AMERICAN ASSOCIATION OF WINE ECONOMISTS

AAWE WORKING PAPER
No. 115
Economics

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July 2012
ISSN 2166-9112

www.wine-economics.org

How the liberalization of planting rights will affect the wine sector of Rheinland-Pfalz, Germany: a partial equilibrium analysis

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Abstract. This study aims at predicting the effects of planting rights liberalization on the wine industry of south-western region of Germany. Introduced by the CAP reform of 2008, abolishment of planting rights shall go into effect from 2018 the latest and is expected to cause changes in production volumes and market prices for wine throughout the EU. Rheinland-Pfalz is the most important wine producing region in Germany and thus investigated as a relevant case study here.

In order to assess the effects of planting rights liberalization a long run static partial equilibrium model is developed. The model projects equilibrium supply, demand and wholesale market price for two types of wine: barrel quality wine and wine for further processing. Since the modelling is conducted for the long term perspective, climate change effects on the land suitability for wine grapes growing are taken into consideration. With abolishment of planting rights, the model projects an increase of production of quality wine and wine for further processing and the fall of their domestic market prices.

Keywords: quality wine, wine for further processing, planting rights liberalization, partial equilibrium modeling

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We would like to thank the Ministerium Umwelt, Landwirtschaft, Ernährung, Weinbau und Forsten in Rheinland-Pfalz for financial support of the project "Szenarien weinbaulicher Flächenausweitung" within which the current study is conducted. We also thank the Statistisches Landesamt Rheinland-Pfalz for providing the statistical records.

1 Introduction

Production and marketing of wine in the EU are governed via the Common Market Organization (CMO), which is a part of the EU Common Agricultural Policy (CAP). Since 1976, a crucial point of this CMO has been a prohibition on planting of new vineyards (EEC 1976). The aim of this measure was to prevent overproduction, stabilize the prices, and support a quality oriented industry. Thus, for several decades total acreage of vineyards in Germany has been strictly regulated, as has been the case for the rest of the EU.

With the CAP reform of 2008, a new approach in regulating the wine sector has been introduced. Following the goal of elimination of political intervention into the market, the planting rights are to be liberalized from 2018 the latest (EC 2008[1]). Among other changes of the CMO for wine, this one has been debated the most.

Many wine producers, experts, policy makers and other interested parties doubt about the efficiency of planting rights liberalization and argue its negative effects on the profitability and quality orientation of the industry (see for example Agra-Europe 2012). For Rheinland-Pfalz, which is the main wine producing region in Germany (SBA, 2010), the effect of the reform could be substantial. The characteristic features of its wine industry are a considerable variation of cost-efficiency levels among the wine farms and an orientation towards the production of quality wine. Typically, units which are larger and situated in flatter areas have lower production costs than those of smaller size and in mountainous areas. Since the market price for wine is supported via a restriction on total acreage of vineyards and on the amount of wine produced per hectare, most of the farmers involved in the wine production benefit from the policy. Despite the indirect price support, a shift of the vineyards to flatter areas and structural change towards larger farms have been observed. Under the planting rights liberalization these developments are expected to accelerate.

Whereas less productive wine farms can survive under the current situation mainly by producing more expensive wine, more productive units are also able to produce wine for further processing which receives a lower market price. Nevertheless, majority of the more productive farms focus on producing quality wine, for two main reasons. Firstly, the price premium for domestic quality wine is substantial. Secondly, not only the total acreage under vineyards is limited, but, in addition, there exists a per hectare wine production quota.

The per hectare wine production quota limits the amount of wine produced per hectare to a certain maximum volume. It differs within the production regions and wine quality levels. For example, in the production regions Ahr and Mittelrhein the maximum production volume of any type of wine should not exceed 100 and 105 hl/ha respectively. In Mosel, Nahe, Pfalz and Rheinhessen the maximum production volume of wine for further processing is 200 hl/ha, and of quality wine 105 hl/ha and 125 hl/ha (only in Mosel) (AID 2011). Naturally, these additional restrictions influence the production choice. Instead of producing large volumes of

[1] Commission Regulation (EC) No 479/2008 is amended by the (EC) No 1493/1999, (EC) No 1782/2003, (EC) No 1290/2005, (EC) No 3/2008. Commission Regulation (EC) No 606/2009, Commission Regulation (EC) No 436/2009 and Commission Regulation (EC) No 607/2009 lie down the detailed rules on implementation of this Regulation.

low quality wine, some of the vintners choose to produce both types of wine since the quota for wine for further processing is too low to reach the optimal production volume and market price for quality wine is relatively high. This creates a situation that depending on the wine grapes yields, most of the farmers alter between production of the two types of wine from year to year. They give preference to quality wine production in the years of better yields, and to wine for further processing in the years of poorer yields. The influence of this rather intricate policy regime on production decisions has been analysed by Dabbert and Oberhofer (1990). They found that this political system favored organic wine farms on the contrary to conventional ones.

Liberalization of the planting regime implies the potential to increase total vineyards area and, thus, wine production volumes. Following the microeconomic theory, this will *ceteris paribus* lead to a decrease in the domestic market prices for wine. Depending on the new market situation and cost-efficiency of the farms, the options to produce quality wine or wine for further processing will be reassessed by the farmers. Apart from the question on whether a production of quality wine will remain a viable option for the majority of farms, another area of concern much debated in the public is about the beautiful vineyard landscapes in mountainous areas and special oenological practices entailed in small-scale wine farming.

Since no comprehensive analysis of the effects of planting rights liberalization on the German wine market has been done so far, the current work is devoted to bringing some light on this issue. In particular, we attempt to answer the following research questions: how much of the new available land for wine grapes cultivation will actually be used, will more of high or low quality wine be produced, what will be the domestic market price for these wines in the long run and what will be the prevailing farm type.

The paper is organized in the following way: Firstly, the wine sector of Rheinland-Pfalz is described in detail. Secondly, the model is presented along with its implementation; thirdly, the results are given and further implications of the model's output are discussed and lastly, problems and limitations of the modeling approach are pointed out, recognizing the need for further consideration and refinements.

2 Wine sector of Rheinland-Pfalz

Around 100,000 ha of vineyards were cultivated in Germany in 2010. Almost two thirds of this area were distributed among production regions of Rheinland-Pfalz: Ahr, Mittelrhein, Mosel, Nahe, Pfalz and Rheinhessen. They produced more than 66% of the German wine that year (SBA 2010).

Wine production has the biggest share in the total agricultural production value of Rheinland-Pfalz, – around 33.5%. According to the records of 2010, there are 9,382 registered viticulture farms, which is 42% out of the total amount of agricultural production units in Rheinland-Pfalz (SLRP 2010a). Their size ranges from less than 1 to more than 50 ha. The farms of less than 20 ha of cultivation area are the majority (SLRP 2010b).

For more than 55% of the viticulture farms, wine grapes cultivation is the main agricultural activity. Almost half of the required labor hours at the farms are provided by the family

members (DLRRP 2005a, b, c, d). Average profits of the wine production units differ according to the production region, farm size and cultivation area (BMELV 2009). In particular, the steeper the slope of the cultivation area, the more difficult it is to nurse the vineyard and, thus, the higher the production costs are, and vice versa. Different production areas of Rheinland-Pfalz have different acreage of land of steeper and flatter slopes. According to the data of 2010, less than 1% of Pfalz and Rheinhessen, 16% of Nahe, 42% of Mosel, 68% of Ahr and 83% of Mittelrhein are the areas with more than 30% slope (data from Statistisches Landesamt Rheinland-Pfalz, personal communication 2012).

Despite financial support which is received by wine producers of Rheinland-Pfalz in the form of payments for yield insurance and investments, subsidies within the framework of the EU Rural Development Programme and regional programmes for promotion of organic and sustainable farming such as PAULa (Programm AgrarUmweltLandschaft) (MJVRP 2010, DLRRP 2010a), the sector tends to reorganize into more cost-effective production. In particular, the number of large farms situated on areas of flatter slope increases and the number of smaller units in hilly regions decreases. Thus, throughout the last decade areas of vineyards cultivated by the farms of less than 10 ha have decreased by almost 40%, while those cultivated by units which are larger than 20 ha almost doubled. Similarly, total area of vineyards situated in regions with a slope of more than 30% has decreased by 27%, and the area of vineyards situated on flat lands has decreased by only 1.3% (data from Statistisches Landesamt Rheinland-Pfalz, personal communication 2012).

More than two thirds of the wine farms in Rheinalnd-Pfalz are equipped with processing facilities. The vast majority of them uses the possibility of self-processing, whereas one third exposes their grape must for processing to a third party (DLRRP 2005a, b, c, d). The recipients are usually various trade companies or producer organizations, where around 15% of the total area of vineyards is registered (LWKRP 2006). More than 83% of wine from this land is marketed only via the cooperations.

On average, production of quality wine prevails in Rheinland-Pfalz. Currently, there are four main quality levels of wine defined in Germany: Grundwein (wine for further processing), Deutscher Wein, Landwein and Qualitätswein (quality wine). Qualitätswein is the wine of the highest quality level which bears the label of protected geographical origin, whereas Grundwein is the product of full or partial fermentation of a grape must for further processing into sparkling wine, liquor, wine drinks etc. (see BMJ 2011 and EC 2008).

In 2007, a year when the volume of grape yield in Germany were about average (SLRP 2012), only 15% of the total amount of wine produced in Rheinland-Pfalz were wines other than quality wine. On average, Germany is self-subsistent in higher quality wine by almost 80%, while imports of lower quality wine are greater than the domestic production by a factor 1.6 (Eurostat 2012).

Although white grapes cultivation prevails (55,213 ha in 1999 and 44,350 ha in 2010) in Rheinland-Pfalz, throughout the last decades its area has been decreasing in favor of black wine grapes (11,618 ha in 1999 and 19,356 ha in 2010) (SLRP 2010a, SLRP 2010b). This is due to the decline of white wine consumption in Germany and increase of red and rose wine

consumption. In 2009, 12% of consumed domestic wine was rose wine, 42% red wine and 46% white wine (DWI 2011/2012).

3 Modeling concept

In this study a long-run comparative static regional partial equilibrium model is used as a method to evaluate the effects of planting rights liberalization on the wine sector of Rheinland-Pfalz. The model projects the equilibrium demand, supply and wholesale domestic market prices for barrel quality wine and wine for further processing for 2025. By this time, a considerable amount of vineyards planted after 2017, i.e. five generations, will be mature enough to produce (additional) wine.

In contrast to the mathematical programming and econometric models, equilibrium modeling allows considering the whole sector instead of a single representative farmer, and constructing of an artificial dataset (that is consistent with the model's assumptions) instead of relying on the time series data (Tongeren et al. 2001). The equilibrium modeling of the wine sector, needs however, a sophisticated approach. The supply side of the model is influenced by the diversity of a grape processing outputs, the perennial character and 4-year maturation period of vines, and diversity of farms sizes and cost situations.

Starting from the very first step of a wine market simulation, i.e. definition of the production function, a modeler must deal with the problem of multiple output. A typical wine farmer in Germany can produce wine of several quality levels and types, wine drinks, grape juice, vinegar, ethanol or can end his processing chain by selling grapes or grapes must. Depending on the production output, the use of production factors may vary and, thus, the parameters or the form of production function might be different. Whereas it is not usually with respect to the research question to treat all of the grape produce as a homogeneous good, the choice often falls upon the differentiation between the commodities or groups of them.

There are a number of options for estimation of the production volumes of a multiproduct industry. One can apply the product transformation function to simulate the farmer's production choice and then use supply functions for estimation of the actual production volumes (Roth 2001). Following Cutts et al. 2007, it is also possible to limit the commodities' supply functions by the total volume of grapes production and apply product prices which are dependent on each other in order to calculate the production volumes. Wittwer et al. 2001 apply the model where wine sector is split in industries according to the commodities and where grapes are both inputs and outputs (see also Wittwer 2007, Wittwer and Anderson 2001 and Wittwer and Rothfield 2005).

In the present study we include two production outputs: quality wine and wine for further processing. These goods are produced in volumes determined by their constant elasticity supply and demand functions. The substitutability in production of these commodities is represented by the cross-price elasticity of supply and uniformity of the land area available for wine grapes cultivation.

The perennial character of vines poses a challenge to economic analysis since the planting decision must weight costs and returns over more than 20 years. In addition, the optimal

rotation of vines might vary over time as a response to many factors such as market and policy changes, fluctuations in yields and input requirements over the life time of the crop and, thus have an influence on planting decisions (Knapp 1987). For long run static equilibrium modeling, the main task in this case would be to assume reliable values of input and output price elasticities of supply as well as values of exogenous variables. For the current study these values are taken from literature sources.

Regarding the maturation period, the supply of vines can mainly be modeled in three ways. The first way is to model the acreage of only wine bearing plants. The second is to estimate the change in the active vineyards and then add them to the plantings of the baseline period with the four year lag. The third option suggests modeling of new and uprooted plantings (Cutts et al. 2007). Each of the options has its advantages and disadvantages and, thus, depending on the modeling approach, either of them can be preferred. For example, whereas the second and third options make the model more informative, their application to the long-run equilibrium modeling is rather doubtful. On the contrary, modeling of wine bearing wines does not allow accounting for new and uprooted plantings which might lead to under- or overestimation of the modeling results. It, however, is suitable for the modeling of market equilibrium in the long run, since no positive or negative changes are assumed to happen at this point.

Diversity of the vineyards is another point to account for when modeling the wine sector. Depending on slope and size of the area of vineyard, production costs as well as the wine yields vary. Whereas in this study we use aggregate yield values, it is also possible to model wine bearing numbers to account for different vine densities in different areas (Cutts et al. 2007) or construct several production functions according to the variety of vineyards structures.

A particular complexity of the wine sector modeling might arise from the demand side due to the changing and diverse consumer preferences. For example, throughout the last four decades the consumption preferences in Germany have switched from white to red wine (MWVLWRP 2006). In this case, one would expect a disaggregation between the wine types (Wittwer et al. 2001) and a particular care when choosing consumer utility and demand functions as well as own and cross price elasticities of demand.

There are not, so far, many publicly available studies devoted to discovering the effects of planting rights liberalization on the German or EU wine sector. One of them is a research by Montaigne et al. 2012 which analyzes socioeconomic impacts of the reform in several EU and New world wine producing countries in retrospective. The main findings include vineyards reallocation, overproduction of wine and price pressure in case of the planting rights relaxation. It is, however, stated that the effects might change depending on the market regulation measures introduced instead of the planting rights.

Following the discussion, basic features and assumptions of the model presented in this study include constant economy of scale and perfect market competition, constant elasticity demand and supply functions, constant consumer preferences, zero effects of wine stocks on the equilibrium market price and production volumes, constant wine trade balance and assumption on market equilibrium in the baseline scenario and that at the points of

equilibrium all of the vineyards are at their productive stage. These assumptions are embedded into the demand, supply and closure equations, overview of parameters and variables of which are presented in Table 1.

Table 1*: Overview of variables and parameters included in the model

Function of demand for quality wine			
Qd_q	quantity of quality wine demanded, hl	*Pop*	population growth rate
const_dq	constant term	*e_opd_q*	own price elasticity of demand for quality wine
P_q	wholesale market price of quality wine, EUR/hl	*e_cpd_qi*	cross-price elasticity of demand for quality wine with respect to imported wine
P_i	wholesale market price of imported wine, EUR/hl	*e_cpd_qb*	cross-price elasticity of demand for quality wine with respect to beer
P_b	wholesale market price of beer, EUR/hl	*e_cpd_qs*	cross-price elasticity of demand for quality wine with respect to spirits
P_s	average wholesale market price of spirits, EUR/hl	*e_id_q*	income elasticity of demand for quality wine
Inc	real GDP per capita growth rate		
Function of demand for wine for further processing			
Qd_v	quantity of wine for further processing demanded, hl	*P_out*	wholesale market price of output from processing of wine for further processing, EUR/hl
const_dv	constant term	*e_opd_v*	own price elasticity of demand for wine for further processing
P_v	wholesale market price of wine for further processing, EUR/hl	*e_cpd_vil*	cross-price elasticity of demand for wine for further processing with respect to the imported wine for further processing
P_il	wholesale market price of imported wine for further processing, EUR/hl	*e_cpd_vout*	cross-price elasticity of demand for wine for further processing with respect to the price of output
Function of supply of quality wine			
Qs_q	quantity of quality wine supplied, hl	*e_cps_vq*	cross-price elasticity of supply of quality wine with respect to wine for further processing and vice versa
const_sq	constant term	*YIELDq*	volume of quality wine produced per hectare, hl/ha
e_ops_q	own price elasticity of supply of quality wine	*AREAq*	total acreage of vineyards from which grapes for quality wine production are harvested, ha
Function of supply of wine for further processing			
Qs_v	quantity of wine for further processing supplied, hl	*YIELDv*	volume of wine for further processing produced per hectare, hl/ha
const_sv	constant term	*AREAv*	total acreage of vineyards from which grapes for wine for further processing are harvested, ha
e_ops_v	own price elasticity of supply of wine for further processing		
AREAt	total area available for wine grapes cultivation, ha	*T*	productivity growth induced by the structural change towards more productive wine farms

*Similar indices are used in the GAMS code.
Source: own compilation

Demand block

The demand side of the wine market is represented by constant elasticity demand functions for quality wine and wine for further processing. Such functions imply constancy of own and

cross-price elasticities as well as income elasticity over all time and over all levels of the respective variables. The demand function for quality wine has the following form:

(4.1) $$Qd\_q = const\_dq \times (P\_q)^{e\_opd\_q} \times (P\_i)^{e\_cpd\_qi} \times (P\_b)^{e\_cpd\_qb} \times (P\_s)^{e\_cpd\_qs} \times (Inc)^{e\_id\_q} \times Pop,$$

where *Qd_q* is quantity of quality wine demanded, *const_dq* – constant term, *P* are the wholesale market prices for domestic quality wine, imported wine, beer and spirits, *Inc* is the real Gross Domestic Product (GDP) per capita growth rate, *Pop* is the population growth rate, and *e* are the own and cross-price elasticities (for details see Table 1).

Since quality wine is a finished product and marketed for direct consumption, a consumer demand function is used in this study. This function is also a constant elasticity function which means it is exponential and thus, infinite. A possible disadvantage of its application could be a possibility to estimate only relative consumer welfare change. This, however, is of little relevance for the current study due to the primary interest in the change of equilibrium supply and demand volumes and of market prices.

Variables included in the model correspond to the general economic assumptions on factors that influence consumer demand and to the conclusions of various studies dedicated to discovering of wine consumption patterns in Germany. The latter especially refers to the choice of products-substitutes for the quality wine. According to MULEWF 2010 and MWVLWRP 2006, beverages most commonly substituting Qualitätswein in Germany are imported wine of various quality levels, beer and spirits. Although certain kinds of imported wine or spirits are preferred by the consumers (for example, wines from France, Italy and Spain are the most popular), the category rather than certain type of beverage creates market competition to the domestic quality wine.

Although, the consumers usually purchase wine, beer and spirits at the retail prices, wholesale market prices are considered in the model. The use of the wholesale market prices and absence of the price transmission process is, first of all, due to data availability reasons. Whereas the database for the wholesale market prices is publicly available and consistent, the estimations of retail market prices found in different sources are difficult to justify.

The demand for wine for further processing is expressed as a constant elasticity processing demand function:

(4.2) $$Qd\_v = const\_dv \times (P\_v)^{e\_opd\_v} \times (P\_il)^{e\_cpd\_ilv} \times (P\_out)^{e\_cpd\_outv},$$

where *Qd_v* is quantity of wine for further processing demanded, *const_dv* – constant term, *P* are the wholesale market prices for domestic wine for further processing, imported wine and output from processing the wine for further processing and *e* are the own and cross-price elasticities (for details see Table 1).

According to BMJ 2011, wine for further processing, i.e. Grundwein, is a half-fermented must which can be used for production of spirits, sparkling wines, traditional fruit drinks such as Glühwein, Sangria (in Spain) or Glögg (in Scandinavian countries). Major factors influencing demand for wine for further processing, apart from its own price, are prices of substitutes and

of outputs. Therefore, average wholesale market prices for imported wine for further processing and for sparkling wines together with vermouth are considered in the model.

The functions of demand for quality wine and wine for further processing fulfill the conditions of negativity of the own-price effect and symmetry of cross-price effects via the choice of the respective elasticity values from the literature. They are also assumed to meet conditions of additivity and of zero degree homogeneity in all prices and incomes.

Prices for substitutes, for output from processing of Grundwein as well as income and population growth rates are entered in the models as parameters. Whereas income and population growth are future projections, prices represent actual values for the reference year.

Supply block

Supply functions of quality wine and of wine for further processing are defined as:

(4.3) $Qs\_q = const\_sq \times (P\_q)^{e\_ops\_q} \times (P\_v)^{e\_cps\_vq} \times T,$

(4.4) $AREA\_q = Qs\_q / YIELDq,$

(4.5) $Qs\_v = const\_sv \times (P\_v)^{e\_ops\_v} \times (P\_q)^{e\_cps\_vq} \times T,$

(4.6) $AREA\_v = Qs_v / YIELDv.$

Here, *Qs* are quantities supplied of quality wine and wine for further processing, *const_s* are constant terms, *P* are the wholesale market prices of quality wine and wine for further processing, *e* are own- and cross-price elasticities of supply, *T* is a productivity growth parameter induced by the structural change towards more productive farm units (already described in the previous chapter), *YIELD* are the volumes of wine produced per hectare and *AREA* are the acreage of vineyards (for details see Table 1).

In order to account for wine production quotas and for increase of the land area available for vineyards cultivation after the abolishment of planting rights, the supply block includes the functions of vineyards area. Wine production quotas are included in the model via the volume of wine produced per hectare, i.e. wine yield. The model assumes an average yield of 108 hl/ha of quality wine. This yield represents the average quota per hectare. The differing production quotas among the regions of Rheinland-Pfalz are thus not taken into account. Similarly for wine for further processing: 200 hl/ha are assumed as the yield. Overproduce beyond the maximum allowable yields is usually disposed of to the production of by-products such as vinegar or ethanol. Since the latter process is not modeled, and the vintners usually reach the quotas except for the years of extremely low yields, e.g. the year of 2010, the production quotas are used as yields per hectare.

Whereas yields per hectare are entered in the model as parameters, the land areas that are needed to produce grapes for quality wine or for wine for further processing are endogenous to the model and determined via the respective supply functions. These functions themselves depend on the wholesale market prices for wine, own- and cross-price elasticities and productivity growth. Quality wine and wine for further processing are assumed to be substitutes in production. Since the farmers typically aim at production of quality wine but yearly adjust their production decisions with the objective to fulfill the quota under specific

weather conditions of the respective year and in response to the market prices for wine, production costs of both types of wine are nearly similar.

The parameter for productivity growth, *T*, represents an assumption that with the planting rights liberalization the wine farms will tend to improve their productivity by enlargement and reallocation of their vineyards. Consequently, the wine sector is assumed to constitute mainly of larger farms on flatter areas. Such situation implies the reduction of the average wine production costs of the sector and, thus, to the outward shift of the aggregate supply functions.

The supply functions comply with conditions of non-negativity of the own price effect, global homogeneity of the supply function in all prices and local symmetry of cross price effects via the composition of supply elasticities. It is, however, assumed that all other factors such as, for example, input prices or land values remain constant.

Closure

To close the model, quality wine and wine for further processing produced in Rheinland-Pfalz are set to equal the domestic demand volumes for these types of wine plus the volumes of exports respectively. According to Eurostat 2012, 19.3% of German quality wine and 17.8% of wine for further processing was exported in 2007. Thus, assuming that the export volumes remain constant starting from the reference year of 2007, 881,083 hl and 55,632 hl of quality wine and wine for further processing produced in Rheinland-Pfalz respectively are exported.

(4.7) $Qs\_q=Qd\_q+881{,}083$ and

(4.8) $Qs\_v=Qd\_v+55{,}632$,

where Q are quantities demanded and supplied of quality wine and wine for further processing.

4 Data and model application

Exogenous parameters of the model are taken from various sources and corrected to fit the model. They are presented in Table 2.

Table 2: Values of the model's exogenous parameters

Parameters	Values	Sources
Inc, real GDP per capita growth rate (factor) up to 2025	1.32	USDA 2012
Pop, population growth rate (factor) up to 2025	0.97	EU 2007, UN 2004
T productivity growth up to 2025	1.1[f)]	
YIELDq, volume of quality wine produced per hectare (hl/ha)	108	weighted average of production quotas
YIELDv, volume of wine for further processing produced per hectare (hl/ha)	200	production quota
P_b, wholesale market price for beer (EUR/hl)	58	BMELV 2011
P_i, wholesale market price for imported quality wine (EUR/hl)	60,100[e)]	sensitivity analysis
P_il, wholesale market price for imported wine for further processing (EUR/hl)	20,40[e)]	sensitivity analysis
P_s, wholesale market price for spirits (EUR/hl)	60,100[e)]	sensitivity analysis
P_out, wholesale market price for output from processing (EUR/hl)	60,100[e)]	sensitivity analysis
e_opd_q, own price elasticity of demand for quality wine	-0.38	Labys 1976
e_opd_v, own price elasticity of demand for wine for further processing	-0.9	following Zhao et al. 2003
e_ops_q, own price elasticity of supply of quality wine	1.2	following Rickard 2009
e_ops_v, own price elasticity of supply of wine for further processing	1.2	following Rickard 2009
e_cpd_qb, cross-price elasticity of demand for quality wine with respect to beer	0.60[d)]	Customs associated 2001
e_cpd_qi, cross-price elasticity of demand for quality wine with respect to imported wine	0.34	following Gruenewald et al. 2006
e_cpd_qs, cross-price elasticity of demand for quality wine with respect to spirits	0.7[d)]	Customs associated 2009
e_id_q, income elasticity of demand for quality wine	0.51	Labys 1976
e_cpd_vil, cross-price elasticity of demand for German wine for further processing with respect to imported wine for further processing	2[b)]	
e_cpd_vout, cross-price elasticity of demand for wine for further processing with respect to the price of output	0.8[a)]	following Shumway et al. 1988
e_cps_vq, cross-price elasticity of supply of quality wine with respect to the wine for further processing and vice versa	-1[c)]	

[a)]Following Shumway et al 1988, cross-price elasticities between inputs and outputs in agriculture are very low. Since, the relationship between output price and input demand is obviously positive and the long term period is considered in our case, the elasticity taken has positive sign and somewhat higher than proposed by the authors, i.e. Shumway et al 1988.
[b)]Assuming a considerable substitutability between imported and domestically produced wine, we assume higher elasticity of substitution than Wittwer et al. 2001.
[c)]Since quality wine and wine for further processing are substitutes due to the existing per hectare production quotas but the exact elasticity values are unknown for this study, a unitary cross-price elasticity is assumed.
[d)]The cross price elasticities of demand for wine in the EU range from 0.35 to –0.73 with respect to beer and from 0.94 to –0.95 with respect to spirits (Customs associated 2009).
[e)]Sensitivity analysis is conducted for those parameters, reliable values of which could not be found.
[f)]The parameter value is based on the assumption of decrease of the average wine production costs by 8% due to the farms enlargement and reallocation.
Source: own compilation from the sources mentioned in the table.

The model is calibrated to the data of 2007 in order to estimate technical coefficients of the supply and demand functions. Since some of the parameters' values are arbitrary and require sensitivity analysis, the model is calibrated twice. The procedure is performed by solving the

supply and demand equations with one unknown within the partial equilibrium model in GAMS software for two types of constant price values. The following table, Table 3, displays the calibration results.

Table 3: Calibration results

Records of 2007	**Equations***	**Results for lower values of P_i:60, P_s:60, P_il:20, P_out:60**	**Results for higher values of P_i:100, P_s:100, P_il:40, P_out:100**
Qd_q=3,684,115 hl (assumed)	Qd_q: $3{,}684{,}115 = const\_dq \times 95.02^{-0.38} \times (60 \text{ or } 100)^{0.34} \times 58^{0.60} \times (60 \text{ or } 100)^{0.7}$	*const_dq*= 25737.644 *const_dv*=632.248	*const_dq*= 15130.250 *const_dv*=105.038
Qd_v= 256,909 hl (assumed)	Qd_v: $256{,}909 = const\_dv \times 37.10^{-0.9} \times (20 \text{ or } 40)^{2} \times (60 \text{ or } 100)^{0.8}$	*const_sq*=722885.295	*const_sq*=722885.295
Qs_q= 4,565,199 hl	*Qs_q:* $4{,}565{,}199 = const\_sq \times 95.02^{1.2} \times 37.41^{-1}$	*const_sv*=384714.153	*const_sv*=384714.153
AREAq= 42,270 ha	*AREAq:* $42{,}270 = 4{,}565{,}199/108$		
Qs_v= 312,542 hl	*Qs_v:* $312{,}542.20 = const\_sv \times 37.41^{1.2} \times 95.02^{-1}$		
AREAv= 1,562 ha	*AREAv:* $1{,}562 = 312{,}542/200$		
$P\_q^{a)}$= 95.02 EUR/hl			
$P\_v^{a)}$=37.41 EUR/hl			

*All of the parameters' values are presented in Table 2. The numbers in brackets, e.g. 20 or 40, indicate possible values of the parameters, according to which the calibration is conducted.

[a)] The prices are calculated as weighted average of prices for various types of wine within 12 months of 2007. Source: DLRRP 2010

Source: own compilation and based on the records of 2007 provided by SLRP.

Scenario

The model is estimated under the scenario of increased land availability due to the relaxation of planting rights and climate change. Thus, total area that can be occupied by the vineyards for production of quality wine and wine for further processing, *AREAt* in inequality 4.9, cannot exceed total acreage of land suitable for vines cultivation in 2025. The latter is a projection of RLP AgroScience GmbH under the *WETTREG 2006 A1B normal* scenario of IPCC for the year of 2050. The upper limit of wine production under the new climatic conditions and taking into account other restrictions of land use is 135,521 ha. This is integrated into the following equation:

(4.9) $AREAt \geq AREAq + AREAv,$

where *AREAt* equals to 135,521 ha, *AREAq* and *AREAv* are the areas of vineyards for production of quality wine and wine for further processing, respectively. The GAMS code of the model is presented in the Annex.

5 Results

With regard to the values of prices for major substitutes in consumption and production of wine as well as the price of output from wine for further processing, the modeling results as the following. The future total vineyards area will increase by the factors of 1.11. It turns out that suitability of land for wine production is not a binding restriction. The wine area in the scenario will mostly be dedicated to the production of quality wine (97% of the area). In equilibrium state, a production of 5,083 thousands hl of quality wine and 330 thousands of hl of wine for further processing is calculated. Such supply volumes will change the equilibrium price on the wholesale market: for quality wine 90.05 EUR/hl (down by 5% from the reference situation) and 34.65 EUR/hl for wine for further processing which means a decrease of 7% compared to the reference situation. The baseline and projected values are summarized in the following table (Table 4):

Table 4: Modeling results

Variables	**Baseline (2007)**	**Projection (2025)**	**Comparison of the effect of a unit price increase of P_i, P_s, P_il and P_out between the models with constant terms for**	
			lower values of P_i, P_s, P_il, P_out	higher values of P_i, P_s, P_il, P_out
Domestic market price for quality wine, EUR/hl	95.02	90.05	95.76	93.07
Quantity of quality wine supplied, hl	4,565,199	5,083,200	5,057,300	5,074,000
Quantity of quality wine demanded, hl	3,684,115	4,202,100	4,176,200	4,192,900
Vineyards area for production of quality wine, ha	42,270	47,067	46,827	46,981
Domestic market price for wine for further processing, EUR/hl	37.10	34.65	37.49	36.12
Quantity of wine for further processing supplied, hl	312,542	330,890	342,060	336,470
Quantity of wine for further processing demanded, hl	256,909	275,260	286,430	280,840
Vineyards area for production of wine for further processing, ha	1,562	1,654	1,710	1,682
Total area of vineyards	43,833	48,721	48,537	48,663

Source: own compilation and the records of 2007 provided by SLRP

In addition to the main results, sensitivity of the model to the assumptions on the price values for substitutes in consumption and production of wine as well as of the prices for output from wine for further processing is estimated. As displayed in Table 4, if the prices of P_i (price for imported wine), P_s (price for spirits), P_out (price for output from wine for further processing) and P_il (price for imported wine for further processing) rise by one unit, the model simulates increase of prices for quality wine and wine for further processing. This can be explained by the demand growth for both types of wine due to the elasticity effects. The model calibrated with respect to lower values of the parameters, i.e. 60 and 20 EUR/hl respectively, seems to be more responsive to the changes of their values than the one calibrated with respect to the higher values of the parameters.

6 Concluding remarks

Apart from the increase of wine production volumes and fall of the market prices, planting rights liberalization will most probably affect the structure of the wine sector. The current trends towards farms enlargement and reallocation on the flatter areas will accelerate, leading to the prevailing farm types of more than 20ha on flatter areas. Such farms will be the drivers of the wine sector expansion since they are assumed to accumulate enough of the investment capital for enlargement. In addition, lower production costs of larger farms on flatter areas will allow them to compete on the domestic and international markets under the price fall.

Under the new market circumstances, smaller farms in hilly regions will be disadvantaged. Bearing rather high production costs even for the baseline market situation, they might be forced to deal with the market price which is lower than their production costs under the projection. The possible ways for such farms to continue their business include reorientation towards production of high value wines, so-called “luxus” wines, enlargement and reallocation. The possibility to realize these options will largely depend on the future political and market situation.

The model presented is of course a highly simplified representation of the wine market. The results seem plausible but further refinements of the model are desirable. The limitation of the analysis to Rheinland-Pfalz limits the inferences that can be drawn from the results, especially as the liberased quota regime applies throughout the EU and its common wine market. Thus it seems necessary to better include the effects in other parts of the EU to the model. Another interesting way to improve the model would be a much more sophisticated way of dealing with the supply side. The current way of estimating the supply function is workable and theoretically consistent, but does not make use of much detailed information we have on the cost of wine production. In addition to these model improvements a more sophisticated way of sensitivity analysis will be important as a next step of the work.

However, even with further modeling work ahead the preliminary results presented in this paper already make clear that the liberalization of the planting rights regime is likely to have a substantial influence on the wine sector of Rheinland-Pfalz.

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Annex: GAMS code of the basic model

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"Partial equilibrium model for the wine sector of Rheinland-Pfalz for the
lower values of prices for spirits, imported wine, imported wine for
further processing and output from wine for further processing"

     This model consists of three blocks: demand, supply and closure. Each
block is divided into the sub-blocks for quality wine and wine for further
processing.

The variables are: quantities supplied and demanded of quality wine and of
wine for further processing, prices for these types of wine and areas
dedicated for cultivation of quality wine and wine for further processing.

Lower price values include: 60EUR/hl of spirits, 60EUR/hl of imported wine,
60EUR/hl of output from processing of Grundwein and 20EUR/hl of imported
wine for further processing. Higher price values include: 100EUR/hl of
spirits, 100EUR/hl of imported wine, 100EUR/hl of output from processing of
Grundwein and 40EUR/hl of imported wine for further processing.

Under the enlargement scenario, maximum possible area occupied by the
vineyards must not exceed 135,000 hectares.
```

Model calibration defines the technical coefficients for the demand and supply functions of barrel quality wine and wine for further processing. The records of production volumes and market prices correspond to the reference year of 2007. The source of the records: Statisticshes Landesamt Rheinland-Pfalz

```
 19  sets
 20  RES results
 21 /P_q market price for quality wine,
 22 Qd_q demand for quality wine,
 23 Qs_q supply of quality wine,
 24 Areaq area for quality wine cultivation,
 25
 26 P_v market price for wine for furher processing,
 27 Qd_v demand for wine for further processing,
 28 Qs_v supply of wine for further processing,
 29 Areav area for cultivation of win for further processing,
 30 AREAt total area of vineyrads/
 33
 34  Parameters
 35  const_dq technical coefficient for demand function of quality wine 60 and 20
 36   const_dv technical coefficient for demand function for wine for further processing 60 and 20
 37  const_sq technical coefficient for supply function of quality wine
 38   const_sv technical coefficient for supply function of wine for further processing
 39
 40  Pop population shifter
 41  Inc income shifter
 42  T productivity shifter
 43
 44  YIELDq per hectare yield of quality wine
 45  YIELDv per hectare yield of wine for further processing
 46
 47  Eq export volume of quality wine
 48  Ev export volume of wine for further processing
 49
 50  P_b price of beer
```

```
  51  P_s prce of spirits
  52  P_i price of imported wine
  53  P_il price of imported wine for further processing
  54  P_out price of output from wine for further processing
  55
  56   e_cpd_qb cross price elasticity of demand for beer with respect to
quality wine
  57  e_cpd_qs cross price elasticity of demand for spirits with respect to
quality wine
  58   e_cpd_qi cross price elasticity of demand for imported wine with
respect to quality wine
  59   e_cpd_vil cross price elasticity of demand for imported wine for
further processing with respect to the domestic wine for further processing
  60   e_cpd_vout cross price elasticity of demand for output from wine
further processing with respect to wine for further processing
  61  e_id_q income elasticity of demand for quality wine
  62
  63  e_opd_q own price elasticity of demand for quality wine
  64  e_opd_v own price elast of demand for wine for further processing
  65  e_ops_q own price elst of supply of quality wine
  66  e_ops_v own price elast of supply of wine for further processing
  67
  68   e_cps_vq cross-price elasticity of supply of quality wine with
respect to the wine for further processing;
  69
  70
  71  Pop=0.97;
  72  Inc=1.32;
  73  T=1.1;
  74
  75  YIELDq=108;
  76  YIELDv=200;
  77
  78  Eq=881083;
  79  Ev=55632;
  80
  81  P_b=58;
  82
  83  P_s=60;
```

```
 84  P_i=60;
 85  P_il=20;
 86  P_out=60;
 87
 88  e_cpd_qb=0.6;
 89  e_cpd_qs=0.7;
 90  e_cpd_qi=0.34;
 91  e_cpd_vil=2;
 92  e_cpd_vout=0.8;
 93  e_id_q=0.51;
 94
 95  e_opd_q=-0.38;
 96  e_opd_v=-0.9;
 97  e_ops_q=1.2;
 98  e_ops_v=1.2;
 99  e_cps_vq=-1;
100
102  variables
103  P_q price of quality wine
104  Qs_q quantity supplied of quality wine
105  Qd_q quantity demanded of quality wine
106  AREAq area of vineyards dedicated for quality wine production
107
108  P_v price of wine for further processing
109  Qs_v quantity supplied of wine for further processing
110  Qd_v quantity demanded of wine for further processing
111  AREAv area of vineyards dedicated for production of wine for further
processing
112
113  AREAt total area of vineyrads;
114
115  *Start values for variables
116  P_q.l=95.02;
117  Qs_q.l=4565199;
118  Qd_q.l=3684115;
119  AREAq.l=42270;
120
```

```
 121  P_v.l=37.41;
 122  Qs_v.l=312542;
 123  Qd_v.l=256909;
 124  AREAv.l=1562;
 125
 126  AREAt.l=43833;
 127
 128  *Calibration of the intercepts
 129
const_dq=Qd_q.l/(P_q.l**e_opd_q*P_b**e_cpd_qb*P_s**e_cpd_qs*P_i**e_cpd_qi)
      ;
 130  const_sq=Qs_q.l/(P_q.l**e_ops_q*P_v.l**e_cps_vq);
 131  const_dv=Qd_v.l/(P_v.l**e_opd_v*P_il**e_cpd_vil*P_out**e_cpd_vout);
 132  const_sv=Qs_v.l/(P_v.l**e_ops_v*P_q.l**e_cps_vq);
 133
 134
 135  equations
 136  *Declaration of equations
 137  EQd_q quantity demanded of quality wine
 138  EQs_q quantity supplied of quality wine
 139  cl_q closure
 140
 141  EQd_v quantity demanded of wine for further processing
 142  EQs_v quantity supplied of wine for further processing
 143  cl_v closure
 144
 145  EAREAq area of vineyards dedicated for quality wine production
 146  EAREAv area of vineyards dedicated for production of wine for further
processing
 147
 148  EAREAt total area of vineyards;
 149
 150
 151  *Definition of equations
 152                                                              EQd_q..
Qd_q=e=const_dq*(P_q**e_opd_q)*(P_b**e_cpd_qb)*(P_s**e_cpd_qs)*(P_
      i**e_cpd_qi)*(inc**e_id_q)*pop;
 153  EQs_q.. Qs_q=e=const_sq*(P_q**e_ops_q)*(P_v**e_cps_vq)*T;
```

```
 154  cl_q.. Qd_q=e=Qs_q-Eq;
 155
 156                                                                  EQd_v..
Qd_v=e=const_dv*(P_v**e_opd_v)*(P_il**e_cpd_vil*P_out**e_cpd_vout)
      ;
 157  EQs_v.. Qs_v=e=const_sv*(P_v**e_ops_v)*(P_q**e_cps_vq)*T;
 158  cl_v.. Qd_v=e=Qs_v-Ev;
 159
 160  EAREAq.. AREAq=e=Qs_q/YIELDq;
 161  EAREAv.. Areav=e=Qs_v/Yieldv;
 162
 163  EAREAt.. AREAt=e=AREAq+AREAv;
 164
 165
 166  model wine /all/
 167  solve wine using mcp
```