexities of the conditional tense. The choice of future tense in no way suggests that our scenario predicts likely future events. Its purpose simply is to prepare readers for the future of wine certification in the digital information era.

7.2.1 Lobbying for digitization by A.P. Nr. applicants

In Section 5 we have identified four types of agents, viz. bottlers, wine laboratories, the testing centers, and wine experts. From which group will emerge the entrepreneurs who trigger the digital evolution of wine certification? Plausible candidates for this critical role are some commercial wineries or some progressive wine estates among the bottlers who have digitized much of their own business operations and who need to maintain inconvenient bridges that allow them to interact with the Testing Center's conventional technology. For example, the wine making processes of a commercial winery in Germany with the largest bottling capacity per day in Europe are fully controlled by computers. Does it make sense for such a winery to submit a paper form or a fax as an application for an A.P. Nr.? Hardly. Also, an increasing number of wine estates uses digital technologies for meeting the legal vineyard and cellar documentation requirements. Moreover, the tax accounts of all businesses tend to be fully digitized. A digital A.P. Nr. application would seem to be the 'natural' thing to do for the more progressive estates, just as it is for the large wineries. If it is not yet happening already, entrepreneurial bottlers are likely to lobby with the testing center and the Chamber of Agricultural for the introduction of digital A.P. Nr. applications that can be generated automatically by their computer systems, and transmitted over the Internet to the Testing Center, perhaps together with the wine's laboratory analysis results.

7.2.2 Digital document flow in the Testing Center;

When pressured by applicants, the Testing Center will accept digital A.P. Nr. applications. How will the Testing Center process the applications? One option is to build a bridge between the entry point of the digital applications and the conventional document processing system of the center, that is, digital applications will be printed out and then processed together with the rest of the applications forms. This option denies the testing center all advantages from digital data processing. Shannon's Touch will, however, eventually set in: the printer as a bridge will come to be seen as an awkward kludge and the Testing Center will perceive internal cost and performance benefits from introducing a digital system for processing the certification applications. Moreover, some Center staff will remember Leibnit'z observations that "... it is unworthy of excellent men to lose hours like slaves in the labor of calculation which could be safely relegated to anyone else if the machine were used" (Leibnitz ca. 1674-1695) and the routine decisions about an application's completeness and validity will be fully automated too.

7.2.3 Digital data services by the laboratories

Of the four types of agents in the certification network, the wine laboratories are probably the most closely connected to digital IT and they are probably the most familiar with this technology. Their role as entrepreneurs leading the network on the evolutionary path towards digitization is, however, likely to be encumbered because they are pure service providers who have no representation in the Chamber of Agriculture, which operates the testing centers in Rheinland-Pfalz. Nevertheless, as new datafication methodologies arise, and as the performance of digital sensors improves with the rest of digital IT, laboratories will be able to shift the frontier of wine datafication and provide at falling costs much more accurate digital data on a wine's chemical composition and physical attributes. Moreover, enhanced digital measurement data on a wine will be cheaply stored in the cloud, where they can be accessed by authorized users, or they will be transmitted over broadband internet connections to bottlers, and to the testing center too.

Without any suitable tools for accessing and analyzing the data, testing centers and bottlers will benefit little or not at all from the widened breadth and increased accuracy of wine datafication. Which tools would be suitable for the task of analyzing quickly and comprehensively large volumes of wine data? A candidate class of tools is machine learning software that exploits two developments: the availability of large data sets, 'big data' in the jargon of computer science, and the super-exponentially rising performance of computers at equally rapidly falling costs of computation (Domingos 2015; Mayer-Schönberger and Cukier 2013; Varian 2014). Such tools will assist decision making by wine experts and by the Testing Center as well.

7.2.4 Intelligent assistance for wine testing experts

When laboratories measure at low cost the concentration of compounds that cause wines to be deemed faulty, wine experts will request to have access to these data before or during wine testing sessions. Given the time-pressure under which experts often have to examine the wines - a minute per wine is a common frequency - experts will not be helped by long lists of chemical analysis results, irrespective of whether such lists are printed or displayed on computer screen or tablet computers. Rather, the results of chemical analysis will be used to identify wines which are potentially faulty.

When an expert calls up a wine on his computer screen or tablet computer, the potentially faulty wine will be flagged for having one or several specific wine faults. The final decision whether the wine is actually deemed faulty will, however, be left with the wine examination expert.

The assignment to a wine of a quality number is a subjective act by a wine expert and there is no known algorithm that can replicate that act. If such an algorithm were available, wine experts could be replaced by wine examination robots. Research by Ashenfelter and Jones (2013) suggests, however, that wine expert opinions do not consistently reflect all information that is available to the experts and that expert judgments can be improved. To bring about such an improvement, machine learning software will be trained with the huge data set on wine test results that the Testing Centers amass, with wine analysis data, with weather data from the location where a wine was grown, and any other data that are deemed relevant for a wine's classification. The trained software will then use the data of wine that is up for examination to compute an analytic test result, including an analytic quality number. Such analytic test results will be personalized for individual expert panel members by taking an expert's personal history of examination results into account. Experts will then use the analytic results as benchmarks for their own personal judgments about a wine and for fixing its quality number.

7.2.5 Intelligent assistance for wine examination panel management

Human performance in any task is more easily improved when performance can be measured and when the performer is provided with feedback about the performance. The performance of wine examiners is difficult to measure because there is no ready standard of comparison for the judgments made by an expert. Nevertheless, two types of feedback may be provided. Currently, experts, having completed an examination round, may compare their own examination results for a wine with the results of their peers on the panel. This feedback is immediate, informal, and its scope covers only single wines. In addition, the testing center may track the performance of individual experts, again by means of peer performance comparisons. It is, however, not clear whether information provided by the Testing Center about the experts' performance track record would be perceived by the experts as useful feedback information, or as a form of paternalistic tutelage that challenges their status.

When the results of all wine examinations are stored and processed in a computer system of the testing center, and when wine laboratories make detailed data on the wines available to the centers, the centers will have a strong incentive to combine both types of data to see whether there are correlations between the wine characteristics and the judgments of individual wine experts, including the deviations of their judgments from those of their peers. Results of such analyses, which will be performed with the help of machine learning tools, will have mainly two uses: they will help the testing centers identify experts with high frequencies of erratic judgments, given the characteristics of the wines, and they will facilitate the selection of experts into panels with a balanced profile of strengths and weaknesses of the individual experts on the panel.

7.3 Two caveats

Scenarios have a tendency to be deceptive. They tend to invite one of two errors, and sometimes both. The "swagman's error" is to confuse a clear vision with a short distance. As many swagmen in

the Australian outback have learned, the error can be lethal. The other is the "sailor's error" which is to confuse a poor vision with a long distance. Many shipwrecks bear witness of the error.

The creative destruction of the existing certification system at the hands of digital technology is in clear view to us. The swagman's error implies that this does not mean that the conversion to digital will occur any time soon. Moreover, the sailor's error reminds us that some entrepreneurs may be ready to introduce some digital technology unseen by us, but which may, via the Shannon Touch, obliterate the present certification technology much sooner, much more quickly, and differently from what we have described in our scenario.

The caveats refer to the timing and to the specifics of the digital destruction of the present certification technology; we submit no caveats for our conviction that the digital conversion will happen.

7.4 Takeaways

- (1) Wine certification is a non-physical information processing technology and advances in information technologies will affect wine certification;
- (2) wine is most likely to become increasingly datafied because of continued super-exponential growth in the performance of digital technologies and because of the growing availability of cheap, small, and accurate sensors for measuring wine attributes;
- (3) all information processing activities by the agents of the certification network will benefit from digitization;
- (4) both, datafication of wine and digitization of the certification network will transform certification;
- (5) digital computers and robots are unlikely to become satisfactory substitutes for the expertise of human wine examiners, but they are likely to become valuable tools that support examiners' tasks.

8 TAKEAWAYS

Section 2: "Tested Quality in the Glass": What you see, and what you don't see

- (1) German wines are classed into nine main grades; the most important criterion for the grades is the must weight of the grapes from which the wine was made;
- (2) the two lowest grades, viz. "Deutscher Wein" and "Landwein," are not considered to be quality wine; "Deutscher Wein" has no geographical indication; "Landwein" is wine with a "Protected Geographic Indication"(PGI);
- (3) The remaining higher grades are "Qualitätswein" and six "Prädikat"-grades ("Kabinett", "Spätlese", "Auslese", "Beerenauslese", "Eiswein", and "Trockenbeerenauslese"); all are wines with a "Protected Geographic Origin" (PGO);
- (4) the option to improve a wine through chaptalization discriminates between "Qualitätswein" and all of the "Prädikat"-grade wines: "Qualitätswein" may be chaptalized, "Prädikat"-grades wine may not;
- (5) German PGO-grade wines are produced from *vitis vinifera* varieties; varieties are officially approved for each of thirteen specified wine regions;
- (6) all German PGO-grade wines have an A.P. Nr. printed on the label; this number is evidence that the wine has been officially examined and is deemed to be "Tested Quality in the Glass";
- (7) "Tested Quality in the Glass" is an information certification technology: wine bottlers (estates, wineries, cooperatives, etc.) suggest the grade under which they intend to market a wine and they submit the wine at the time of bottling to a testing center for examination;
- (8) a wine's examination involves three activities: (i) chemical and physical analysis by a laboratory; (ii) review by the testing center of the plausibility and legality of the claims the bottler intends to make on the label, and (iii) sensory examination by a panel of trained experts;
- (9) wines are tested blind by the experts who check for wine faults and who rate each wine on a 0-5 point scale for its odor, flavor, and harmony;
- (10) testing center may lower the grade of a wine below the one claimed by its bottler, but may not raise it.

Section 3: Production, exports, and prices of German quality wines

- (11) Germany is the world's 10th largest wine producer; slightly more than 20,000 viticultural enterprises produce about 900 mio l (100 mio cases) of wine annually from slightly more than 100,000 ha (247,000 acres) of vineyard area;
- (12) white wines dominate national wine production with a share of about two thirds of total volume;
- (13) PDO-grade wines dominate national wine production and, averaged over a 30 year period, jointly account for more than 95 percent of the total volume of wine produced;
- (14) of the PDO-grade wines, "Qualitätswein" accounts for more about 85 percent; the rest are wines of the several "Prädikat"-grades;
- (15) among the "Prädikat"-grades, the lowest two, viz. "Kabinett" and "Spätlese" account for more than 80 percent of the total volume of "Prädikat"-grade wines;
- (16) wine prices tend to increase with the wine's grade; the price premia increase with the wine grade, and grade premia tend to be higher for premium wines than for bulk wine.

Section 4: The legal basis for "Tested Quality in the Glass"

- (17) Wine is deemed an agricultural product and the EU has competence over regulations that concern the wine industries of its member states;
- (18) three layers of legal norms govern wine testing in the EU: EU regulations, German federal legislative acts and regulations, and legislative acts and regulations of the wine growing states of Germany;
- (19) the objectives of EU regulations concerning wine are income support for wine producers, protection of consumers from error and fraud, protection of producers from unfair competition, and harmonization of wine quality requirements across member states;
- (20) from 1962 to 2000 EU wine quality policy was concerned with setting and enforcing criteria for "quality wine produced in specified regions"; with EU Regulation No 479/2008 the EU switched to two new quality categories (PDO and PGI) that are based on the geographic origin of wine;
- (21) PDO-wines must pass analytic and organoleptic testing;
- (22) PDO-wine testing in Germany is based on the Weingesetz (WeinG) of 1994, the secondary Weinverordnung (WeinVO) of 1995, and various administrative orders issued by the wine growing states;
- (23) the German grading system was adapted to the EU's quality system based on geographic origin by declaring the grades to be "traditional terms".

Section 5: Organization of Quality Wine Certification

- (24) Wine quality certification is organized as network with four types of agents: certification applicants (e.g. wine estates, wineries, co-operatives), laboratories, testing centers, and wine testing experts;
- (25) the agents are connected by affiliation linkages that obtain from the agents being subject to the same legal norms, by information linkages, and by linkages that involve the transfer of wine samples;
- (26) the legal form of the testing centers varies across states: in some state the testing centers are operated by the state, in others by the chamber of agriculture in the state, or by the wine producers' association in the state;
- (27) testing panels are managed by the testing centers; in their recommendations testing panels are independent of the testing centers; the panels' recommendations are binding for the testing centers.

Section 6: The quality pyramid of the VDP

- (28) The VDP, a voluntary association of some 200 of the best wine estates in Germany, has developed a private wine grading scheme for dry wines;
- (29) the VDP grading scheme exemplifies the flexibility of the official scheme: (i) VDP wines are submitted for testing as "Qualitätswein" and, if certified, are assigned an A.P. Nr. like any German PDO-grade wine; (ii) for dry wines VDP estates use the VDP-grades in place of the official "Prädikat"-grades.

Section 7: Outlook: Digitization of "Tested Quality in the Glass"

- (30) Wine certification is a non-physical information processing technology and advances in information technologies will affect wine certification;

- (31) wine is most likely to become increasingly datafied because of continued super-exponential growth in the performance of digital technologies and because of the growing availability of cheap, small, and accurate sensors for measuring wine attributes;
- (32) all information processing activities by the agents of the certification network will benefit from digitization;
- (33) both, datafication of wine and digitization of the certification network will transform certification;
- (34) digital computers and robots are unlikely to become satisfactory substitutes for the expertise of human wine examiners, but they are likely to become valuable tools that support examiners' tasks.

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