THE PRICING EFFICIENCY OF GERMAN WINE COOPERATIVES: A HEDONIC METAFRONTIER APPROACH

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2023

Vortrag anlässlich der 63. Jahrestagung der GEWISOLA
(Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V.)

Nachhaltige Ernährungssysteme und Landnutzungswandel
20. bis 22. September 2023

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Abstract

Cooperatives have long been criticised for their inefficiency due to high internal coordination costs and inefficient decision-making. This is a particular disadvantage in the production and marketing of agri-food products that have heterogeneous (hedonic) quality attributes. However, cooperatives continue to be widespread in agriculture, notably in the wine sector, because they can achieve scale economies and reduce transaction cost for their members. This paper compares the efficiency of cooperatives and non-cooperatives in the German wine sector with respect to their ability to place wines on the market at prices above their measurable quality attributes. The results from a stochastic metafrontier panel of 1,223 wine prices from two wine guides suggest that consumers should purchase wine from cooperatives if they are seeking market prices that correspond closely with a wine's quality. In turn, members of wine cooperatives should ask themselves why non-cooperatives are typically better at attracting an even greater willingness to pay for the respective quality of their wines.

Keywords

Wine cooperatives, price efficiency, hedonic price analysis, stochastic metafrontier

1 Introduction

The agricultural sector is facing multiple challenges as consumer preferences regarding product quality and origin of production play an increasingly important part in purchase decisions (MEREL et al., 2009; SAITONE and SEXTON, 2017). Therefore, the provision of product quality characteristics that satisfy consumer preferences is becoming more essential for producers. However, consumers' willingness to pay for certain quality attributes often remains unknown when these attributes are difficult to observe or experience directly. These are known as credence attributes (NELSON, 1970; TEISL and ROE, 1998; BONANNO et al., 2018). Thus, in practice, the pricing of a product with respect to provided credence attributes is often more an approximation of the maximum willingness to pay.

Wine cooperatives follow a long tradition in Germany and account for 30 % of the total German wine production (SCHAMEL, 2015). In some growing regions the wine production is mainly characterised by cooperative producers, e.g. in Baden or Wuerttemberg, where wine cooperatives have a market share close to 75 % (HANF and SCHWEICKERT, 2007).

Cooperatives are a form of enterprise that follow traditional values and principles to serve their members because they provide patronage and reduce transaction costs in the distribution of products (COOK, 1995; NILSSON, 1996). However, alongside their many advantages, compared with other forms of enterprises this member-oriented business form faces structural issues, such as moral hazard, control or free-riding problems (COOK, 1995; FANASCH and FRICK, 2018). These problems are mainly based on their members' heterogeneity, which means there are different production and investment motives and preferences among several member groups (HÖHLER and KÜHL, 2018). Owing to these well-known issues that seem to outweigh the advantages, cooperatives are often claimed to be less efficient than other forms of enterprises at selling their products at competitive prices (FERRIER and PORTER 1991; PORTER and SCULLY, 1987; DILGER, 2005; SCHÄUFELE et al., 2016).

Wine cooperatives in particular are known to face challenges competing in a saturated market with increasing numbers of national and international competitors as they suffer from an image of primarily serving the mass market and cannot compete with other organisational forms in terms of quality (HANF and SCHWEICKERT, 2007; PENNERSTORFER and WEISS, 2012). However, YU et al. (2022) have shown that, compared with investor-owned firms, cooperatives can potentially develop incentive strategies that lead to higher quality in production and may have a competitive yardstick effect to increase the overall sectoral quality of the wine market (YU et al., 2022). Thus, while market differentiation by wine quality attributes is on the rise (COSTANIGRO and MCCLUSKEY, 2011), wine cooperatives face a challenge convincing their members to produce in a more quality-oriented than quantity-oriented way in order to remain competitive and satisfy consumers' demand (HANF and SCHWEICKERT, 2007).

Wine can be described as an experience good, and from a consumer's perspective its value is hard to evaluate before consumption (COSTANIGRO et al., 2007), especially as about 66 % of total wine sales in Germany are made by supermarkets and discounters (DEUTSCHES WEININSTITUT, 2022), where consumers are not able to test the wine before buying it. Therefore, wine guide evaluations can provide a platform that helps the consumer evaluate a wine *a priori* and guide a buying decision as they provide an external source to reduce information asymmetries for the consumer (OCZKOWSKI, 1994; LANDON and SMITH, 1998; TEISL and ROE, 1998; SCHAMEL and ANDERSON, 2003). It is possible that some firms achieve systematically higher prices for their wines than others because they have developed individual pricing strategies that exploit the information uncertainty about wine quality on the market. This is amplified by the fact that the information search on the value and quality of a wine is costly for consumers (WILDENBEEST, 2011).

The question therefore arises as to how wine cooperatives' pricing strategies can compete with those adopted by non-cooperatives. Furthermore, it is not clear how effectively the resulting wine price matches the consumers' maximum willingness to pay for quality attributes of wine, and which form of enterprise is more likely to achieve potential price premiums that exceed the pure value of the sold wine with respect to the provided attributes.

This paper analyses the pricing efficiency of German agricultural cooperatives using the wine sector as a case study. The remainder of the paper is organised as follows: Section 2 provides an overview of the extant literature on the efficiency and competitiveness of agricultural cooperatives in general and of wine cooperatives specifically; Section 3 introduces the concept of a hedonic stochastic metafrontier as an econometric framework to estimate the efficiency of cooperatives with respect to hedonic pricing of their wines in comparison with other forms of enterprises; Section 4 describes the data; Section 5 presents and discusses the results; and finally the paper concludes with Section 6.

2 Theoretical Background: Efficiency of cooperatives

CARTER (1984) states that the inefficiency of cooperatives is rooted in weak authority and an inappropriate supervision of members by cooperative management. In line with this, PORTER and SCULLY (1987) argue that free-riding problems and the ownership structure of cooperatives lead to incentive problems that cause low efficiency in production. In addition, the horizon issue occurs when members of different ages and remaining time in the cooperative act in a rather short-term way, meaning that they are not interested in long-term investments. Therefore, the allocative efficiency of cooperatives may suffer, especially with increasing numbers of members and proportionally rising control costs (FERRIER and PORTER, 1991). SEXTON and ISKOW (1993) provide a literature review of the efficiency of cooperatives and conclude that cooperatives cannot *per se* be defined as being less competitive than other forms of enterprises. However, they state that a cooperative business operates very differently to other firms. In

particular, if the cooperative's non-monetary services are not taken into account in the evaluation of efficiency, results can be biased because these services may indirectly affect members' efficiency in production. However, taking potential cost savings and the reduction of transaction costs and vertical integration for cooperative members into account, cooperatives can be an efficient form of enterprise (SEXTON and ISKOW, 1993).

AHN et al. (2012) investigated the technical and allocative efficiency of different forms of enterprises using a stochastic frontier approach, introducing a dummy variable to take into account the difference between cooperatives and other forms of enterprises. They concluded that cooperatives suffer from low incentives among their members to produce efficiently and are therefore less competitive than other forms of enterprises (AHN et al., 2012). SOBOH et al. (2012) state that cooperatives have a different objective function that includes a restriction of members' revenue maximisation compared with solely profit-maximising investor-owned firms. Therefore, any comparison needs to be based on the behavioural characteristics of cooperatives in order to be unbiased (SOBOH et al., 2012).

Comparing cooperative and non-cooperative wine producers in Portugal, BARROS and SANTOS (2007) established that cooperatives produce more efficiently than private producers and can therefore be seen as competitive on the wine market. However, they did not take into account the heterogeneity of different organisational forms of producers. FRIED and TAUER (2019) investigated the American wine market using a two-tier stochastic frontier model to observe pricing mechanisms and the reasons for over-pricing and under-pricing of wine. They concluded that wine pricing is driven by multi-dimensional product characteristics and that the wine price is affected by wine rating scores and regional reputation. However, they did not take into consideration the effect of producers' different organisational forms, i.e. no cooperatives were explicitly included in their analysis.

To conclude, it can be assumed that there may be numerous causes of potential inefficiency in cooperatives. For instance, technical inefficiency could arise from structural issues in relation to member heterogeneity and existing uncertainty about the quality of the grapes delivered by individual members. In addition, there may also be other inefficiencies with respect to the marketing strategy. Therefore, an unbiased comparison of efficiencies within cooperatives and non-cooperatives needs to take these differences between organisational forms carefully into account.

For this reason, a stochastic metafrontier approach has been adopted in this paper, assuming different production technologies among cooperatives and other forms of enterprises. Although several comparisons have been made of the efficiency found in cooperatives and other forms of enterprises, there has been no in-depth investigation of pricing efficiency with regard to credence attributes and the assumption of technical differences between cooperatives and non-cooperatives. Therefore, the following section outlines the econometric model of a hedonic metafrontier approach that contributes to an appropriate comparison of the efficiency of wine cooperatives to answer the following research questions (RQ):

RQ 1: *Do wine cooperatives operate under a fundamentally different pricing strategy than other forms of enterprises in the wine business?*

RQ 2: *Do wine cooperatives in Germany suffer from structural inefficiency in their pricing strategies for wines, making them less competitive than other forms of enterprises when pricing their wines?*

3 Methods

3.1 Hedonic price analysis

It is assumed that a price p of a wine j is determined by a vector a of its k product attributes:

(1) $$\boldsymbol{p_j = a(Q_j, R_j, W_j, F_j)}$$

The vector $\boldsymbol{a_j}$ contains other vectors that define the attribute categories, including quality (**Q**), reputation (**R**), wine (**W**) and farm (**F**) characteristic attributes. The hedonic price model of ROSEN (1974) serves as the theoretical model and is applied to explain the wine price. This is affected by consumers' evaluation of the sum of product characteristics. Quality ratings in particular play a major role in price formation as they provide a basis for evaluation and reduce uncertainty among consumers (COSTANIGRO et al., 2007). Several analyses have used the concept of hedonic price analysis as a suitable way of describing the relationship between a wine's price and its quality attributes (for a detailed review, see OCZKOWSKI and DOUCOULIAGOS (2015)). The hedonic price regression therefore takes the following form with the dependent price variable in its logarithmic form, as this specification has been identified as most appropriate for explaining the wine price and attribute relation (OCZKOWSKI, 2001; COSTANIGRO et al., 2007):

(2) $$\log(P_j) = f(\boldsymbol{a_j}) + \varepsilon_j$$

3.2 Hedonic stochastic metafrontier

The measurement of efficiency of firms is based on a conversion of inputs **x** into outputs **y** according to a technology *T*. The production technology *T* in this context provides a set of all input-output combinations that are feasible. Technical inefficiency is the inability to convert a given input into the maximum potential output and it can have various causes. The main reason for technical inefficiency in a firm can be found in agency costs, e.g. in the case of cooperatives for member supervision or members' behaviour negatively affecting the performance of a cooperative (SEXTON and ISKOW, 1993). The class of parametric approaches of the stochastic frontier analysis (SFA) (AIGNER et al., 1977; BATTESE and CORRA, 1977; MEEUSEN and VAN DEN BROECK, 1977) models this inefficiency as a two-component error term. The error term ε_j is divided into a random part v_j and a technical inefficiency part u_j.

The use of a maximum likelihood estimation to estimate a stochastic frontier and the assumption that the random error is independently and identically distributed (iid) provide an approach for a detailed explanation of inefficiency sources (for a detailed overview of different approaches to measuring efficiency, see MURILLO-ZAMORANO (2004)). In the hedonic pricing framework, technical inefficiency u_j is explained by incomplete information. Consumers are not perfectly informed about the producers' minimum price that they are willing to accept (WTA) for a certain bundle of product attributes, i.e. the supplied wine, and producers do not have knowledge about a consumer's highest WTP for a bottle of wine with the same attributes. It is assumed that the inefficiency of pricing deceases as the uncertainty about the wine quality decreases. Thus, the hedonic stochastic frontier takes the following form, with the achieved wine price as the dependent output variable (P_{jt}) and the vector of product attributes as the input vector:

(3) $$\log(P_{jt}) = f(\boldsymbol{a_{jt}}, \boldsymbol{\beta}) + v_{jt} + w_{jt} - u_{jt}$$

As the data provide no information about the consumer side of the equation, following the example of BONANNO et al. (2018) the inefficiency of the consumer is set at $w_{jt} = 0$. To give consideration to the change in efficiency over time, the stochastic frontier approach has been further developed. BATTESE and COELLI (1992) introduced a model that defines technical inefficiency as an exponential function of time that includes an additional parameter η to

include the time effect (denoted by the subscript *t*) to the truncated-normal distributed inefficiency term:

(4) $u_{jt} = \delta(t)u_j = [\exp(-\eta(t-T)]u_j$

The technical efficiency reveals the efficiency in pricing a wine that can be explained by the matching of price and product attributes in the regression model:

(5) $TE_{jt} = 1 - E[u_{jt}|v_{jt}]$

The random inefficiency, v_{jt} explains unobserved factors that affect pricing, e.g. with respect to marketing activities or labelling of the wine, and are not captured by the regression model. For instance, these are price mark-ups that producers achieve beyond the maximum price level that are explained by $\boldsymbol{a_{jt}}$. In this framework, the gamma parameter reveals the share of technical inefficiency u_{jt} in relation to total inefficiency:

(6) $\gamma_{jt} = \sigma^2_{u_{jt}}/{\sigma_{jt}}^2$

The efficiency of achieving consumers' highest WTP and pricing a produced wine effectively is assumed to differ systematically between cooperatives and other forms of enterprises as the underlying pricing technologies, i.e. the possible combinations of product attributes and respective wine price, differ for these $m = 2$ groups:

(7) $T^m = \{(f(\boldsymbol{a}_j), p_j): f(\boldsymbol{a}_j) \geq 0; p_j \geq 0\}$

To account for these differences, the concept of a stochastic metafrontier is applied. This two-step approach was first introduced by BATTESE et al. (2004) and O'DONNELL et al. (2008) and further developed by HUANG et al. (2014), who replaced the second step of the metafrontier calculation based on mathematical programming with a stochastic approach.

In the first step of the estimation procedure, one separate stochastic frontier for each of the m groups, thus in the present case one for the cooperative wine growers and one for wine growers with other forms of enterprises, is estimated to predict the group-specific pricing efficiency related to the provided product attributes:

(8) $\log(P^m_{jt}) = f(\boldsymbol{a^m_{jt}}, \boldsymbol{\beta}) + v^m_{jt} - u^m_{jt}; m = \{1,2\}$

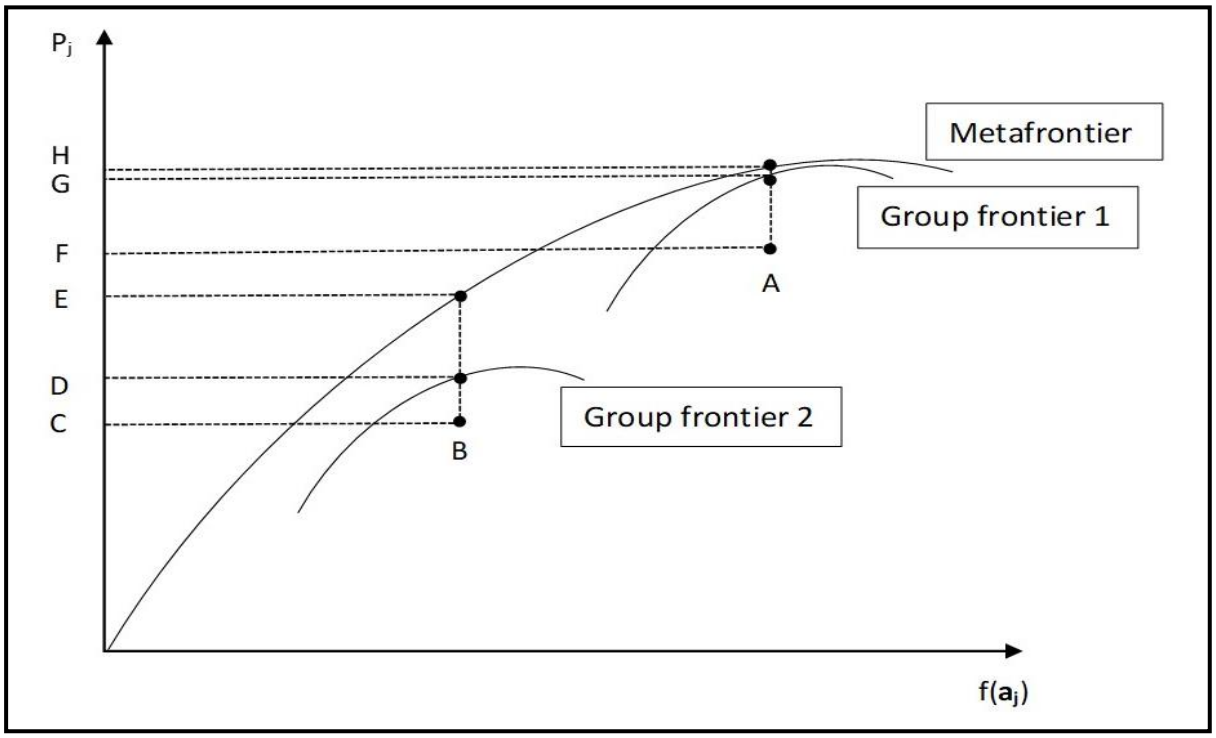
In the second step, the predictions of the group-specific frontiers, $\hat{f}(\boldsymbol{a^m_{ijt}}, \boldsymbol{\beta})$, are projected against an all-enveloping metafrontier:

(9) $f(\boldsymbol{a^M_{jt}}, \boldsymbol{\beta}) = \hat{f}(\boldsymbol{a^m_{jt}}, \boldsymbol{\beta}) + v^M_{jt} - u^M_{jt}$

with M accounting for the metafrontier rather than the group frontier (HUANG et al., 2014). Figure 1 provides an overview of the metafrontier concept. The firm observations A and B belong to group 1 and 2 respectively. The distances $\overline{CD}$ and $\overline{FG}$ show a firm's efficiency at pricing a wine (P_j) according to its product attributes ($\boldsymbol{a}_j$) with respect to the group frontier, i.e. using the technology of the cooperative or non-cooperative. The distances $\overline{DE}$ and $\overline{GH}$ reveal the efficiency of the groups with respect to the meta frontier. Finally, the distances $\overline{CE}$ and $\overline{FH}$ reveal the efficiency of a firm, belonging to a group *m* with respect to the metafrontier. This overall efficiency with respect to the metafrontier can therefore be divided into a group-specific part, measuring the efficiency related to group *m's* frontier, and the meta technology ratio (MTR) that measures how close the frontier of group *m* is to the metafrontier that envelops all groups under consideration (O'DONNELL et al., 2008), with:

(10) $$MTR_{jt} = \frac{TE_{jt}^{m+M}}{TE_{jt}^{m}}$$

Figure 1: Graphical illustration of the metafrontier concept



Source: Own presentation based on O'DONNELL et al. (2008)

In order to test whether the estimation of a pooled frontier is inappropriate due to technical differences between the two groups, a likelihood ratio (LR) test has been conducted before estimating the two-step metafrontier. This validation test compares the pooled (restricted) model and the group (unrestricted) frontier models, testing the null hypothesis of poolability for the two groups of cooperative and non-cooperative wine producers. If the hypothesis of poolability is rejected, the estimation of a metafrontier is justified and appropriate as different technologies underlie the production process of cooperatives and non-cooperatives (BATTESE et al., 2004). Even though for hedonic price analyses the log-linear functional form is stated as being appropriate, the stochastic frontier estimation is performed assuming a Cobb-Douglas functional form. A Box-Cox transformation of the model is also considered as it reduces the omitted variable bias (BONANNO et al., 2018). However, with the underlying data it was not possible to estimate a valid model with this transformed functional form. Therefore, the results are presented in the Cobb-Douglas form.

4 Data

A panel dataset of 1,223 wines evaluated and listed in wine guides between 2016 and 2020 provided the data basis for the study. For each wine producer in the sample, four wines were included, two red and two white, with one of each chosen from the upper and lower bound of the price range where the producer offers its wines. The sample included eight wine cooperatives and 48 non-cooperative wine producers. As the objectivity of such wine guide quality ratings has been criticised in the past, especially if the evaluation is not based on a blind tasting procedure, two different wine guides, *Gault Millau* (GM) and *Eichelmann* (E), were

used to reduce any bias that may be caused by the subjectivity of the tasters (LIVAT and VAILLANT, 2006; CASTRIOTA et al., 2013). Both use an international 100-point scale for their quality rating of the wine and a 1 to 5-star rating for the evaluation of a company's reputation. Alongside farm size and the organisational form of the wine producer (cooperative or non-cooperative) and the quality and long-term quality (= reputation) rating, other attributes have also been taken into account. The storage of the wine, i.e. whether it has been stored in steel tanks, barriques or wooden barrels, the vintage of a wine, whether it has been produced organically and whether it is a red or white wine form the basis of credence attributes included in the analysis.

5 Results

5.1 Descriptive statistics

The wine price per bottle in the sample is the dependent variable of the analysis. The distribution of this variable is right-skewed and ranges from € 4.10 to € 85.00, with a mean price of € 16.50. This distribution is also reported in the analysis of COSTANIGRO et al. (2007) and is rooted in the (price) heterogeneity of the wine market. On average, the wine producers that are organised in a cooperative achieve a wine price of € 14.50 per bottle, whereas the price achieved by non-cooperative wine growers is € 2.40 higher, i.e. € 16.90. A comparison of the maximum price achieved underlines the difference between cooperatives and other forms of enterprises: the maximum price from cooperatives is € 49.30 whereas the maximum price from non-cooperatives is € 85.00.

5.2 Hedonic stochastic group frontier

The LR test for poolability of the data rejects the null hypothesis with a p-value < 0.05 that the production technology is the same for cooperatives and other forms of enterprises, and the assumption of the existence of group-specific technologies (Eq. 7) holds. Therefore, the estimation of a metafrontier is appropriate and the formulated RQ1 can be answered such that the wine pricing of cooperatives differs from the pricing of non-cooperatives within this dataset.

The models show that mainly quality attributes, such as the quality rating of the wine guides and storage in barrique barrels, affect the wine price, although the effect differs between groups (see Table 1). Furthermore, non-cooperatives are able to achieve higher prices for red wine than for white wine, whereas the colour of the wine does not affect the price of a cooperative's wine. Additionally, larger wineries are able to achieve higher prices in the non-cooperative group. In contradiction of the hypothesis that larger cooperatives tend to face supervision issues in terms of member management that have a negative effect on the wine price achieved, the size of the cooperative has no statistically significant effect on the achieved wine price.

The estimated group frontiers (according to Eq. 8) show that non-cooperatives price their wines with a mean efficiency of 61 % with respect to group-related technology. In comparison, cooperatives price their wines with a mean efficiency of 75 %. The gamma parameters for the group-specific frontier models show that in the cooperative model, 50 % of the inefficiency can be explained by the relationship between wine prices and product attributes $\boldsymbol{a_{jt}}$. In the non-cooperative model, 68 % of the variance in error terms can be explained by technical inefficiency. Table 1 shows that the mean efficiency of both forms of enterprises decreased between 2016 and 2020.

There are different interpretations of this finding. It is possible that consumer preferences and especially the WTP for wine product attributes are becoming harder to estimate for wine producers, but cooperatives have detached their wine pricing from wine quality attributes over the years. Instead, other factors unrelated to the measured quality attributes in the model are increasingly affecting pricing by cooperatives, as these (unobserved) factors already affected

non-cooperative wine prices in earlier years of the observed period. The lower gamma parameter of the cooperatives compared with non-cooperatives indicates, however, that pricing inefficiencies of cooperatives originate in factors that are not observed in the model, e.g. marketing activities or labelling. Hence, non-cooperatives are more successful at using these marketing attributes to achieve higher prices per quality, as their share of inefficiency not explained by the model is smaller. Furthermore, the pricing efficiency of non-cooperatives remains stable over time, even though some firms are pricing their wines below what they could charge, as shown by the distribution of efficiencies in Table 1.

Table 1: Estimation results of the group specific frontier models

Variable	Cooperative group model	Non-cooperative group model
Dependent variable: wine price per bottle	**Coeff. (Std. error)**	**Coeff. (Std. error)**
Intercept	-68.71*** (1.40)	-53.77*** (1.35)
Log quality GM	7.31*** (0.98)	3.48*** (0.36)
Log quality E	8.87*** (1.02)	9.22*** (0.39)
Log reputation GM	0.10 (0.09)	0.03 (0.03)
Log reputation E	0.03 (0.12)	-0.04 (0.04)
Red wine	0.11 (0.07)	0.09* (0.04)
Storage: 1 year	0.29*** (0.06)	0.08* (0.03)
Storage: 2 years	0.21* (0.09)	0.15*** (0.04)
Storage: 3 years	0.17 (0.14)	0.19** (0.07)
Member in an interest association	-0.08 (0.08)	-0.02 (0.02)
Log farm size	-0.09 (0.10)	0.10*** (0.02)
Storage barrique barrel	0.12 (0.08)	0.12*** (0.03)
Storage wooden barrel	-0.01 (0.09)	0.04 (0.02)
Gamma	0.50*** (0.13)	0.68*** (0.02)
Time effect	-0.16 (0.09)	-0.02 (0.01)
Mean efficiency 2016	0.82	0.62
Mean efficiency 2017	0.79	0.61
Mean efficiency 2018	0.76	0.60
Mean efficiency 2019	0.72	0.60
Mean efficiency 2020	0.69	0.60
Overall mean (max.; min.) efficiency	0.75 (0.96; 0.49)	0.61 (0.95; 0.36)
Significance levels: * p<0.05; ** p<0.01; *** p<0.001		

Source: Own estimation results

5.3 Hedonic stochastic metafrontier

After estimating the group-specific frontier models, a metafrontier (Eq. 9) was estimated to reveal the efficiency of the two groups with respect to an all-enveloping metafrontier (Fig. 1). The results of the estimated metafrontier show that, beyond the inefficiency detected in the group-specific frontier models, the non-cooperatives observed price their wines on average with a mean efficiency of 98 % and cooperatives with 77 %. The gamma parameter of 0.97 is statistically significant with a p-value < 0.001, and indicates that the inefficiency can mostly be explained by technical inefficiency.

A comparison of the results of the group frontier and metafrontier shows that the cooperative wine producers are approximately as close to the group-specific frontier as to the metafrontier. Non-cooperatives are closer to the metafrontier than to the group frontier (see Tables 1 & 2). In Figure 1, group frontier 1 may therefore explain the non-cooperatives' pricing environment

and group frontier 2 the cooperatives' pricing environment. Even though the non-cooperative wine producers show lower mean efficiency levels in the group-specific frontier, the metafrontier reveals that group efficiency in pricing their wine with respect to the metatechnology is higher than that of the cooperative group. The results from the measured MTR according to Eq. 10 show that over the observed period the cooperatives in the sample achieve 83 % to 93 % of the prices they could potentially achieve for their wines if they priced their wines according to the meta-technology. In comparison, the MTR of the non-cooperatives reveal their closeness to the metafrontier as they can realise 91 % to 97 % of the maximum prices that can be achieved within the metafrontier technology space.

However, as Table 2 shows, the efficiency of cooperatives increased between 2016 and 2020. It can be assumed that cooperatives improved their image on average and/or were able to increase market prices in recent years. As RICHTER and HANF (2020) suggest, it is therefore possible that cooperatives have improved their management, production and marketing strategies to remain competitive in the wine market. While the stability of the efficiency of non-cooperatives relies on existing, well-developed marketing strategies that lead to highly efficient pricing of their wines with respect to the metafrontier, wine cooperatives show a positive development over time as they have been able to shift the group frontier closer to the metafrontier, as shown by the development of the MTR.

Table 2: Meta frontier efficiencies

Measure	Cooperatives	Non-cooperatives
Efficiency MF	0.77	0.98
Efficiency MF 2016	0.74	0.98
Efficiency MF 2017	0.72	0.98
Efficiency MF 2018	0.79	0.98
Efficiency MF 2019	0.80	0.98
Efficiency MF 2020	0.81	0.98
MTR 2016	0.86	0.91
MTR 2017	0.83	0.92
MTR 2018	0.93	0.97
MTR 2019	0.92	0.92
MTR 2020	0.92	0.92

Source: Own estimation results

In summary and in response to RQ2, cooperatives are more efficient at matching the wine price to the quality provided, as shown by the comparison of the group-specific frontier models. In contrast, non-cooperative wine producers are less quality-oriented when they price their wine as the inefficiency is greater and the price therefore relies less on quality attributes included in the regression model than on other unobserved factors. However, as the metafrontier efficiency reveals, cooperatives are less efficient overall than the non-cooperative wine producers at achieving higher prices. This finding may be due to the ability of non-cooperative wine producers to market their wines successfully at higher prices as consumers are willing to pay a higher price for non-cooperative wines. As cooperatives may suffer from an image of producing wine of basic quality rather than premium quality (PENNERSTORFER and WEISS, 2012; SCHAMEL, 2015), the market price of cooperative wine is lower and seems not to achieve any price premiums that go beyond the price explained by the quality attributes of a wine. Thus, they price their wines below their possibilities and therefore not efficient if they follow their (group specific) pricing strategies. Although non-cooperatives are on average not fully efficient at exploiting price premiums for quality attributes, it seems that they take advantage of a better reputation or image effect on the market overall that leads to a higher price than that achieved by cooperatives.

6 Discussion and conclusions

The results show that cooperatives are more efficient than other forms of organisations at achieving a market price that corresponds closely with the quality they produce. Is this a positive finding from the perspective of cooperative members? No! Achieving roughly the price that a wine is worth according to its quality basically means that additional marketing did not take place or had a very limited effect in terms of attracting additional WTP. Instead, according to this analysis, the observed relationship between price and quality in cooperatives may be regarded as the 'fair' baseline (from the consumers' perspective), while non-cooperative producers are apparently substantially better at selling wines at a much wider price/quality ratio. In addition, cooperatives achieve lower prices overall as they are not able to serve higher price segments in comparison with non-cooperatives. Considering the metafrontier, non-cooperatives market their wines more efficiently beyond the consideration of observed quality attributes. The results show that the metafrontier approach is a way to account for differences between cooperatives and non-cooperatives that would otherwise bias the results of a pooled frontier approach. What remains unclear is whether non-cooperatives potentially overprice their wines with respect to quality attributes and thus benefit from positive reputation effects of their type of (non-cooperative) business or whether they simply run better marketing and pricing campaigns.

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