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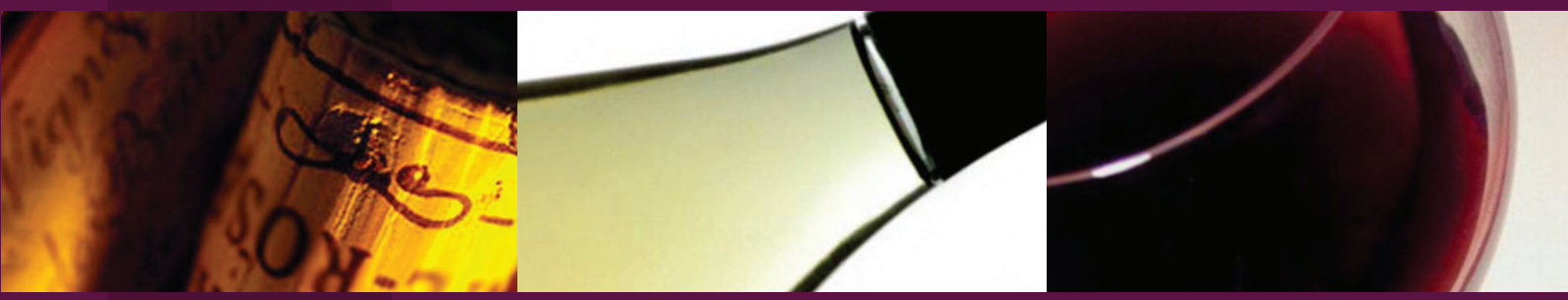

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Subsidies and the income inequality in the Hungarian wine sector

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Abstract. The paper investigates the impact of different sources of income on wine farm total income inequality in Hungary using Farm Accountancy Data Network data for the period 2013-2019. The decomposition of the Gini coefficient is applied to focus on the impact of the Common Agricultural Policy (CAP) shift from market to government budgetary support on wine farm total income inequality. Off-farm income has a rather stable impact on wine farm total income inequality. CAP Pillar 1 subsidies have remained more important than CAP Pillar 2 subsidies, both in the structure of wine farm total income and in the reduction of wine farm total income inequality. The most striking finding is regarding a shift in wine farm market income from a negative (losses) to a positive (profit) value and its increasing role in wine farm total income inequalities. The 20% of the largest wine farms created from almost 90% to less than 80% of wine farm total incomes between 2013 and 2019, but during the same period their participation in CAP subsidy payments was reduced much more from more than 80% to around 60%. Subsidies from Pillars 1 and 2 were reduced, and wine market income increased wine farm total income inequality, while it remained constant for off-farm income. The wine farm market income has driven wine farm total income inequalities. This might strengthen because of the ongoing market selection process with the exit of less efficient and loss-making wine farms and the increasing role of surviving profitable wine farms. This market selection process can be related to managerial, entrepreneurial, and innovation activities based on the differentiation and segmentation of wine farm products and their market incomes.

Keywords: income inequality, off-farm income, market income, subsidies, wine farms, Gini decomposition.
JEL classification: Q12, Q18, D31, H23.

1. INTRODUCTION

Reducing in farm income inequalities is one of the agricultural and farm policy challenges. The available public financial resources and the restructuring of budgetary expenditure patterns create additional challenges for the reduction of farm income inequality. Outside the European Union

(EU), attempts have been made to address the situation by amending the regulatory and institutional frameworks and strengthening market orientations, meanwhile, the goal is to reduce or eliminate income inequality between farmers [1,2]. The impact of the agricultural policy measures applied may vary depending on whether the payments are decoupled [3], on the share of market income and direct payments within the total farm income [4] as well as the size of farms and their market positions [5]. The effect of market income remains significant while its share in total income decreases or is unstable [6,7]. In addition to subsidies, agricultural and farm income inequalities, social factors can lead to an increase in the farm income of farmers [8]. Due to agricultural policy regulations, the concentration of direct payments is observed in several countries. Small number of farms can receive most of the direct payments, while many small farms share the remaining part of the subsidies [9,10,11]. Regional differences in economic, agri-environmental, and competitiveness conditions [12,13] and the regional needs to support regional-level decision-making can also influence the effects of reducing income inequality through direct payments [14,15]. The level and distribution of farm incomes and their potential inequality have been topics of the highest political and economic importance [16,17].

Earlier literature has developed and empirically applied the concept and context of the decomposition of the Gini Coefficient to the structure and evolution of farm income [1,14,18,19,20,21]. These papers focus on the impact of Common Agricultural Policy (CAP) reform on farm income inequality. While there may be heterogeneity in results across EU member states and their regions, most studies report that CAP subsidies have reduced farm income concentration and thus also farm income inequality. Keeney [18] finds that direct payment policies have reduced farm income concentration in Ireland – particularly, the compensatory allowances awarded to farmers in areas faced with natural production handicaps – which are at the greatest risk of having low farm income. Allanson [6] and Allanson et al. [22] for Scotland, Allanson and Rocchi [23] in a comparative study of Scotland and Tuscany (Italy), El Benni et al. [24] and El Benni and Finger [14] for Switzerland, and Severeni and Tantari [19,20,21] and Cilierti and Frascarelli [25] for Italy have reported that agricultural support, especially direct payments (within the EU's CAP Pillar 1) have reduced income concentration and thus reduced farm income inequality within the agricultural sector. Hanson [26] carried out a panel-level assessment of the redistributive impact of the 2013 CAP reform. The negative impact of direct payments has been shown for the largest beneficiaries, while the redistributive effect on small farms is significant. Bojnec and Fertő [27] find that subsidies from Pillars 1 and 2 reduce farm income inequality in Slovenia, especially for less-favoured area (LFA) farms. In short, empirical evidence suggests that farm subsidies may reduce farm income inequalities in the investigated European countries.

This paper contributes to the analysis of the impact of CAP reform on wine farm income inequality. The EU geographic concentration of wine farms is in Mediterranean, South-East, Central and Eastern European countries. The European Commission [28] provides an overview of a synthetic presentation of EU wine policy in the framework of CAP. In addition, Pomarici and Sardone [29] present the evolution and post-2020 challenges of EU wine policy in the framework of the CAP. While the performance indicators to support firm/farm-level decision-making in the wine sector [30] and the effects of agricultural policy on farm income inequality are well documented for Western European countries and for other developed countries, there have been limited similar studies for Central and Eastern European countries, except [27] for Slovenia and [31] for Hungary. This paper represents a rework of previous research [27,31] using a different dataset in terms of the types of farms and time span. In this paper, the time period is updated from the period 2007-2015 for all farm types in Hungary [31] to the period 2013-2019 for the wine farms in Hungary, thus covering the most recent CAP changes in the EU wine sector [32]. An adjusted Gini Coefficient decomposition is applied to deal with negative income values in two ways: first, by substituting negative income values with zeros, and second, by omitting the observations with negative income values [33].

Hungary is an interesting example to investigate the issues of farm income inequality in wine sector. Hungary has a more than 1,000-year wine tradition. 2021, Hungary was 16th among the world's wine producers with 2.59 million hectoliters, 16th in exports with 1.14 million hectoliters, 25th in wine consumption with 1.83 million hectoliters and 70th in imports 79 thousand hectoliters. These data show that Hungary is self-sufficient in terms of wine production, with a low volume of imports. The average annual wine consumption has been decreasing since 2010 and is currently around 22.0 litres per capita. Finally, the Hungarian wine sector can be characterised by a dual production structure. Therefore, it is an interesting question to see how subsidies affect income inequalities between farms under this production structure.

The remainder of this paper is structured as follows. In Sections 2 and 3, the methods and data used are presented. Section 4 presents and explains our results on

the effects of CAP reforms on the income distribution of wine farms. Section 5 discusses the results and derives managerial and policy implications, focusing on the effects of subsidies from Pillars 1 and 2 on wine farm income inequality. Finally, Section 6 summarises the main findings and concludes with study limitations and directions for research in the future.

2. METHOD

Following the FADN definition, we consider the farm-level income as a farm's gross income, which is equal to the total value of output minus intermediate consumption plus the balance of current subsidies and taxes. We focus on income inequality at the farm level instead of per hectare of land (vineyard) area, labour unit or any other input used. This is because the production structure of the Hungarian wine farms is highly dualistic, with a mass of small farms on one side and a few large farms on the other. As their farm organisation and labour use in terms of paid and unpaid labour and wage structure are fundamentally different, the income per unit indicators can lead to misleading results in the analysis of income inequality.

We employ Gini coefficient decomposition to analyse the inequality of the wine farms' income. Because some wine farms have negative total income values or in some of their components, these negative income values can violate the normalisation principle of the Gini coefficient [33].

Then, the decomposition procedure proposed by Jenkins and van Kerm [34] was applied to analyse the change in wine farm income inequality. The authors suggest the following method for determining the change in a single Gini index (G(v)):

$$\Delta G(v) = R(v) - P(v), \tag{1}$$

where

$$R(v) = G_0(v) - G^0{}_1(v) \tag{2}$$

and

$$P(v) = G_1(v) - G^0{}_1(v) \tag{3}$$

$G^0{}_1(v)$ is the generalized Gini concentration index for year one, based on the ranking of year zero. The value of $P(v)$ can be interpreted as a measure of the progressivity of income growth, while the value of $R(v)$ can be interpreted as a mobility index, based on re-ranking. Equation (1), therefore, expresses that inequality is progressive with an increase in income, assuming that it is not offset by simultaneous mobility. If the income grows between the starting and end periods, and the value of $P(v)$ is greater than zero, this means that the income is more concentrated in the "poor" than the "rich" wine farms. This is called pro-poor growth. If $P(v)$ is less than zero, then income growth is more strongly concentrated in "rich" than in "poor" wine farms. In our case, when the income does not grow but decreases, we can speak of growth in the "poor" wine farm population, when losses are less concentrated among the "poor" units compared to the "rich" ones.

In the second step, we decompose the inequality by income sources based on the approaches employed in earlier literature [1,14,18,19,20,21,24], in which income is generated by k components, and the decomposition of the Gini (G) coefficients by income source is undertaken in the following way:

$$G = \sum^{K}_{k=1} R_k * G_k * S_k \tag{4}$$

where R_k is the 'Gini correlation' between the income component k and the rank of total income, G_k is the Gini coefficient for the kth income component or factor Gini, and S_k is income component share of the kth income source of total income.

The concentration of coefficients of the kth income source is defined as:

$$C_k = R_k * G_k * S_k \tag{5}$$

The product of R_k, G_k, and S_k is C_k, which is defined as a contribution to total income inequality: the higher the value of each factor, the greater the contribution of the income component to total income inequality.

The share (%) of total inequality from an income component (P_k) represents an income source's contribution to total income equality. The 'proportional contribution to inequality' of the kth income source (P_k) is defined as:

$$P_k = R_k * G_k * S_k/G \tag{6}$$

Relative income inequality from an income source, P_k/S_k, implies that income component kth contributes more or less than its share to total inequality. $P_k/S_k>1$ means that the income component kth contributes more than its share to total inequality, and vice versa $P_k/S_k<1$. The marginal change of income component kth will change the status of total inequality. The Gini coefficient rate of change with respect to the mean of the kth income component is defined as:

$$\frac{dG}{d\mu_k} = \frac{1}{\mu} * (C_k - G) \quad (7)$$

The Gini coefficient, as a measure of income inequality, leverages a scale of 0 to 1. The Gini coefficient of 0 would imply perfect income equality, while the coefficient of 1 would imply complete income inequality. One of the strongest limitations of the Gini coefficient is that in the presence of negative incomes, the coefficient is greater than 1 and the original Gini coefficient decomposition formulae become inappropriate [33]. Due to this limitation, the Gini coefficient decomposition to analyse wine farm total income inequality comparisons is also estimated using an adjusted Gini coefficient dealing with the problem of negative income values in two ways: negative income values are substituted with zeros, and the observations with negative income values are omitted.

3. DATA

The Hungarian Farm Accountancy Data Network (FADN) panel data for the period 2013-2019 is used as a data source to evaluate the impact of CAP reform and farm entrepreneurial-innovation activities on wine farm total income inequality in Hungary. The sample includes 492 farms over the period, with an average of 70 farms per year. Note that out of the total 492 observations, negative income was observed in 37 cases. The number of farms with negative income per year varied between 4 and 6.

The representativeness of the FADN sample, supporting the survey data collection is often biased towards more viable farms with economic size equal to or greater than a minimum determined by each Member State. The adoption of a random representation of the farms in the sample by economic size and type of farming can be also violated due to possible problems with non-responding and delay-responding farms [35].

According to the FADN farm typology (TF8), the sample covers specialist vineyards (code: 35). The average size of farms is 16.8 hectares, ranging between a minimum 2.4 of hectares and maximum of 114.6 hectares (Table 1). Half of the farms are below 10 hectares, and only 5% of them are above 50 hectares, while less than 5% of farms are organic.

The price indices as deflators obtained from the Hungarian Statistical Office are used to transform current forint values into constant forint values, using 2013 as the base-year. Total wine farm income is comprised of two potential components: 1) income components, which can contain market income and off-farm income; and 2) subsidy components, which can contain CAP subsidies from Pillars 1 and 2. Pillar 2 support includes subsidies related to agri-environmental measures, LFAs and other rural development measures. Pillar 1 subsidies play a dominant role in total CAP subsidies. Their share ranges between 75% and 95%.

Table 1. The distribution of the FADN wine farms in Hungary by their land size (in %).

Hectares	number of farms (%)
0-5	25.8
5-10	25.3
10-50	43.6
50-	5.4
mean (ha)	16.8
std. deviaton (ha)	19.6
minimum (ha)	2.4
maximum (ha)	114.6

Source: Authors' calculations based on the Hungarian FADN dataset.

EU Member States can choose a set of measures from the 5-year National Support Programme (NSP) that the CAP provides for the wine industry. Moreover, with 2014-2020 reform, vineyard areas became potentially eligible for Basic Income support. In the execution of the NSP for the wine sector by the CAP measures, Hungary devoted a major amount restructuring and conversion, by green harvesting, by-products and crisis distillations. In October 2020, the percentage execution of the financial ceiling for the Hungarian NPS in the wine sector was 93.7% [(total expenditures/ceiling) * 100], compared to 81% in October 2019 [36]. Note that FADN data and NEP expenditure statistics for the wine sector by the CAP measures are not based on the same conceptual approach, which limits direct comparisons.

According to FADN subsidy definitions, we can distinguish the following types of CAP subsidies within Pillar 1 payments: 1) total subsidies on crops; 2) total subsidies on livestock; 3) total subsidies on intermediate consumption; 4) total subsidies on external factors; 5) decoupled payments; and 6) other subsidies. Within Pillar 1, decoupled payments dominate with a share of around two thirds (Figure 1). The share of other subsidies and subsidies on intermediate consumption is around 24%.

4. RESULTS

The empirical results are presented in three steps. First, we present the evolution of wine farm total income

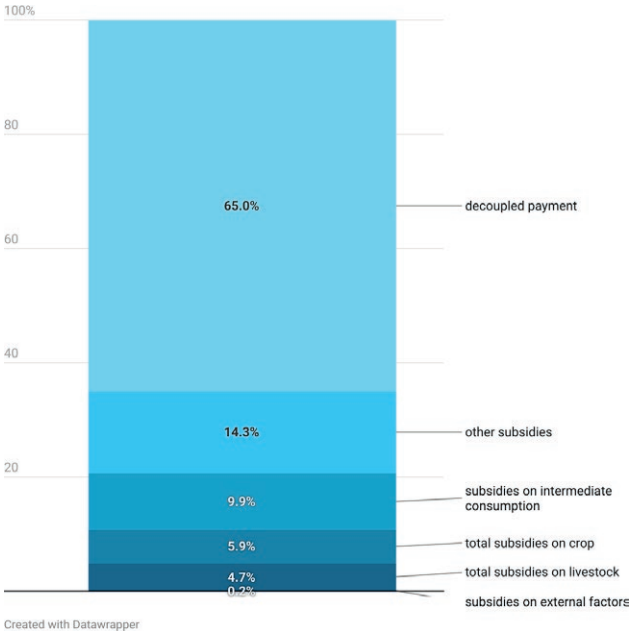

Figure 1. The distribution of Pillar 1 payment by subsidy types in 2013-2019 (in %). Source: Authors' calculations based on the Hungarian FADN dataset.

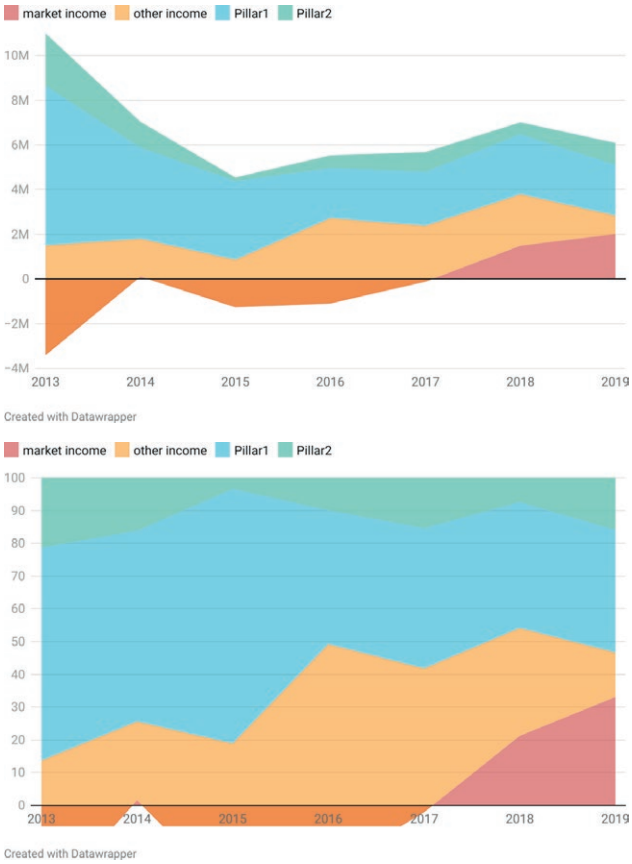

Figure 2. Total income and its composition for wine farms, 2013–2019. Source: Authors' calculations based on Hungarian FADN dataset.

structures in constant value terms and as relative shares. Second, we present wine farm total income inequality distribution by sources of income and total CAP subsidy distribution. Third, the wine farms total income inequalities are applied using the Gini coefficient decompositions over time and income sources.

4.1. The evolution of wine farm total income and its components

Figure 2 illustrates the evolution in total income for wine farms in Hungary (Figure 2 upper part) and the structure of different sources of wine farm total income: subsidies from Pillars 1 and 2, market income, and other income (Figure 2 lower part). Subsidies from Pillar 1 were the most single important source of wine farm total income, particularly prior to 2015 but also later, with a slightly smaller share. The most volatile was the market income, which was negative up to 2017 and was the second-most important source of wine farm total income in 2019. This shift from losses to profits in market income suggests substantial improvements in market-based economic performance of wine farms that can be a result of improved managerial, entrepreneurial, and innovation performance of wine farms and/or better selling and other economic conditions in the wine markets.

The importance of other income sources, or off-farm income, has oscillated between being the most important single source of wine farm total income in 2016 and mostly the second most important source of wine farm total income, but with a decline in 2019. Finally, subsidies from Pillar 2 are a continuously important and rather stable source of wine farm total income, being between the second and largely the third most important source of wine farm total income, except being the fourth one in 2018. In this year, the share of subsidies from Pillars 1 and 2 was less than 20%, unlike in the other years when their share in wine farm total income was greater and more important than market income and other income sources.

4.2. Wine farm total income inequality and CAP subsidy distribution

Figure 3 presents a rather unequal distribution of wine farm total income that remained rather stable over

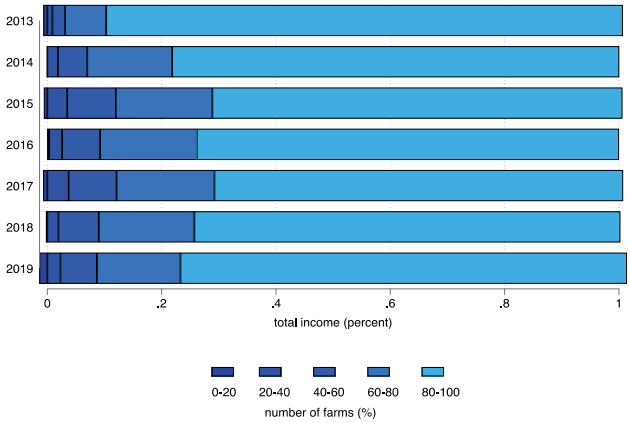

Figure 3. Distribution of wine farm total income between 2013 and 2019 (in %). Source: Authors' calculations based on the Hungarian FADN dataset.

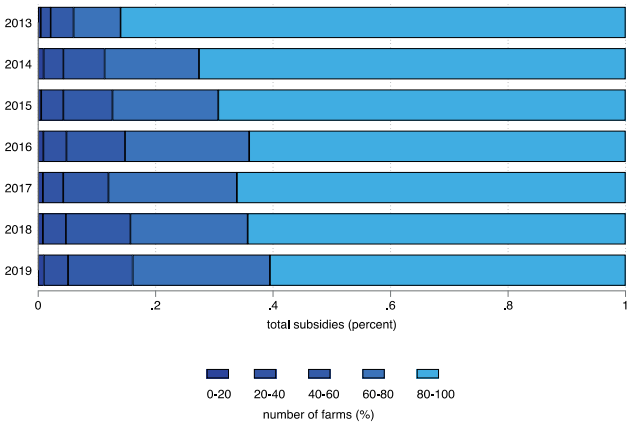

Figure 4. Distribution of total CAP subsidy payments to wine farms between 2013 and 2019 (in %). Source: Authors' calculations based on the Hungarian FADN dataset.

the years 2013-2019: 20% of the largest wine farms contributed around 80% of wine farm total income, but this share declined from almost 90% to less than 80%. The second largest group of wine farms contributed additional around 10% of wine farm total income. Finally, all other 60% of smaller wine farms contributed less than 10% of their total income.

While a concentration on a smaller percentage of the largest wine farms is also confirmed for the distribution of total CAP subsidy payments to wine farms, they are slightly less concentrated than wine farm total income. The comparison of Figures 3 and 4 showed similarities and differences in the distribution of wine farm total income and the distribution of total CAP subsidies to wine farms according to wine farm size: 20% of the largest wine farms received from substantially more than 80% of total CAP subsidy payments to wine farms in 2013 to slightly more than 60% of total CAP subsidy payments to wine farms in 2019. Unlike for wine farm total income, there is a substantial reduction in the percentage of total CAP subsidy payments to wine farms over the analysed years for the largest wine farms. The second largest group of wine farms received additional between less than 10% of CAP subsidy payments to wine farms in 2013 and more than 20% of CAP subsidy payments to wine farms in 2019. All other 60% of smaller wine farms received between slightly more than 5% of CAP subsidy payments to wine farms in 2013 and less than 20% of CAP subsidy payments to wine farms in 2019. These results and findings confirmed the redistribution of CAP subsidies from 20% of the largest wine farms to other smaller wine farm structures.

However, the unequal distribution of wine farm total income and CAP subsidy payments to wine farms strongly revealed thee dual structure of Hungarian wine farms where, a smaller number of the largest commercial wine farms dominates in the structure of wine farm total incomes and, to a lesser extent, also in total CAP subsidy payments received by wine farms over a larger number of smaller, mostly individual wine farms.

4.3 Gini coefficient decompositions

To analyse the dynamics of income inequality, we use the Gini decomposition methodology. Table 2 presents the Gini decomposition of change in wine farm total income inequality between 2013 and 2019. First, wine farm total income, including negative income values. Second, wine farm total income is substituted for negative income values with zero. Third, wine farm total income with omitted observations with negative income values. The values of the initial (year zero = 2013) and final (year one = 2019) single-parameter Gini coefficients show that the income in Hungarian wine sectors was strongly concentrated in 2013, and that this inequality had further strengthened by 2019. The main change in the results is observed for the P-component with a shift from negative values to positive values when dealing with negative income values. The negative value of the P-component that the decline in farm income tended to affect 'richer' wine farms with a higher income in the initial period switches to the positive values when negative income values have been replaced by 0 or they were omitted. The negative P-component indicates a 'pro-rich' ('for whoever has, to him more will be given') income reallocation, and vice versa, the positive P-component with the 'pro-poor' income

Table 2. Decomposition of change in wine farm total income inequality between 2013 and 2019.

Components	farm total income with negative income values	farm total income with replaced negative income values by 0	farm total income with omitted negative income values
Initial S-Gini	0.776	0.756	0.725
Final S-Gini	0.850	0.790	0.755
Change	0.074	0.035	0.030
R-component	0.052	0.047	0.046
P-component	-0.022	0.013	0.016
Change of R and P component in % of the initial Gini			
Change	9.5	4.6	4.1
R-component	6.7	6.3	6.4
P-component	-2.8	1.7	2.3

Source: Authors' calculations based on the Hungarian FADN dataset.

growth concentrated in the "poor" than the "rich" wine farms. In other words, when considering also negative income values wine farms with a small initial income were the losers of the income change, and the 'pro-rich' process intensified the increase in income concentration in the Hungarian wine sector. However, when the negative income values were replaced by 0 or omitted, Hungarian wine farms with a small initial income were the gainers of the income change, and the 'pro-poor' process deteriorated the increase in income concentration. On the other hand, the high value of the R-component reinforces these pro-rich or pro-poor effects. The increase or decrease in concentration in the Hungarian wine sector was due to a high degree of reranking between wine farms.

The Gini (G_k) coefficients decomposition according to the different wine farm total income sources ranged between 0 and 1, except for market income with negative wine farm total income values (Table 3, upper part), which overshoots absolute value 1: wine farm market income was a negative (loss) in 2013 and a positive (profit) in 2019. In 2013, this was due to a negative wine farm total income caused by losses from wine farm market activities [7,31,37]. Wine farm market income, wine off-farm income, and Pillar 2 subsidies (LFA payments, agri-environmental measures, and other rural development programmes) are much more unequally distributed than subsidies from Pillar 1 (direct payments). Between 2013 and 2019, the G_k coefficients suggest substantial overshoots of 1 for wine farm market income with their negative values. The G_k remains constant for wine farm total income inequality from off-farm income, and decreases for the Pillars 1 and 2 subsidies.

The proportional contribution () to wine farm total income inequality by income sources changed between the years 2013 and 2019. While in 2013, Pillar 1 and off-farm income played a crucial role in terms of their proportional contribution to wine farm total income inequality, this changed in 2019 with a switch from a negative to an increasing positive contribution of wine farm market income in wine farm total income with its negative values and a substantial decline of off-farm income and Pillar 1 subsidies, as well as a slight decline of Pillar 2 subsidies. Interestingly, unlike in Slovenia [7], the proportional contribution of subsidies from Pillar 2 in Hungary is less important for wine farm total income inequality. The for off-farm income remains relatively low but makes a relatively stable proportional contribution to wine farm total income inequality. Unlike for all farm total income inequality in Hungary with the substitution effect of market income with off-farm income and further increase of Pillar 1 subsidies to farm total income inequality [31], wine farm total income inequality in Hungary has declined over time, but the increasing pressures were coming from wine farm market income from its negative to positive values, suggesting possible managerial, entrepreneurial, and innovation improvements in wine farms in achieving more favourable conditions for profit and market income. Table 3 also suggests a correlation between the values in the columns and the Share (in %) that captures similar structures.

The Pseudo-Gini correlation coefficients of the different wine farm total income sources are, except for wine farm market income with its negative values in 2013 (Table 3, upper part), greater than 0, suggesting that wine farm total income from the specific income sources is mainly distributed to farms in the upper tail of wine farm total income distribution [14]. Except for wine farm market income with its negative values in 2013 and Pillar 2 subsidies in 2019, all other sources of wine farm total income are correlated with total wine farm income. The highest Pseudo-Gini coefficients are found for off-farm income and subsidies from Pillar 1 as well as subsidies from Pillar 2 in 2013 and wine farm market income in 2019. Unlike for Slovenian farms [7], but consistently for Hungarian farms [31], the Pseudo-Gini coefficients suggest that subsidies from Pillar 2 in Hungary were slightly less important than subsidies from Pillar 1 in 2013, and this gap further increased over time in 2019. This can be explained by the greater role of direct payments from Pillar 1 subsidies than Pillar 2 subsidies as an important source of total income for Hungarian wine farms.

Table 3. Gini decomposition of wine farm total income by income source in 2013 and 2019.

Source	Sk	Gk	Rk	Share (%)	Marginal Change
farm total income with negative income values					
2013					
market income	-0.3105	-2.1735	-0.2791	-21.71	0.0934
off-farm income	0.4472	0.9523	0.9573	46.98	0.0226
Pillar 1	0.6507	0.8188	0.9042	55.52	-0.0955
Pillar 2	0.2126	0.9069	0.8642	19.20	-0.0206
2019					
market income	0.3306	1.6014	0.8262	56.36	0.2330
off-farm income	0.1357	0.9515	0.9125	15.18	0.0161
Pillar 1	0.3748	0.6631	0.7449	23.86	-0.1362
Pillar 2	0.1589	0.7408	0.3031	4.60	-0.1129
farm total income with replaced negative income values by 0					
2013					
market income	0.2127	0.9056	0.8926	20.16	-0.0111
off-farm income	0.4436	0.9523	0.9571	47.41	0.0305
Pillar 1	0.6455	0.8188	0.9055	56.12	-0.0843
Pillar 2	0.2109	0.9069	0.8643	19.38	-0.0171
2019					
market income	0.4710	0.8416	0.9446	50.25	0.0315
off-farm income	0.1333	0.9515	0.9125	15.53	0.0220
Pillar 1	0.3682	0.6631	0.7477	24.50	-0.1232
Pillar 2	0.1561	0.7408	0.3046	4.73	-0.1088
farm total income with omitted negative income values					
2013					
market income	0.5197	0.8142	0.9797	54.28	0.0231
off-farm income	0.0363	0.9289	0.9538	4.21	0.0058
Pillar 1	0.3992	0.7579	0.9569	37.91	-0.0201
Pillar 2	0.0448	0.8338	0.7353	3.60	-0.0088
2019					
market income	0.5117	0.7577	0.9508	51.95	0.0078
off-farm income	0.1207	0.9473	0.9575	15.43	0.0336
Pillar 1	0.2850	0.7136	0.9544	27.36	-0.0114
Pillar 2	0.0825	0.7990	0.5657	5.26	-0.0300

Source: Authors' calculations based on the Hungarian FADN dataset.

The estimated marginal changes in the Gini Elasticities for the different income sources relating to wine farm total income distribution, which are presented in the last column in Table 3, range between less than zero (negative values) and more than zero (positive values). Values above 0 for wine farm market income and off-farm income show that an increase in the income source under consideration of 1 percent increased wine farm total income inequality (as measured using the Gini coefficient) by the defined percentage, ceteris paribus. While values below 0 for an increase in Pillars 1 and 2 subsidies decreased the inequality of wine farm total income.

5. DISCUSSION OF THE RESULTS WITH MANAGERIAL, ENTREPRENEURIAL AND POLICY IMPLICATIONS

Our empirical results confirmed that the wine farm total income inequality in Hungary highly depends on wine farm market income, which has shifted from a negative value (losses) to a positive value (profits). The wine farm total income inequality primarily driven by market components suggests that the wine production sector and wine farm total incomes rely to greater extent on managerial, entrepreneurial, innovation, and human-based wine farm specific factors [38,39] than some oth-

er farm type specialisations such as crop farms [27,31]. In the initial stage of transition in the early 1990s, the Hungarian wine sector was also open to new initiatives coming from foreign innovation and foreign direct investment that had a spillover effect on wine farms and the wine sector [40].

CAP-subsidies represent a stable source of wine farm total income that slightly decreases the wine farm total income inequality with a shift in their reduction from the 20% of the largest wine farms to their increase in other smaller wine farm sizes. This redistribution in CAP subsidy payments was more substantial than changes in wine farm total incomes according to their size. This striking finding suggests that 20% of the largest wine farms compensated for reductions in CAP subsidy payments with increases in wine farm market incomes. This is consistent with the finding that if wine farms make a positive profit, the contribution of Pillar 2 subsidies is marginalised due to the prevailing wine farm market income. Therefore, wine farm differentiation and wine farm total income inequalities are driven by non-governmental policies such as managerial, entrepreneurial, marketing, and similar farm-specific measures rather than relying on government transfers related to CAP-subsidy payments. However, income redistribution through public policies poses a challenge to farm management and policy-making due to fluctuations in wine farm market incomes [41]. While wine farm total incomes still depend on CAP subsidies and their reforms with income redistribution in the EU [29], the wine sector and wine farm total income can more related to adjustments to regional determinants of wine consumption and purchasing behaviour [42], and wine prices in association with geographical indications, objective quality, brand names, and individual reputation [43]. One additional factor for market income oscillations over time can be related to climatic risk and variations in weather conditions in Hungarian grape growing regions [12]. Wine tourism on a farm can also be an important source of wine farm market income generation [44]. Investments in wine tourism as on-farm activity can also contribute additional flows of investments and Pillar 2 subsidies into wine farms that can drive efficiency and profitability of wine farms [45,46,47].

As for several EU countries [425,29,48], Pillar 1 subsidy payments are for Hungarian farms [31] and narrowly for Hungarian wine farms, the most important CAP subsidy payments in reducing farm total income inequalities. Farm total income inequalities can be biased to farm type specialisation and the different regional and agri-ecological farming characteristics eligible for different types of CAP subsidies regarding different production conditions [14,15,27]. The comparison of the results from the previous research for all farms in Hungary for the period 2007-2015 [31] vis-à-vis this research for the wine farms in Hungary for the period 2013-2019 suggests diminishing role of the CAP subsidies in the structure of farm total incomes and in total income inequality. This finding is consistent with the changes in the CAP measures leading to reductions of subsidies for wine farms [29,32] and the greater role of entrepreneurial spirit in wine farms as drivers of competitiveness, farm growth, and farm survival [30,49].

The Gini coefficient is less than 1 for off-farm income and subsidy payments from Pillars 1 and 2. It is a greater than 1 only for wine farm market income with its negative values, with a shift from a negative value in 2013 to a positive value in 2019. The negative wine farm market income suggests that without CAP subsidy payments and off-farm income, farms experienced losses and difficulties covering their operation costs to survive. However, a large dependence of wine farms on CAP subsidy payments and non-farming activities has weakened at the end of the analysed period, reinforcing the importance of wine farm market income and profitable wine farm business performances. This might suggest an ongoing market selection process in the Hungarian wine sector, exiting less efficient and indebted wine farms and the survival of the profitable ones. While this process may lead to greater inequality in wine farm market incomes, at the same time, it may lead to more efficient, competitive, and profitable wine farms that may rely less on CAP subsidy payments. With efficient wine farms, there can be a greater need for on-farm employment that can generate on-farm wine farm market incomes. However, it is still likely that off-farm incomes will continue to be an important source of total income for wine farms in Hungary.

There is a clear pattern regarding a reduction in the concentration of CAP subsidy payments that allows for a more equal distribution of government support for lower income wine farms. While there is a correlation between subsidy payments from Pillars 1 and 2, and the level of wine farm total income, this has weakened over time. The crucial problem can be instabilities in market-driven income that have become an increasing pattern, but they are still unclear whether it is of a cyclical nature or whether they can be expected to have a more stable positive (profitable) development in the future. This is the reason that subsidy payments from Pillar 1 have an impact on the reduction of wine farm total income equality [25]. In trade-offs between the wine farm efficiency and equity of CAP subsidy payments, wine farm managerial, entrepreneurial, and innovation measures that can generate

greater wine farm market incomes should not be neglected, despite the fact that this can contribute to greater wine farm total income inequality and create a possible additional market selection process with the exit of economically less efficient wine farms and the survival of more efficient and competitive wine farms.

6. CONCLUSION

The paper investigated the development of total income inequality in Hungarian wine farms over the period 2013–2019 using FADN data. A shift in CAP policy and related measures, off-farm income, and particularly a shift from a negative (losses) to a positive (profit) wine farm market income have determined the evolution and structure of wine farm total incomes. CAP subsidy payments, particularly from Pillar 1, have reduced wine farm total income inequality, while wine farm market incomes have increased wine farm total income inequality. While CAP subsidy payments have been shifted from 20% of the largest wine farms to smaller wine farm sizes, this has to a lesser extent caused changes in wine farm total incomes according to their size. This finding implies that the 20% of the largest wine farms compensated for the reduction in CAP subsidy payments with an increase in other incomes, particularly in wine farm market incomes that can be the result of on-farm managerial, entrepreneurial, and innovation improvements, including in wine farm marketing channels for their produce.

While the results highlight the importance of CAP subsidy payments in Hungarian wine farms total incomes and in the reduction of wine farm total income inequalities, it is also clearer that wine farms do not share the same characteristics as all other farm types. This finding can also be biased to the different dataset used in terms of the analysed time span and dealing with the problem of negative farm incomes (losses).

Wine farms produce specific products that are sensitive to managerial, entrepreneurial, and innovation activities on farms, but the final products that appear on the market are not necessarily homogenous in monopolistic competition that relies on quality and diversity. The product differentiation and market segmentation in on- and off-farm marketing activities make the specific product that can achieve different prices, thus resulting in different wine market incomes, a reason for wine farm total income inequality. This finding should be considered a positive outcome of market developments in the Hungarian wine sector that cannot be only related to the existence of large-scale commercial wine farms. They can operate efficiently and profitably in spite of the reduction of CAP subsidy payments during the period 2013-2019. The stabilisation of wine farm total incomes is likely to largely depend on the greater stability of wine farm market income.

Policy modelling of wine farm total income diversification and the role of CAP subsidy payments on wine farm total incomes and wine farm total income inequalities across different wine farm structures is important for improving understanding of the impacts of CAP on different total income structures and their associated total income inequalities on wine farms and in rural areas. It is also important to increase and stabilise wine market incomes. Questions that are related to wine farm management, entrepreneurial and innovation activities in wine farm total income generation, wine farm sustainability, and international competitiveness, will be issues for future research. Among such open questions is wine farm specialisation in protected designation of origin (PDO) and protected geographical indication (PGI) wine quality products. Finally, among the specific challenges for research in the future is the investigation of the CAP 2021-2027: How total income inequality in wine farming can be more effectively reduced? How can agricultural policy measures adapt to and influence the special dual farm structure in Hungarian wine farming?

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The competitiveness of Romagna wineries. An exploratory analysis of the impact of different strategic approaches on business performance

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Abstract. This paper proposes an exploratory study of the competitiveness of Romagna wineries. A double approach has been adopted to analyse it, as both Porter's Theory of Competitive Advantage and Barney's Resource-based Theory have been considered. The final purposes are to uncover which categories of resources and capabilities are related to firm performance and to investigate the main strategic orientations of the most successful Romagna wineries. To conduct the research, an online questionnaire was sent to 115 wineries located in the Romagna territory, achieving a response rate of about 24.35%. According to the preliminary results, it has been found that the most successful wineries in this area do not follow a cost leadership strategy, while they perform a differentiation strategy. These firms put a lot of effort into building a reputation in the market. On the other hand, managerial and technological capabilities seem to be not positively related to firm performance, while marketing capabilities exert a stronger impact. This study would give an input to the strategic and managerial studies in the wine business sector, and adopt an innovative theoretical approach in the analysis of competitive advantage. Moreover, this work focuses on the Romagna territory, fulfilling the need for research that considers the local wine industry and its competitiveness, to open the way to further studies.

Keywords: competitive advantage, strategic orientation, resource-based theory, Romagna wineries.

1. INTRODUCTION

This study focuses on the wine industry, which is a very important and strategic agro-industrial sector worldwide. In the global market, the principal players considering both production and export are three EU nations, i.e. Italy, France, and Spain, which are responsible for about 50% of the total world wine production in 2019 [24]. In particular, the Italian wine sector is mainly composed of small and medium enterprises, as the average cultivated surface per winery is 2.1 hectares, although it records a high level of profitability and competitiveness, as the annual revenue of the sector is equal to 13.4 bn € in 2019

[15]. Moreover, the value of Italian wine exports has rocketed in the last ten years [24]. It has been calculated that the percentage weight of wine exports on the total national agri-food export is close to 15% [14]. It is also worth noting that the attitude towards wine export in volume is equal to 45.4% for Italy in 2019 [15]. In this context, the Emilia-Romagna region plays an important role, as it contributes to 5.74% of the Italian export value in 2022 and it is the first region in Italy in terms of consumption [44]. In addition, Emilia-Romagna owns certified wines that are well-known in the international scenario [45].

Some of them, such as Albana, are prerogative of the Romagna territory (the southeast area of the region).

This study aims to examine and explore the competitiveness and strategic orientations of wineries located in Romagna. Specifically, the goal is to analyse the impact that business strategies and resources and capabilities could have on the creation of a competitive advantage in the market, which is expressed by a better performance of the Consorzio Vini di Romagna wineries. To survey the critical factors for Romagna wineries in achieving their competitive advantage, this study adopts a double approach, derived from two different strategic theories: the Theory of Competitive Advantage [28, 29] and the Resource-based Theory [2]. These two strategic theories can be applied together because they analyse the competitiveness of firms from complementary points of view. Therefore, a double approach has been adopted, following the positive results already presented in the literature [10, 36, 38].

In detail, the authors investigate if wineries that follow one of Porter's competitive strategies will obtain a better performance in the market concerning their competitors or if some resources and capabilities owned by firms are positively related to their performance. Hence, a set of four hypotheses to be verified has been proposed.

The study is structured as follows: the next chapter focuses on the theoretical aspects of strategic theories and their practical applications in the wine sector. In paragraph 3, materials and methods used to conduct the analysis are presented, together with the hypotheses set. The following section reports the results of the study, while paragraph 5 presents the discussion of the results obtained. Finally, the last section shows the conclusions reached, together with managerial implications, limitations and future research directions.

2. LITERATURE REVIEW

2.1 Theoretical framework

This study takes into consideration the competitive advantage of companies, which is a necessary condition to obtain good performance and success in the market [1, 34]. Hence, firms have to implement strategies that enable them to obtain a sustainable competitive advantage (SCA) [2].

One of the most important approaches to obtaining an SCA in the market was theorized by Barney [2]. He promoted the theory of resources and capabilities, known as Resource-Based Theory (RBT), which focuses on internal resources and capabilities controlled by the firm, viewed as the fundamental elements for the firm in order to conceive and realize strategies that improve its efficiency and effectiveness, achieving a SCA [2, 40]. Resources can be classified into three categories: physical capital, human capital and organizational capital. A company aims to develop distinctive resources and capabilities, which are the result of superiority in process management, integration of knowledge and diffusion of learning [6]. The RBT model lays its foundations on two main assumptions: the first one is that the strategic resources of companies within an industry must be heterogeneous. The second one is that resources do not have to be perfectly mobile across firms, in order to secure a long-lasting SCA obtained [2, 26]. To have the potential to be a source of SCA, a resource must have four characteristics: it must be valuable, rare, imperfectly imitable, and there cannot be strategic equivalent substitutes [2].

During the following years, many authors enriched the RBT. Regarding organizational capital resources, Nonaka [23] affirmed that organizational knowledge is created through a continuous dialogue between tacit and explicit knowledge and pointed out the importance of common knowledge, which is the intersection of individual knowledge sets. Therefore, human capital resources are directly linked with organizational capital. Human capital resources and organizational knowledge together are also known as managerial capabilities [27]. About physical capital resources, Rivard et al. [31] studied the relevance of information technology in the definition of business performance. Furthermore, another important extension of RBT was provided by Teece et al. [37], who focussed their attention on dynamic capabilities, which are the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments. A fundamental tool of dynamic capabilities is represented by technology. Even small firms must possess a bundle of technological capabilities that ensure them to keep up with the rapid evolution that is happening in this field and to take advantage of new development opportunities [16, 22].

However, some critiques have been moved against the RBT. The most relevant ones are addressed to the definition of resource, that is overly inclusive, and to the

role of value, which is exogenous to the theory and too indefinite to provide for useful theory [18, 30]. The common theme underlying these critiques is that the RBT does not sufficiently capture the essence of competitive advantage. In fact, it overestimates the possession of individual resources and underestimates the importance of bundling resources and of the human involvement in assessing and creating value [18].

Despite the importance of these critiques, RBT has progressively shifted its focus from an inside-out perspective to both an inside-out and outside-in view [3]. In this context, marketing and information about the market are two of the most relevant resources, precious to orient in an increasingly competitive scenario.

Pursuing in this change of orientation and moving to a completely outside-in perspective, the focus shifts to the other approach that can lead a firm to obtain a SCA. It was theorized by Michael Porter in the 1980s [28, 29]. He affirmed that a firm reaches success in the market by positioning itself better than competitors. He found that this position depends on five forces (barriers to entry, power of suppliers and buyers, threat of substitutes, and intensity of internal rivalry). Therefore, the objective of a company's strategic plan is to find a position that allows it to better defend itself against these forces or make it able to influence them in its favour. These strategic plans are called "competitive strategies". Two of them are generic strategies, that allow for the pursuit of a competitive advantage position: they are cost leadership and differentiation. On the other hand, the third competitive strategy, which is focalization, is given by the implementation of one of the first two strategies in a niche market [28, 29]. More in detail, cost leadership is based on the firm's ability to reduce its costs per unit, without negatively altering the characteristics of the product or service offered. On the other hand, differentiation strategy is obtained by attributing tangible or intangible elements to an offered product or service that increase its value for the target of consumers [28, 29]. Definitely, RBT and Porter's approaches are different in the sense that the last one is focused on the external environment in which the company is inlaid, while the first one is based on the interiority of a firm, or rather on resources and capabilities that it possesses. However, these two strategic theories can be used simultaneously by companies to achieve an SCA in the market.

2.2 Application of competitive strategies

Various case studies embraced the abovementioned strategic theories (RBT and Porter's), taken singularly or together. Considering the Porter's model, Dess and Davis [7] examined the strategic orientations of firms in an industry. These orientations are defined by the most used competitive methods and companies have been clustered in different groups according to them. Strategic groups reflect three of Porter's strategies, plus a fourth one: "stuck in the middle", expressing firms with no clear strategic orientation. Moreover, Robinson and Pearce [32] wanted to analyse the impact of intended strategies and planning processes on firm performance, following Porter's principles. In this case, the authors have identified four patterns in order to group firms with similar strategic orientations. These patterns are efficiency, service, product innovation and development, brand/channel influence. Otherwise, Spanos and Lioukas [36] considered both RBT and Porter's approaches and elaborated a composite model. In particular, this model includes firm assets (from RBT), industry effects (from Porter) and their relationship with the creation of a successful strategy, which finally lead to profitability. In line with this composite model, Ortega [25] focused on technological capabilities, finding that they are resources that guarantee the company to achieve an SCA through the implementation of the Porter's [28, 29] generic strategies. Many studies have been done applying Porter's and/or Barney's theories in the wine industry. Relating to the application of both theoretical frameworks, Ferrer Lorenzo et al. [10] empirically tested how resources, capabilities and strategies modulate the results of Spanish wineries. To define strategies, twenty-two competitive methods have been considered, like in the studies of Dess and Davis [7] and Robinson and Pearce [32]. An analogous research has been performed by Villanueva and Ferrer Lorenzo [38] regarding wineries located in Connecticut and Rhode Island (US). Authors have found that managerial capabilities are more important than the strategic intent in the explanation of wineries' performance. It has been also verified that differentiation strategy is linked to a better business performance with respect to competitors, and that successful wineries invest a lot in the service offered to the consumer. On the other hand, other research considered the application of just one of the two competitive theories defined above. First of all, Martinez-Canas and Ruiz-Palomino [19] applied the RBT framework by interviewing wineries' managers in Castilla-La-Mancha region (Spain), aiming to understand which are the resources and capabilities that possess VRIO attributes. Regarding the Italian wine industry, Galati et al. [11] wanted to explore the role of internal resources (tangible, intangible and financial) and their impact on the business performance of cooperatives operating in Sicily, using the RBT of firms as theoretical basis. Otherwise, various studies have applied Porter's competitive strategies to the wine

sector. In detail, a winery can decide to reduce its carbon footprint and obtain a related certification that can be a tool to differentiate in the market [12]. On the other side, wineries can opt for a power-assisted pruning and tying to diminish costs in the vineyard management compared to manual operations, becoming an essential element in following a cost leadership strategy [33].

3. MATERIALS AND METHODS

In order to identify Romagna wineries, information taken from websites of "Enoteca Regionale dell'Emilia-Romagna" [43], "Quattro calici" [46], "Consorzio Vini di Romagna" [42] and "Aida database" [41] has been collected and cross-referenced. So, a list of wineries has been composed. The "Consorzio Vini di Romagna" has directly collaborated with this study. The Consortium is composed of 7 cooperatives and 108 individual winemakers. Its contribution is fundamental as it works to support the quality of Romagna wines, the balance of prices and the enhancement of the product quality and its connection with the territory. Thanks to this collaboration, a questionnaire has been submitted both to Consorzio Vini di Romagna wineries and the other units of the list even if they are not members of the Consortium, informing them about the aim and importance of this research. Questionnaire has been administered online, sending e-mails to a sample of 152 wineries. To stimulate the completion of the survey, most of the wineries have been also contacted by telephone. The structure of the questionnaire has been derived from Ferrer Lorenzo et al. [10] with modifications according to the Romagna wine sector characteristics. At the end of the survey, data have been implemented and checked in order to prepare a database fitting for the successive elaborations.

3.1 Hypotheses

Studying in depth the literature, it is worth noting that a high level of resources and capabilities can positively influence performance and profitability of firms, and a clear strategic orientation is crucial to obtain optimal results in the market. Therefore, in this study we have decided to take into consideration four main hypotheses that we aim to verify, in line with the study of Ferrer Lorenzo et al. [10]. Regarding resources and capabilities, we have selected two of the categories presented in the literature, i.e. managerial capabilities and technological capabilities. Consequently, the first (A) and second (B) hypothesis are:

Hypothesis A: *In Romagna wineries, the managerial capabilities owned by the firm are positively related to the firm's performance.*
Hypothesis B: *In Romagna wineries, the technological capabilities owned by the firm are positively related to the firm's performance.*

Then, in relation to Porter's business strategies, the study has the objective to analyse which type of strategy is followed by Romagna wineries: leadership in cost or differentiation. Hence, hypothesis (C) and (D) are:

Hypothesis C: *The wineries tending towards a cost leadership strategy will have a better performance.*
Hypothesis D: *The wineries tending towards a differentiation strategy will have a better performance.*

3.2 Measurement scale

To measure resources and capabilities, the scale used is adapted from Spanos and Lioukas [36], Ortega [25] and Ferrer Lorenzo et al. [10]. Variables are measured with a 5-point Likert scale, where companies evaluate their position with respect to their competitors and where the values of the scale are classified from 1 "much weaker than competitors" to 5 "much stronger than competitors". Regarding strategy, responses to the twenty-two competitive strategies have been given by wineries through a self-evaluation of the grade of utilization of them. The scale adopted is again a 5-point Likert scale, where 1 stands for "not utilized at all" and 5 for "the principal strategy used". Also the pairing of competitive methods and Porter's generic strategies was evaluated through a 5-point Likert scale (1-least important for Porter's strategy, 5-most important for Porter's strategy) [7]. Finally, following Spanos and Lioukas [36] and Ortega [25], business performance is evaluated through seven indicators grouped into the two dimensions of performance described before (internal and external). All the items use a 5-point Likert scale, where companies evaluate their position with respect to competitors and where the values of the scale are rated from 1 "much weaker than competitors" to 5 "much stronger than competitors". The use of a subjective evaluation scale is justified since it has been demonstrated that it converges with objective scale in business evaluation [35, 39]. Moreover, the validity of subjective scales has been confirmed in various empirical studies [10, 25, 36, 38]. The last section of the questionnaire deals with general characteristics of wineries. In fact, it is aimed at characterising the sample and collect general and objective information of wineries, such as billing business and assets in 2019, or the percentage of market sales according to different distribution channels.

4. RESULTS

4.1. Data gathering and sample characteristics

The data gathering started in May 2020 and finished in August 2020. It should be observed that the COVID-19 outbreak has affected the possibility to keep in touch with the wineries as well as their availability to the survey in a such difficult period. Once the questionnaires have been collected, we decided to focus the analysis only on the Consortium wineries because of their homogeneity and availability. A final number of 28 responses has been collected, out of the 115 wineries of the Consortium contacted. Therefore, the response rate is 24.35%, which is above the minimum value reported by Baruch and Holtom [4], for industrial sectors. However, the response rate is not explicative of the representativeness of the sample. The surveyed firms are 26 individual wineries and 2 cooperatives. Cooperatives have been excluded because of their small number. Table 1 summarizes the structural characteristics of the sample. It emerges that Romagna wineries are principally small family-run enterprises. This is clear considering the average wine production, the number of long-term employees and both assets and billing business. The average surface cultivated with vineyards is about 33.4 hectares, which is representative of small/medium companies. However, 21 out of the 26 firms of the sample have a vineyard surface between 2.5 and 23 hectares, confirming the fact that the sample is principally characterized by small enterprises. The average value of 33.4 hectares is also influenced by 3 firms whose vineyard surface is above 100 hectares.

Most of these firms produces and processes grapes, and sell bottled wine on their own. They principally sell their products in the same region of production (Emilia-Romagna), while the most used distribution channel is HO.RE.CA (HOtel, REstaurant and CAtering), followed by direct sale to consumers. Finally, it results that the most produced wine is the red one, followed by white and at a great distance, by sparkling wine and rosè. It is crucial to underline that most of the wine produced and sold is PDO or PGI branded.

Table 1. Sample characteristics.

Variable	Mean	Standard Deviation	Min	Max
Year of establishment			1933	2020
Number of permanent employees	14	26	0	250
Vineyard surface	33.40	59.03	2.5	250
Wine production (litres; 2019)	119,212	252,714	180	1.2 Mln
Firm's activities (1=0%; 2= 0-10%; 3= 10-80%; 4= 80-100%)				
Grape production	3.88	0.33	3	4
Wine bottling	3.61	0.98	1	4
Sales	3.88	0.43	2	4
Production of wine (1= 0%; 2= 0-10%; 3= 10-25%; 4= 25-50%; 5= 50-75%; 6= 75-100%)				
% of transformation of own grapes	5.84	0.55	4	6
Red wine	5.00	0.80	4	6
White wine	3.15	0.97	1	5
Rosè wine	1.60	0.58	1	3
Sparkling wine	1.63	0.71	1	3
Assets (€; 2019) (1= < 400K; 2= 400K-1M; 3= 1-5M; 4=5-10M; 5= 10-20M; 6= > 20M)	2.04	1.00	1	4
Billing business (€; 2019) (1= <50K; 2= 50-200K; 3= 200K-1M; 4= 1-5M; 5= 5-10M; 6= >20M)	2.38	0.87	1	4
Market sales (1=0%; 2= 0-10%; 3= 10-25%; 4= 25-50%; 5= 50-75%; 6= 75-100%)				
In the same region	4.96	1.08	2	6
Abroad	2.80	1.41	1	6
Directly to consumers	3.20	1.41	1	6
HO.RE.CA.	4.69	1.32	2	6
PDO/PGI wines	5.20	0.96	3	6

Source: our elaboration from survey data *4.2 Questionnaire and analysis of the independent and dependent variables.*

Table 2. Performance variables – self-evaluation of winery managers with respect to competitors (Likert scale 1 "far below average" to 5 "definitely above average").

Variable	Far below avg. 1	Below avg. 2	On avg. 3	Above avg. 4	Definit. above avg. 5
Sales volume, in €	12%	16%	40%	32%	0%
Growth in sales volume, in €	4%	12%	44%	40%	0%
Market share, % over sales, in €	12%	12%	50%	26%	0%
Growth in market share over sales, in €	12%	8%	54%	26%	0%
Profitability performance. Profit margin	4%	16%	48%	32%	0%
Profitability performance. Return on own capital	4%	20%	64%	12%	0%
Profitability performance. Net profits	4%	32%	48%	16%	0%

Source: our elaboration from survey data.

Although the sample is not so heterogeneous in terms of firm's dimension, it is true that branches of research focus their attention only on micro and small companies, which are a typical trait of Italian agro-industrial sector [8, 9, 17].

The first section of the questionnaire aims to detect which are the most important resources and capabilities owned by Consorzio Vini di Romagna wineries. These resources and capabilities have been classified into different categories, i.e. technology, innovation, quality, information and cooperation, human capital, management, and marketing. In the second part of the questionnaire, the strategic orientation of Romagna wineries has been investigated. It is expressed by the grade of adoption of twenty-two competitive methods [32], as confirmed in bibliography [10, 25, 36, 38]. This model was developed by Dess and Davis [7] and aims to expand the generic strategies of Porter [28] facilitating their characterization and declination in empirical business studies [10]. Therefore, these twenty-two competitive methods reveal the competitive approach of wineries between Porter's generic strategies (cost leadership or differentiation) [7]. Although there is a direct connection with Porter's generic strategies, this further characterization is distinct and has been useful to verify the effects that different strategic behaviours have on performance [32].

In this part of the questionnaire, wineries have been also asked about their market positioning with respect to competitors and their profitability. Profitability and market positioning are used to determine business performance [36] as they refer respectively to internal and external performance of companies. Therefore, the objective is to uncover if wineries are competitive, by investigating on performance. Finally, the last branch of questions relates to general information of companies, such as their dimension, partnership, financing, the types of wine produced, and the distribution channels used.

Table 2 presents the performance of the wineries. In particular, it has been asked to managers to position their firms in the market by taking into consideration the average level of performance of the competitors. Therefore, the evaluation is subjective but, considering the geographical focus of this study, it is real to imagine that competitors of wineries are located in the same Romagna territory. The logical process of this analysis is based on the cause-effect relationship that exists between resources and strategic orientation from one side, and profitability and performance on the other one [36]. This measurement analysis follows the research done by Ferrer Lorenzo et al. [10].

Performance is composed by four items that are referred to the external performance (sales volume, growth in sales volume, market share, growth in market share), and three the internal (profit margin, return on own capital, net profits). It emerges that wineries' performance is acceptable, as managers consider it on average compared to competitors. Our results are in line with the research done by Ferrer Lorenzo et al. [10] and Villanueva and Ferrer Lorenzo [38]. In particular, the internal performance indicators of Romagna wineries are comparable to that of Spanish firms [10]; on the contrary, external performance values are similar to US outcomes [38].

Table 3 summarizes managerial and technological capabilities owned by Romagna wineries. It emerges that firms' managerial capabilities are better than technological one. In detail, the interviewed Romagna wineries are characterized by excellent work climate, as 60% of the companies consider themselves stronger or much stronger than competitors. Another interesting outcome regarding managerial capabilities is represented by coor-

Table 3. Managerial and technological capabilities – self-evaluation of winery managers with respect to competitors (Likert scale 1 "much weaker than competitors" to 5 "much stronger than competitors").

Variable	Much weaker 1	Weaker 2	Equal 3	Stronger 4	Much stronger 5
Managerial capabilities					
Managerial competencies	0%	20%	48%	20%	12%
Know-how and skills of employees	0%	16%	56%	24%	4%
Work climate	0%	0%	40%	48%	12%
Efficient organizational structure	0%	12%	60%	28%	0%
Coordination	0%	8%	52%	40%	0%
Strategic planning	0%	8%	64%	24%	4%
Ability to attract creative employees	8%	12%	60%	16%	4%
Technological capabilities					
Technological capabilities and equipment	8%	28%	32%	24%	8%
Efficiency and effectiveness of the production department	4%	23%	38%	35%	0%
Economies of scale	8%	40%	36%	16%	0%
Technical experience	4%	8%	42%	38%	8%

Source: our elaboration from survey data.

dination, while for technological capabilities we see that technical experience stands out. These results confirm the importance of human capital resources in positioning in the market, as some studies reported in the literature have pointed out [5, 23, 27].

Table 4 instead presents the grade of adoption of the twenty-two competitive methods of Robinson and Pearce [32]. These methods have been classified into four patterns of strategic behaviour, i.e. efficiency, service, product innovation and development, brand/channel influence. From the data gathered, we can underline high adoptions of building brand identification, developing and refining existing products, concerted effort to build reputation within the industry and extensive customer service capabilities. On the contrary, the investigated Romagna wineries do not place often products in lower-priced market segments. This is supported by % values also noticed for pricing below competitors.

4.3 Multiple linear regression model

In order to verify the hypotheses, variables have been grouped into two categories: the independent, which are resources, capabilities and strategic orientation of firms, and the dependent variable represented by the performance. We have decided to apply a multiple linear regression model, that permits to distinguish the different contributions of a set of independent variables in the explanation of the dependent one. This is interesting since we can obtain a more specific and detailed result compared to the univariate regression [21]. In particular, multiple regressions for hypotheses A and B have been performed. The multiple linear regression [21] is expressed through the following formula:

$$Yj = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots. + \beta_n X_n + \varepsilon_i \quad (1)$$

where the dependent variable, Yj, is the performance value for the company "j", measured as the average of the seven items contemplated in the answers related to performance (see Table 2); β_0 is the constant; β_1, β_2, …. β_n the coefficients of the independent variables; X_1, X_2, …. X_n the independent variables; and ε_i is the error or the residual of the proposed model.

Moreover, with the aim to deepen our analysis, we have used a logistic regression method. On the other hand, we have applied ANOVA tests to verify hypotheses C and D.

4.3.1 Regression for managerial capabilities

To test the hypothesis A (i.e., *In Romagna wineries, the managerial capabilities owned by the firm are positively related to the firm's performance*), the regression formula includes as independent variables (X) the managerial capabilities of Consorzio Vini di Romagna wineries. This group is composed by seven items, i.e. managerial competencies, know-how and skills of employees, work climate, efficient organizational structure, coordination, strategic planning, and ability to attract creative employees (see Table 3). Therefore, the aim is to uncover which of these items influence wineries' performance the most.

Table 4. Twenty-two strategy questions (=competitive methods) to capture Robinson and Pearce variables (Likert scale 1 "not used" to 5 "the principal strategy").

Competitive methods	1	2	3	4	5
Pricing below competitors	34%	31%	31%	4%	0%
New product development	0%	15%	46%	35%	4%
Broad product range	15%	19%	39%	27%	0%
Extensive customer service capabilities	0%	4%	35%	50%	11%
Specific efforts to insure a pool of highly trained experienced personnel	8%	8%	50%	23%	11%
Extremely strict product quality control procedures	0%	4%	31%	50%	15%
Continuing, overriding concern for lowest cost per unit	8%	19%	50%	19%	4%
Maintaining high inventory levels (disregard the derivative of the aging of the product)	8%	19%	46%	27%	0%
Narrow, limited range of products	20%	36%	28%	16%	0%
Building brand identification	0%	4%	27%	38%	31%
Developing and refining existing products	0%	4%	19%	54%	23%
Strong influence over distribution channels	8%	35%	46%	11%	0%
Major effort to insure availability of raw materials	15%	35%	31%	15%	4%
Major expenditure on production process-oriented R&D	20%	28%	28%	12%	12%
Only serve specific geographic markets	19%	27%	38%	8%	8%
Promotion & advertising expenditures above the industry average	11%	31%	43%	11%	4%
Emphasis on the manufacturing of specialty products	11%	16%	27%	27%	19%
Concerted effort to build reputation within industry	0%	4%	27%	27%	42%
Innovation in manufacturing process	8%	19%	38%	27%	8%
Products in higher-priced market segments	0%	19%	46%	27%	8%
Products in lower-priced market segments	42%	31%	27%	0%	0%
Innovation in marketing techniques and methods	8%	23%	50%	15%	4%

Source: our elaboration from survey data.

From the regression output (2) it has been found that:

$$Y_j = 1.10 - 0.06\ X_1 + 0.42\ X_2 + 0.04\ X_3 + 0.08\ X_4 + 0.07\ X_5 + 0.01\ X_6 + X_7 + \varepsilon_i \quad (2)$$

It could be noted that X_2 is the only independent variable that has a crucial influence on the explanation of performance. Other independent variables are not statistically significant. Hence, we can conclude that *know-how and skills of employees* influence positively the performance of Romagna wineries. The model is invalidated by $R^2 = 0.27$ and $F = 0.52$ Therefore, the independent variables taken together are not good predictors of performance. Hence, we can assert that hypothesis A is rejected, as managerial capabilities are not positively related to performance in this case. However, it is worthwhile to underline that the rejection of this hypothesis does not imply that managerial capabilities are not important in the definition of performance. The regression has told us that they are not significant in predicting the variation of performance, but they are certainly crucial to obtain a result in the market. This is confirmed by data reported in Table 3, where wineries of the Consorzio appear to hold optimal levels of managerial capabilities, as mean values are above 3.

4.3.2 Regression for technological capabilities

To test hypothesis (B), in the regression formula the independent variables (X) are the technological capabilities owned by Consorzio Vini di Romagna wineries (i.e. *In Romagna wineries, the technological capabilities owned by the firm are positively related to the firm's performance*). These capabilities are composed of four items, i.e. technological capabilities and equipment, efficiency and effectiveness of the production division, economies of scale, and technical experience (see Table 3). Hence, the objective is to uncover which of these items influence wineries' performance the most.

In this case, the regression line assumes the following formula (3):

Table 5. Regression results for managerial capabilities.

Variables	Model			
	Coefficients	stat t	standard error	sign.
(X_1) managerial competencies	-0.06	-0.25	0.23	
(X_2) know-how and skills of employees	0.42	1.89	0.22	*
(X_3) work climate	0.04	0.19	0.24	
(X_4) efficient organizational structure	0.08	0.22	0.35	
(X_5) coordination	0.07	0.22	0.31	
(X_6) strategic planning	0.01	0.03	0.41	
(X_7) ability to attract creative employees	0.00	0.01	0.22	
R^2		0.27		
adjusted R^2		-0.03		
F		0.91		
sign. F		0.52		

Significance: *p≤ 0.10; **p≤ 0.05; ***p≤ 0.001.
Source: our elaboration from survey data.

Table 6. Regression results for technological capabilities.

Variables	Model			
	Coefficients	stat t	standard error	sign.
(X_1) technological capabilities and equipment	0.07	0.43	0.15	
(X_2) efficiency and effectiveness of the production department	0.42	1.88	0.23	*
(X_3) economies of scale	-0.02	-0.12	0.16	
(X_4) technical experience	0.08	0.50	0.16	
R^2		0.37		
adjusted R^2		0.24		
F		2.94		
sign. F		**		

Significance: *p≤ 0.10; **p≤ 0.05; ***p≤ 0.001.
Source: our elaboration from survey data.

$$Y_j = 1.18 + 0.07\ X_1 + 0.42\ X_2 - 0.02\ X_3 + 0.08\ X_4 + \varepsilon_i \quad (3)$$

It is worth noting that the only variable that could exert a positive influence on performance is X_2 (i.e. *efficiency and effectiveness of the production department*). On the other hand, the other three technological capabilities are slightly correlated with the performance of the firms. The value of R^2 is 0.37 and indicates that independent variables, taken together, can be moderately good predictors of the dependent one. Moreover, the model set is significant (**).

Hence, we can conclude that technological capabilities are moderate predictors of performance of Consorzio Vini di Romagna wineries if we consider them all together. Therefore, it is possible to affirm that also hypothesis B is rejected, as it is not completely confirmed that technological capabilities owned by Romagna wineries are positively related to firm's performance.

Using the same multiple linear regression formula, we have tested the relationship between other resources and capabilities of wineries and business performance, finding interesting results for marketing capabilities.

Marketing is composed of four items, i.e. knowledge of the market, control and access to distribution channels, advantageous relationships with distributors, and market served. This regression model is significant (**) and we have calculated a R^2 of 0.53. Moreover, two out of the four independent variables that define marketing are significant predictors of wineries' performance.

Table 7. Marketing capabilities – self-evaluation of winery managers with respect to competitors (Likert scale 1 "much weaker than competitors" to 5 "much stronger than competitors").

Variable	Much weaker 1	Weaker 2	Equal 3	Stronger 4	Much stronger 5
Knowledge of the market	4%	19%	46%	27%	4%
Control and access to distribution channels	8%	31%	42%	19%	0%
Advantageous relationships with distributors	8%	38%	27%	27%	0%
Market served	8%	15%	31%	42%	4%

Source: our elaboration from survey data.

Table 8. Regression results for marketing capabilities.

Variables	Model			
	Coefficients	stat t	standard error	sign.
(X_1) knowledge of the market	0.50	2.22	0.22	**
(X_2) control and access to distribution channels	-0.61	-2.23	0.27	**
(X_3) advantageous relationships with distributors	0.26	1.46	0.18	
(X_4) market served	0.27	2.37	0.11	**
R^2		0.53		
adjusted R^2		0.44		
F		5.69		
sign. F		**		

Significance: *p≤ 0.10; **p≤ 0.05; ***p≤ 0.001.
Source: our elaboration from survey data.

These predictors are X_1 and X_4 as it is demonstrated by both the importance of the coefficients and their significance value. Hence, we can conclude that *knowledge of the market* and *market served* are marketing capabilities owned by surveyed Romagna wineries that are positively related to the firm's performance.

4.4 Test of hypotheses C and D

The study goes on with the objective of verifying hypotheses C and D (i.e. C: *the wineries tending towards a cost leadership strategy will have a better performance*; D: *the wineries tending towards a differentiation strategy will have a better performance*). In order to test them, we have considered the only firms that perform better than their competitors, trying to find if there is a connection with the adoption of Porter's generic strategies. The sample of individual wineries has been reduced to 10 firms, which present an average of performance items that is above 3. Regarding Porter's generic strategies, we have considered some of the twenty-two competitive methods of Robinson and Pearce [32], the only ones that are undoubted manifestations of a cost leadership strategy or differentiation strategy [10]. Table 9 presents the mean and standard deviation values of the responses of the 10 selected wineries.

Analysing the results, it can be stated that wineries that perform better than their competitors follow a differentiation strategy orientation. In fact, these companies mainly adopt competitive methods related to differentiation strategy. In particular, these wineries put a lot of efforts into developing and refining existing products (mean of 4.10 on a scale from 1 to 5). On the other hand, firms that obtain a superior performance with respect to their competitors do not follow a cost leadership strategy. This statement is expressed by mean values that are at most 2.80. Therefore, we can confirm hypothesis D and reject hypothesis C, as wineries that perform better than their competitors tend towards a differentiation strategy, while do not follow a cost leadership strategy.

Moreover, we want to analyse the relationship between Robinson and Pearce [32] strategies, (i.e. efficiency, service, product innovation and development, brand/channel influence), and performance. Table 10 presents competitive methods associated to strategic patterns.

Table 9. Grade of adoption of competitive methods related to Porter's strategies (result for wineries that perform better than their competitors).

Competitive methods	Mean	Standard deviation	Min.	Max.
Cost leadership				
Continuing, overriding concern for lowest cost per unit	2.80	0.92	1	4
Pricing below competitors	2.10	0.88	1	3
Products in lower-priced market segments	2.20	0.92	1	3
Differentiation				
New product development	3.50	0.71	2	4
Developing and refining existing products	4.10	0.74	3	5
Emphasis on the manufacturing of specialty products	3.20	1.32	1	5
Products in higher-priced market segments	3.40	0.84	2	5

Source: our elaboration from survey data.

Table 10. Robinson and Pearce [32] strategies. Pattern of classification.

Pattern of classification	Competitive methods associated with each pattern of strategic behaviour
Efficiency	-Seek to ensure trained personnel -Pursue strict quality control -Emphasize the lowest cost per unit -Push innovation in manufacturing processes -Innovation in marketing techniques
Service	-Extensive customer service -Build reputation in the industry -Serve high-priced market segments
Product innovation and development	-New product development -Develop and refine existing products -Emphasize specialty products -Process-oriented R&D
Brand/channel influence	-Build brand identification -Influence channels of distribution -New product development -Innovation in marketing techniques

In order to do so, we have considered the mean values of responses given by Romagna wineries about the grade of adoption of competitive methods that characterize each of the four strategies. In this case, we have divided the sample into two categories, respectively sample A and sample B. Sample A is composed by the eighteen wineries that perform better than the average performance registered for Romagna wineries, while sample B includes the seven wineries that perform worse than this average value. In addition, we have performed ANOVA tests to examine the significance of the difference between the means of sample A and B, with $\alpha = 0.05$. The results found are reported in Table 11.

A first analysis reveals that firms which belong to sample A adopt the selected Robinson and Pearce methods with a higher intensity than companies of sample B. In particular, registered means for *efficiency* pattern are 3.22 for sample A and 2.80 for sample B; while for *service* they are respectively 3.76 and 3.38; for *product development and innovation* respectively 3.36 and 3.03; for *brand/channel influence* 3.32 and 2.78. More in detail, each of the patterns is defined by competitive methods as we have seen [32]. The most adopted competitive methods of firms of the sample A are *build reputation in industry* and *build brand identification* with an average of 4.11; *and developing and refining existing products* with 4.06.

However, the difference between means of sample A and B is higher for *new product development* (0.79) and *build brand identification* (0.68). Moreover, these differences are the only ones to be statistically significant.

Hence, we can conclude that these two competitive methods are the most crucial detectors of winning strategic orientations of the interviewed Romagna wineries. In general terms, the pattern *brand/channel influence* is the most determinant and significant, because these two methods are included in this pattern. Therefore, we can deduce that wineries that follow a brand/channel influence strategy orientation will have a better performance than their competitors. Moreover, this analysis confirms the conclusions achieved by Dess and Davis [7], as firms that follow a strategic orientation will obtain greater results than firms that are "stuck in the middle", i.e. firms with no clear strategic intentions. This is verified

Table 11. Analysis of the relationships between Robinson and Pearce strategic patterns and performance of Consorzio Vini di Romagna wineries.

	Sample A		Sample B		Difference A/B		
Competitive methods and strategic patterns	Mean	Variance	Mean	Variance	Sign.		F
Efficiency	3.22		2.80				
Seek to ensure trained personnel	3.44	1.20	2.71	0.57	0.12		2.59
Pursue strict quality control	3.89	0.69	3.43	0.29	0.19		1.82
Emphasize the lowest cost per unit	3.11	0.81	2.43	0.95	0.11		2.77
Push innovation in manufacturing processes	2.77	1.59	2.71	1.57	0.91		0.01
Innovation in marketing techniques	2.89	1.05	2.71	0.57	0.69		0.17
Service	3.76		3.38				
Extensive customer service	3.83	0.62	3.43	0.29	0.22		1.55
Build reputation in the industry	4.11	1.05	3.86	0.48	0.55		0.36
Serve high-priced market segments	3.33	0.71	2.86	0.81	0.22		1.56
Product innovation and development	3.36		3.03				
New product development	3.50	0.62	2.71	0.24	0.02	**	6.00
Develop and refine existing products	4.06	0.64	3.57	0.29	0.16		2.15
Emphasize specialty products	3.22	1.59	3.14	1.81	0.89		0.02
Process oriented R&D	2.67	1.76	2.71	1.57	0.94		0.01
Brand/channel influence	3.32		2.78				
Build brand identification	4.11	0.81	3.43	0.29	0.07	*	3.49
Influence channels of distribution	2.78	0.65	2.29	0.57	0.18		1.93
New product development	3.50	0.62	2.71	0.24	0.02	**	6.00
Innovation in marketing techniques	2.89	1.05	2.71	0.57	0.69		0.17

Significance: *p≤ 0.10; **p≤ 0.05; ***p≤ 0.001.
Source: our elaboration from survey data.

since firms of sample A adopt competitive methods with a higher intensity than firms of sample B.

5. DISCUSSION

In this exploratory study we have demonstrated that the interviewed wineries in Romagna which perform better than their competitors do not follow a cost leadership strategy. On the other hand, they follow a differentiation strategy. Both these results are in tune with the findings obtained by Ferrer Lorenzo et al. [10] and by Villanueva and Ferrer Lorenzo [38]. The connection between differentiation strategy and performance confirms also the reasonings of Galletto and Barisan [12], which has stated that differentiation is crucial to reach visibility and success in highly competitive markets, such as wine. Moreover, we have found that, among the four strategic patterns defined by Robinson and Pearce [32], the one that exerts a stronger impact on the achievement of a better performance is brand/channel influence. This result is in line with the research of Ferrer Lorenzo et al. [10]. These alignments can be explained since wineries located in both territories (Spain and Romagna) put a considerable effort into marketing techniques, aiming to differentiate and offer a qualitative product to the customers, and trying to build a reputation in the market. We have also found a connection with the study of Di Toma et al. [8], who underlined the importance of building a reputation as a critical factor for the success of small and family businesses.

On the other hand, it has been demonstrated the absence of positive relationships between managerial and technological capabilities and firm performance. Nonetheless, it is crucial to say that managerial capabilities are fundamental for the surveyed Romagna wineries, even though they are not good predictors of performance. In fact, these firms own on average high levels of managerial capabilities, confirming that they are crucial to compete in the market. Regarding technological capabilities, we have found that they are only partial predictors of performance. In general terms, results regarding both managerial and technological capabilities confirm the analysis of Kelliher and Reinl [17], which have asserted that micro-firms are characterized by "resource poverty", especially experiencing financial constraints.

The analyses presented in this paper are again in line with the previously cited study of Duarte Alonso and Bressan [9], who concluded that the small size of the business is perceived as a crucial weakness by interviewed managers.

However, another finding of this research concerns the relevance of marketing capabilities. In particular, *knowledge of the market* and *market served* may have statistically significant relationships with performance. Moreover, marketing capabilities taken together are good predictors of the dependent variable. Therefore, our findings confirm the conclusions of Mu [20], who stated that firms with a superior inside-out marketing capability achieve higher levels of performance, especially regarding new product development. This ultimate outcome is linked with the relationship that has been found between brand/channel influence strategy and performance, as this strategic orientation can be implemented basing on optimal marketing capabilities. In particular, the concomitant importance of marketing capabilities, differentiation and brand/channel influence strategy suggests us that Romagna wine industry is very competitive, and firms are putting energies and resources to stand out in the market. This outcome is corroborated by the fact that the surveyed firms put a considerable emphasis into building a brand reputation and concentrate on developing and refining existing products (see Table 4).

6. CONCLUSIONS

This study investigates the drivers that could explain the competitive advantage of wineries located in Romagna territory. The assumption at its basis is that the competitive advantage is translated into a better firm performance [1, 34]. The final aim of this research was to examine which could be the pivotal factors that affect the performance of Romagna wineries. In order to do so, two different and complementary theoretical frameworks have been considered, i.e. Porter's Theory of Competitive Advantage [28, 29] and Barney's Resource-based Theory [2]. It has been analysed which are the categories of resources and capabilities that could be positively related to firm performance. Moreover, we have examined which are the competitive methods and the strategic orientations adopted by the most successful wineries in Romagna. The tool that has allowed us to collect the necessary data is the survey through a questionnaire. Thanks to the results of the data analysis, it is possible to propose some interesting reflections. First of all, considering the information collected from the respondents, we have rejected the hypothesis that, in this sample, the best-performing companies are those who follow a cost leadership strategy, while it has been verified that they follow a differentiation strategy. Moreover, among Robinson and Pearce [32] strategies, brand/channel influence stands out, as most successful wineries follow this orientation. On the other hand, we have rejected both hypotheses set on resources and capabilities, as both managerial and technological capabilities owned by the surveyed firms are not positively related to performance. However, we have found positive influences of some of these capabilities taken singularly, and it has been uncovered that marketing capabilities can impact on final performance.

6.1 Implications

The survey results suggest that Romagna wine industry is very competitive. It is principally composed by small enterprises and, on the basis of this study, they appear to want to differentiate in the market. In particular, the aim of the respondents is to develop peculiar products and build a positive brand reputation, concentrating on marketing aspects, and putting the customers' desires at the centre of their strategic behaviour. These firms also target their products mainly to high-priced market segments. Therefore, we have found that these Romagna wineries adopt a more outside-in approach in the creation of their strategy and identity. This does not imply that resources and capabilities are not important for firms; on the contrary, they are crucial to survive in a competitive market, such as the Italian wine industry. This is true, especially for managerial capabilities, which are owned on average at high levels by Romagna wineries. On the other hand, according to the results it appears that technological capabilities are held on lower levels, indicating thus that they could represent a weakness to be healed in order to be more competitive. This reasoning is corroborated since technology evolves with great rapidity in nowadays world and could be an interesting tool to differentiate and perform better than competitors, as some research has pointed out [22,25,33,36].

However, we have verified the importance of marketing capabilities, which are the most related to the external environment considering the bundle of resources that a firm can possess. Therefore, our outcomes indicate that in a similar situation managers should continue to potentiate their marketing capabilities in order to reach a greater performance than the current one.

6.2 Limitations and future research

In conclusion, it is important to underline that the results obtained could have been influenced by the negative effects that the Covid-19 pandemic has had on the global economy, as the survey was administered to firms in the period going from May to August 2020 (when Italy was just shyly emerging from the first total lockdown due to the virus). In particular, one of the most used distribution channels by the Romagna wineries, which is HO.RE.CA., has been strongly limited by this pandemic. The study presents some limitations; the most important one is related to the small size of the sample. Although a good percentage of Consorzio Vini di Romagna wineries replied to the questionnaire, definitive conclusions are difficult to draw. In fact, this is an exploratory research that is not explicative of the representativeness of the entire population of Romagna wineries. Another limitation could be represented by the use of subjective scales in the definition of performance. However, it has been demonstrated that these scales converge with objective ones [35, 39], and they were adopted in various empirical studies [10, 25, 36, 38]. It is also worth noting that the statistical models used have been useful for the analyses done, but they can be strengthened in future developments of the paper. Finally, this research represents the starting point for new studies regarding other wine industries in the Italian territory, in order to make a map of the competitiveness in a country where wine is rooted in the local culture and represents a strategic product in the global market.

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Distribution velocity in wine retailing

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Abstract. Little is known about the relationship between distribution and market share in the wine category. Understanding the influences of product and distribution characteristics at the SKU-level and incorporating them into marketing strategy and planning has important managerial and academic implications. Sales of 3,524 wine SKUs across 4,218 stores in 4 states in the US over one year of observation are analyzed. We use an established distribution velocity model (Reibstein & Farris 1995) to estimate the relationship between distribution and market share. We then use the market share deviations from the expected values and apply a secondary robust regression to investigate possible relationships between various product- and distribution characteristics and those market share deviations. The results show that the distribution velocity in wine retailing is convex and increasing, in line with previous findings for other consumer-packaged goods in the marketing literature. Beyond distribution breadth, we find that overall parent brand performance (above), unit price (above), packaging type (above), country-of-origin, grape variety, sales consistency (above) and store specialization (below) are associated with above or below expected market share of wine SKUs.

Keywords: distribution, velocity, wine, retail, channel, strategy.

1. INTRODUCTION

Despite the recent successes of e-commerce and direct-to-consumer sales in the wine industry, "brick-and-mortar" retail sales of wine are important and growing. This trend can be followed in emerging markets as well as in mature markets like the US, which represents the most important wine market globally by total value and import volume [1,2]. According to Euromonitor [3,4], "brick-and-mortar" wine sales in the US grew by 19.1% to 2,609 million liters in a decade from 2009 to 2019. Over this period e-commerce of wine grew by 272.8% to 116 million liters. Even with this strong growth,

e-commerce still only represents 4,3% of all off-trade sales in 2019. For wine brands to be sold and grow in the market, they need to be made available especially in traditional retail channels where most consumers shop. Retail distribution is one of the most important drivers of a brand's market share [5]. However, decisions aimed at increasing market share usually involve a range of marketing strategies besides increasing distribution breadth (i.e., number of stores). This especially applies to the wine category with its naturally limited and varying production levels. Usually only a few large-scale producers can supply enough volume to reach near full distribution or even grow volume substantially as demand increases.

This highlights the need for wine brands to leverage additional strategies to grow in the market. In this study we investigate the role of distribution velocity in wine retailing by analyzing the relationship between distribution breadth and market share for wine. We delve deeper to specifically examine the influence of product and distribution characteristics on market share over- and underperformance, beyond expected market share based on distribution breadth.

We find that despite the huge fragmentation of wine brands, the typical convex and increasing distribution velocity curve also exists in the wine category. In addition, results show that wine brands overperform when they are available across a variety of different retail channels, as opposed to single-channel distribution. Wine brands also benefit from high in-store presence and sales consistency. However, store specialization in the wine category (more brands on offer) is associated with underperformance (below expected market share), relative to a wine brand's distribution coverage (breadth). This may be related to higher levels of in-store intra-category competition in specialized wine stores. But, individual wine SKUs from strong parent brands have excess market share (overperform), which indicates the power of brand size and halo effects from relatively big parent brands. Also, country-of-origin, the grape variety, the packaging type, and not surprisingly price, can each be associated with market share beyond expected distribution velocity.

The findings have implications for academia, suppliers and retailers. Practical implications are specifically related to product and portfolio management, supply chain management and retailer category management. Beyond that, the findings provide needed benchmarks – knowing what to expect – which add comparability and predictability for wine brand managers and retailers.

2. LITERATURE REVIEW & RESEARCH QUESTIONS

Research into the relationship between distribution and market share (distribution velocity) identifies a convex and increasing curve pattern that consistently appears across categories and markets [6,7,8,9,10,11]. This relationship is bi-causal. Higher distribution will increase brands' exposure in the market, growing market share. On the other hand, brands which create consumer demand will be attractive for retailers to stock and therefore may result in increased distribution. This interdependency is explained by the push-and-pull dynamics in the market [6]. Marketing-mix inputs influence consumer behavior (pull) as well as trade behavior (push), both affecting market share. Changes in market share further induce pull effects perceived by trade, which also affects trade behavior.

Previous research on the relationship shows that even at relatively low distribution levels, brands differ in their market share; some are high- or overperformers (above the curve) and others are market share "laggards" or underperformers (below the curve), given their distribution. Beyond distribution breadth, theory offers a complex and incomplete picture of possible causes for over- and underperforming brands at SKU-level [7][1]. This is also acknowledged by Wilbur and Farris [11] who express the need to continue studying the causes and consequences of best- versus worst-performing SKUs. A brand's market performance depends on many possible factors, partly the product offering (e.g., brand, price, packaging) and the nature of its distribution.

Another dimension of distribution which may be related to above or below expected market performance is distribution depth [12]. While distribution breadth entails a brand's presence across outlets, distribution depth involves a more qualitative dimension, for example the length of a brand line offered in-store, the in-store prominence or sales support. Both concepts may influence market performance and are therefore important factors for marketing management. Studies suggest that some product-related characteristics of SKUs may be associated with their position above or below the distribution velocity curve (e.g., [13]). In this context, examining the distribution velocity pattern of the wine category, and empirically investigating the role of individual SKUs' product and distribution-related characteristics in above- or below expected market performance, will advance knowledge in this area.

In this study, we first explore whether the convex

[1] This research was a broader examination by some of the same authors across multiple categories. It was not investigating a specific category as done in this study by utilising additional category-specific variables.

distribution exists in the wine category. The examination is important for a number of reasons. Wine is one of the most fragmented food and beverage categories, where even the largest SKUs do not enjoy market shares over 5% (Table 2). This characteristic could impact the curve pattern of distribution velocity. On the other hand, even in the highly fragmented wine environment, a few big, popular brands (whose SKUs are likely positioned at the right side of the curve) do have the volume capacity to distribute to many stores (high distribution coverage) but also experience high consumer demand (pull). In combination with marketing investments (push), as well as bargaining power for better price negotiations, those market-leading brands ultimately could generate better sales per point of distribution than their competitors. So, compared with the rest of the market this may cause the distribution velocity curve to be convex rather than linear. This brings us to the first question:

RQ1: Does the convex distribution velocity curve exist in the wine category?

2.1 Product characteristics

Prior literature suggests that various product characteristics may be associated with above or below expected market performance of consumer-packaged goods, regardless of how widely these are distributed. For example, Hirche et al. [14] show that product price, brand (private label v. national brand) and packaging size are associated with market share deviations of SKUs from the distribution velocity curve. Based on their findings we would expect wines with higher unit prices, private label wines, and wines with bigger packaging sizes to be overperforming, which means they have excess market share based on what distribution velocity would estimate.

The type of packaging may affect consumer choice and market share outcomes in the wine category [15]. It is possible that packaging types with bigger packaging sizes, such as bag-in-box, are listed and sold in fewer large stores but with high sales frequencies, potentially making them overperforming SKUs.

When reviewing brand equity research, we find strong indications that the reputation of a parent brand influences its sub-brands [16]. Also, the variety of a brand's offering has an effect on consumer choice [17]. Both, the strength of a parent brand as well as the brand's number of different variants may result in market share above expectations.

Focusing on the wine category, it is a widely accepted finding that country-of-origin (COO) is an important cue for consumers when choosing wine [18,19]. With regard to grape varieties, Jarvis, Rungie & Lockshin [20] highlight that some consumers exercise variety seeking, however, some grape varieties enjoy excess loyalty in a market, which may also result in overperforming wine SKUs with above average market share. Literature also suggests that wines labelled "organic" enjoy increased preference over conventional wines, including a consumer acceptance of price premiums for organic-labelled wine [21]. All these concepts could be related to sales above or below expected market share; in other words, over- or underperformance of predicted distribution velocity.

2.2 Distribution characteristics

Expanding a brand's sales across multiple retail chains and channels is an effective strategy to grow a brand's market share [22]. However, over-distribution may cause high retailer competition and cannibalization effects, which put pressure on the price (margin) and may result in lower distribution depth [12]. High distribution exposes SKUs to more local competition across retail chains and channels, which ultimately affects store performance and market share [23]. We therefore expect wine SKUs with increasing numbers of channels and chains to show market share values below distribution velocity estimates (underperformance).

Another important aspect of retail distribution is store size which typically affects retailers' stocking decision-making due to limited shelf space and budget. Small stores with less available shelf space have a small assortment of SKUs and change this assortment more frequently, likely in response to consumer preference over time [24]. Larger stores may benefit from logistic efficiencies and experience better turnover and sales consistency compared to small stores. The consistency of sales may also depend on out-of-stock (OOS) situations, which are inherently linked to supply chain and inventory management problems [25]. Therefore, one could argue that wine SKUs with a higher sales consistency, and hence higher in-store presence, would experience above expected market share (overperformance), regardless of how widely they are distributed.

It appears that consumers pay no attention to the size of assortments, as long as the perceived attractiveness of the options is high [26]. But, Oppewal and Koelemeijer [27] have found that adding items to an assortment is evaluated more positively by consumers, regardless of attribute variety or if the assortment contains individually preferred alternatives. Also Tan and Cadeaux [28] confirm a positive relationship between category sales and

assortment size. However, a broader assortment of a category in-store also increases category competition. While a broader category assortment may increase category sales overall, it could diminish returns per SKU.

We test the above-mentioned concepts of product and distribution characteristics in this study to see if they are indeed associated with the over- or underperformance of individual wine SKUs, i.e. having above or below expected market share relative to distribution velocity estimates. We investigate the following distribution characteristics of wine SKUs: the number of channels and retail chains, store sizes, sales consistency, and specialization in the category. The product related variables tested involve: the price, parent brand performance, the number of different variants and packaging sizes of the parent brand, the packaging type, country-of-origin, grape variety, and organic label or not.

Consequently, the two final research questions are as follows:

RQ2: What product characteristics are associated with individual wine SKUs having above or below expected market share based on the distribution velocity curve?

RQ3: What distribution characteristics are associated with individual wine SKUs having above or below expected market share based on the distribution velocity curve?

3. METHODS

We analyze the sales of 3,524 stock-keeping units (SKUs) of imported dry table wine[2] across 4,218 stores in four US states for the year 2014. As in a previous study on distribution velocity [7], we sample the stores from California, New York, Texas, and Wisconsin, which have a relatively high store coverage and are geographically well dispersed. The study employs weekly retail store scanner data provided by Nielsen©.[3] Rigorous data cleaning, deduplication, transformation and aggregation prepared the data for statistical analysis. The metrics for distribution and market share are calculated as weekly averages for the year. Market share is based on sales value, and distribution is reflected as All-Commodities-Volume (ACV)[4], a metric that counts and weights each store by its total revenue in which at least one item of the SKU was sold. We then apply the distribution velocity model based on Reibstein & Farris [9] to estimate the relationship between distribution and market share of the sampled wine SKUs, as shown in equation (1).

$$MS_i = \frac{\beta_0 * ACV_i{}^{\beta_1}}{(100 - ACV_i)^{\beta_2}}$$

$$\text{where } MS,\ ACV \in [0,100];\ \beta_0,\ \beta_1,\ \beta_2 \in \mathbb{R}_+ \tag{1}$$

The market share (MS) for every i^{th} SKU equals the parameter β_0 multiplied by the SKU's weighted distribution (ACV) raised to the power of parameter β_1, divided by the subtraction of 100 minus weighted distribution (ACV) raised to the power of parameter β_2. Market share and weighted distribution are restricted real numbers between 0 and 100, and all parameters are non-negative real numbers. The resulting market share estimation is the foundation for the secondary regression analysis: the market share deviations from the modelled distribution velocity estimates. The dependent variable for the secondary regression is the deviation between predicted and observed market share (market share deviation MSD) as shown in (2).

$$MSD_i = \hat{u}_i = MS_i - \frac{\hat{\beta}_0 ACV_i^{\hat{\beta}_1}}{(100 - ACV_i)^{\hat{\beta}_2}} \tag{2}$$

The secondary regression tests for associations between the SKUs' product and distribution characteristics, and the market share deviation from the average market share predicted by the distribution velocity model. All variables can be found in Table 3. Independent variables with ordered levels (e.g., low to high) are based on quartiles of the original metric variable. The regression equation (3) states:

$$\begin{aligned} MSD_i = {} & \beta_0 + \beta_1(Private\ Label)_{1i} + \beta_{2\text{-}4}(Unit\ Price\ Level)_{2\text{-}4i} + \beta_{5\text{-}6}(Private\ Label \times Unit\ Price\ Level)_{5\text{-}6i} \\ & + \beta_7(Brand\ Performance)_{7i} + \beta_8(Variants\ of\ Brand)_{8i} + \beta_9(Pack\ Sizes\ of\ Brand)_{9i} \\ & + \beta_{10\text{-}12}(Packaging\ Type)_{10\text{-}12i} + \beta_{13}(Organic)_{13i} \\ & + \beta_{14\text{-}22}(COO)_{14\text{-}22i} + \beta_{23\text{-}31}(Grape\ Variety)_{23\text{-}31i} + \beta_{32}(Channels)_{32i} + \beta_{33}(Chains)_{33i} \\ & + \beta_{34\text{-}36}(Share\ Store\ Sizes)_{34\text{-}36i} + \beta_{37\text{-}40}(Sales\ Consistency\ by\ Store\ Size)_{37\text{-}40i} \\ & + \beta_{41\text{-}44}(Specialisation\ by\ Store\ Size)_{41\text{-}44i} + u_i \end{aligned} \tag{3}$$

[2] We excluded domestic table wine so that SKUs remain comparable in the category with regard to the investigated product- and distribution characteristics.

[3] Researcher(s)' own analyses calculated (or derived) based in part on data from Nielsen Consumer LLC and marketing databases provided through the NielsenIQ Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the NielsenIQ data are those of the researcher(s) and do not reflect the views of NielsenIQ. NielsenIQ is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

[4] For the ACV-weighted distribution metric in this study, we limit the universe of stores to all sampled stores that have sold any wine SKUs in the year of investigation.

Counteracting a non-constant variance of the error term, a robust regression is employed that involves a robust error term [29].

4. RESULTS

The dominant channel for retail sales of imported dry table wine in this study are food stores (i.e., food retailers, supermarkets) followed by mass merchandisers, drug stores and liquor stores (see Table 1).

Table 2 presents some descriptive statistics of the imported wine sample by country of origin. The country that offers the most individual wines (SKUs) is Italy, followed by France and Australia. Chile and Australia have the highest average brand range in the market, with 4.2 and 3.8 SKUs per brand respectively. The overall share of private label brands, brands that are owned and exclusively sold by individual retail chains, is very low with 1.8% of all SKUs. South Africa, New Zealand and Chile have the highest shares of wines with some form of "organic" label. Due to the very high number of wine brands offered in the market, the maximum market share of the best performing SKU is 3.1%, a 750 ml bottle of Pinot Grigio from Italy. In total, less than 25 of all wines have a market share above 1%, illustrating the very high degree of fragmentation in the wine market.

The non-linear robust regression of distribution velocity results in an R-squared value of 0.767 at the 99% confidence level. With reference to research question RQ1 (Does the convex distribution velocity curve exist in the wine category?), Figure 1 demonstrates the convex and increasing relationship between distribution and market share for wine. The vast majority of wine SKUs is bundled at the lower ends of the scales. The graph also shows how individual data points deviate from the model estimate. These deviations are of interest in the secondary analysis, testing possible associations of product- and distribution characteristics with those market share deviations. The results of the secondary robust regression are presented in Table 3.

Table 1. Number of stores and wine sales share by channel.

	Stores Count	Stores %	Sales of imported wine (% of $)
Food	1941	46.0	88.2
Drug	1719	40.8	4.7
Mass Merchandise	510	12.1	6.6
Liquor	48	1.1	0.6
Total	4218	100.0	100.0

Modelling the market share deviation across 3,524 wine SKUs resulted in a statistically significant regression ($F(44, 3479) = 2.670$; Prob. < 0.01; R-squared = 0.094; Root MSE = 0.073). The results provide some indications of relevant associations between SKUs' product and distribution characteristics and the over- or underperformance of wine SKUs from the distribution velocity curve. It is important to remember that the associations discussed go beyond distribution breadth, i.e. disregarding how widely a wine SKU is distributed. Some wine SKUs appear above the curve (overperforming and under-distributed), and others below the curve (underperforming and over-distributed).

The results answering research question RQ2 show that the deviation of wine SKUs from the distribution velocity curve are associated with the following product-

Table 2. Sample statistics for imported dry table wine.

Country of Origin	SKUs		Brands Count	SKUs per Brand Average Count	Private Label SKUs Share (%)	Labelled Organic Share (%)	Max Market Share of SKU % of $ s	Max Distribution of SKUs % ACV	Median Unit Price $US/Litre
	Count	Share (%)							
Italy	866	24.6	396	2.2	1.5	1.1	3.1	61.3	13.63
France	541	15.4	326	1.7	1.3	1.3	0.6	25.5	17.41
Australia	469	13.3	123	3.8	2.8	0.0	2.6	75.5	10.46
Argentina	435	12.3	183	2.4	2.3	2.1	2.2	68.6	12.99
Chile	402	11.4	95	4.2	1.7	3.0	0.7	37.8	11.43
Spain	294	8.3	207	1.4	2.0	1.7	1.1	46.5	14.23
Germany	198	5.6	92	2.2	2.0	0.0	0.4	30.2	12.61
New Zealand	116	3.3	76	1.5	0.9	3.4	2.6	67.6	16.38
South Africa	95	2.7	46	2.1	2.1	5.3	0.0	2.4	12.65
Other	108	3.1	77	1.4	0.0	0.0	0.0	5.1	14.01
Total Sample	3524	100.0	1621	2.2	1.8	1.4	3.1	75.5	13.39

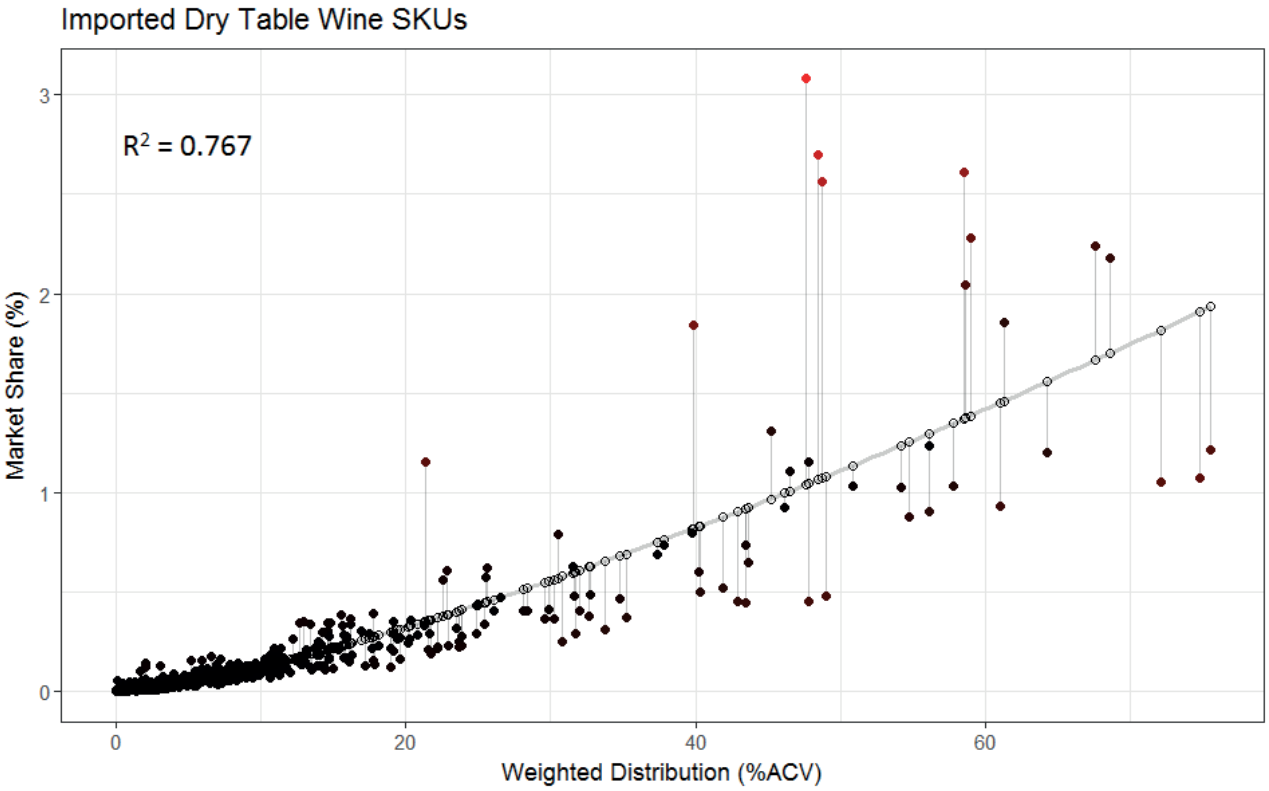

Figure 1. Distribution velocity curve. We validate that the model curve is monotonic increasing and fully convex, i.e. does not contain any concave intervals. The monotonicity criteria for a monotonic increasing interval of the function is for the interval [0, 100]. Since the RF model represents a twice-differentiable function, the criteria for convex function intervals is . If the second differentiation results in one single positive value, the function is declared fully convex.

related characteristics: price, parent brand performance, country-of-origin, grape variety[5], and packaging type. Distribution-related characteristics (RQ3) that are associated with over- or underperforming wine SKUs are: sales consistency and store specialization in the wine category. We discuss below the influence of product- and distribution-related SKU characteristics based on our modelling.

5. DISCUSSION AND CONCLUSION

In this study we investigate the distribution velocity in wine retailing by analyzing the relationship between distribution breadth and market share for wine. We further examine the influence of product and distribution characteristics of wine SKUs on market share over- and underperformance, beyond expected values based on distribution breadth.

When modelling the distribution velocity for wine we identify a convex and increasing distribution velocity curve similar to those in previous studies [6,7,8,9,10,11]. This is an important finding because the distribution velocity model reflects the competitive landscape of the market in terms of distribution and market share, and therefore provides the potential to benchmark, assess, and improve the market outcomes of wine SKUs. A convex distribution velocity in the wine category implies increasing sales returns per point of distribution. But it also means that the objective of increasing an SKU's distribution (i.e., getting listed in retail stores) requires increasing efforts in marketing pull-effects (i.e., consumer demand).

5.1 Product characteristics

When analyzing over- and underperforming wine SKUs that deviate from the distribution velocity curve we identify associated product characteristics that relate to brand management. The analysis reveals that a strong

[5] To ensure independence of variables in the regression analysis, we opted to use grape variety (instead of wine type) as a more useful construct for managers.

Table 3. Results Robust Regression.

Independent variables	Robust			P > t	Beta
	Coef.	Std. Err.	t		
Constant	-0.014	0.009	-1.620	0.105	.
National Brand (ref)	–	–	–	–	–
Private Label brand	0.006	0.005	1.090	0.278	0.010
Unit price low (ref)	–	–	–	–	–
Unit price medium-low	0.012***	0.004	2.850	0.004	0.066
Unit price medium-high	0.017***	0.006	2.730	0.006	0.098
Unit price high	0.024***	0.008	2.880	0.004	0.139
PL x unit price low (ref)	–	–	–	–	–
PL x unit price medium-low	-0.013**	0.006	-2.170	0.030	-0.012
PL x unit price medium-high	-0.012	0.008	-1.440	0.151	-0.007
Performance other SKUs of brand	0.024***	0.006	4.380	0.000	0.246
Number of variants of brand	0.001	0.001	0.090	0.927	0.002
Number of different packaging sizes of brand	0.003	0.004	0.720	0.470	0.033
Glass (ref)	–	–	–	–	–
Plastic	-0.005	0.008	-0.580	0.564	-0.004
Box	0.008	0.005	1.520	0.129	0.006
Bag-in-box	0.034*	0.020	1.730	0.084	0.057
Organic label	0.001	0.003	-0.040	0.970	0.000
Other countries of origin (ref)	–	–	–	–	–
Argentina	-0.010**	0.004	-2.370	0.018	-0.043
Australia	0.001	0.003	0.160	0.872	0.002
Chile	-0.005*	0.003	-1.940	0.052	-0.022
France	-0.001	0.002	-0.690	0.489	-0.007
Germany	-0.003	0.003	-0.980	0.329	-0.008
Italy	0.001	0.002	0.300	0.767	0.003
New Zealand	0.028**	0.014	1.980	0.047	0.065
South Africa	0.001	0.002	0.390	0.694	0.002
Spain	-0.001	0.001	-0.580	0.565	-0.003
Other grape varieties (ref)	–	–	–	–	–
Chardonnay	0.013**	0.006	1.990	0.047	0.038
Moscato	-0.005	0.005	-1.060	0.289	-0.016
Pinot Gris	0.013	0.013	0.990	0.324	0.037
Riesling	-0.001	0.004	-0.420	0.677	-0.004
Sauvignon Blanc	0.019***	0.006	3.020	0.003	0.055
Cabernet Sauvignon	-0.006	0.005	-1.350	0.176	-0.020
Malbec	0.003	0.005	0.590	0.556	0.009
Pinot Noir	-0.005	0.004	-1.200	0.232	-0.013
Shiraz	-0.006	0.007	-0.980	0.328	-0.017

(Continued)

Table 3. (Continued).

Independent variables	Robust			P > t	Beta
	Coef.	Std. Err.	t		
Number of distribution channels	0.007	0.004	1.580	0.115	0.058
Number of different retail chains	-0.001	0.001	-0.930	0.353	-0.081
Share of distribution in small stores (ref)	–	–	–	–	–
Share of distribution in medium-small stores	0.001	0.001	-0.430	0.668	-0.010
Share of distribution in medium-large stores	0.001	0.001	-1.080	0.279	-0.054
Share of distribution in large stores	0.001	0.001	-1.290	0.198	-0.076
Sales consistency in small stores	0.001	0.001	0.480	0.629	0.026
Sales consistency in medium-small stores	0.001	0.001	0.420	0.674	0.014
Sales consistency in medium-large stores	0.001**	0.001	2.410	0.016	0.071
Sales consistency in large stores	0.001***	0.001	3.050	0.002	0.056
Specialization in wine in small stores	-0.001	0.001	-1.260	0.207	-0.038
Specialization in wine in medium-small stores	-0.002**	0.001	-2.180	0.029	-0.052
Specialization in wine in medium-large stores	-0.003	0.002	-1.550	0.120	-0.028
Specialization in wine in large stores	-0.001	0.002	-0.390	0.700	-0.005

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
(ref) = reference level omitted from main model.
Coef. = Deviation from the average market share predicted by the RF model.

parent brand, country-of-origin, the grape variety, packaging type, and price each are correlated with market performance with statistical significance. This may not be overly surprising but there is more to it in detail.

Individual SKUs will benefit from an overall strong parent brand (variable: performance other SKUs of brand). First, this result indicates that the umbrella branding approach is a good branding strategy in wine – a category which is very fragmented and needs those extrinsic quality cues, such as branding. Second, it shows the power of larger brands – in terms of their mental and physical availability, which SKUs can leverage under their umbrella brand. This further supports the argument that the reputation of a parent brand influences its sub-brands [7,16]. Overperforming SKUs may be under-distributed at the point in time of measurement. It is likely that wine SKUs under a strong parent brand have an advantage through consumer preference and demand, as well as through retailers' interest to list those SKUs in their stores. Especially in smaller stores with limited shelf space, SKUs from a strong parent brand have a competitive advantage. How many variants or packaging sizes the parent brand has, according to the results in this study, does not lead to above or below expected market share performance of individual wine SKUs.

Price is another major characteristic affecting choice, and one of the most important marketing functions. The analysis shows that a higher unit price, here above $19.50 USD per liter, is associated with market share overperformance (under-distribution). This is in line with previous findings [14]. Pricing is a very strategic decision and needs to be adjusted for competition and demand dynamics on the consumer and re-seller side. It is possible that wine SKUs with very low unit prices cannot generate enough revenue to overperform in terms of market share, or they tend to be over-distributed, being likely candidates for delisting from retail stores.

Even though consumers may accept to pay a premium for organic wines [21], we could not find any proof that "organic" labelled wine SKUs perform better than those not identified as such.

Not surprisingly, most wines come in 750 ml bottles. But bag-in-box wines seem to have excess market share compared to other packaging formats. This is likely due to their limited distribution - bigger packaging sizes, such as bag-in-box, are listed and sold in fewer large stores with high sales frequencies, and therefore are under-distributed and overperforming SKUs.

We also confirm that country-of-origin (COO) is associated with over- or underperformance of wine

SKUs. For this specific year of US sales data, wines from New Zealand saw strong sales in volume and value, whereas wines from Argentina and Chile significantly underperformed for their level of distribution. In some years it may be SKUs of other COOs over- or underperform. But the finding clearly indicates that COO plays a role in buying and listing decisions. This again may be related to the consumer demand and retail listing situation at the point in time of measurement. Temporary over- or underperformance may affect market developments in the immediate future, either increasing or decreasing distribution, or market shares may normalize to expected levels.

Looking at the results across the grape varieties tested, wines made from Sauvignon Blanc and Chardonnay performed better than we would expect based on distribution, specifically those where the grape variety is written on the label (not blends or regional designations). This confirms previous findings that some grape varieties enjoy excess loyalty in a market [20]. These also may change over time due to changes in consumer preference.

5.2 Distribution characteristics

There is a weak yet notable indication that wine SKUs being available in additional retail channels can benefit performance beyond distribution breadth. This is in line with previous findings [7]. Interestingly, the number of different retail chains as well as store size are just secondary factors and are not directly related to above or below average market performance, which stands in contrast to findings, that they relate to over-, in-line, and underperformance of packaged goods generally [7]. As a consequence, channel diversification and careful chain selection are strategies for suppliers that could lead to above average market performance of individual SKUs.

The data also shows that if stores and their distributers can assure a high sales consistency, it is more likely to achieve above average market share. The results are statistically significant for medium-large and large stores. Sales consistency may be reduced in smaller stores because of fewer and less frequent incidence of purchase, more frequent OOS situations, and lack of logistic efficiencies in supply chain and inventory management [25]. Larger stores may benefit from logistic efficiencies and experience better turnover and sales consistency compared to small stores.

Another interesting finding is that store specialization in wine (more brands on offer) has a significant negative relationship. An increased store specialization may be related to increased intra-category competition and individual brands may suffer from this. One could argue that getting listed in additional small retail stores with lower category competition (wine specialization) can be beneficial for wine SKUs. Indeed, past research has shown that this is the main reason for the convex curve pattern to occur – with growing distribution, being available in additional smaller stores with smaller assortments, hence lower level of competition in these smaller stores, leads to greater marginal sales increases [30].

These findings indicate that suppliers as well as retailers should consider a qualitative dimension of distribution (i.e., distribution depth) for their SKUs to gain competitive advantages and above average market share. The analysis of distribution velocity offers opportunities for benchmarking and competitive comparisons, but it may also serve as a trend indicator. Overperforming (underperforming) SKUs may be candidates for future new listings (de-listings) in retail stores. Equally, temporary overperformance (underperformance) may normalize over time, with market shares reverting to expected levels relative to distribution.

5.3 Practical implications

These findings lead us to recommend some practices that are likely to improve SKU market performance for a given level of distribution.

Supply and retail management have the opportunity to better benchmark and assess the competitive situation of their wine brands at SKU-level, by adding distribution velocity to the analysis. With regard to the identified convex distribution velocity pattern in the wine category, marketers can better evaluate potential effects of their marketing investments. Whether investments are aimed at increasing distribution, market share, or both, marketers can additionally consider a range of product and distribution characteristics to improve their brands' and SKUs' distribution velocity and market performance.

For suppliers of wine, a multi- and omnichannel strategy can be useful. This means that entering additional off-trade channels and thereby facilitating the buying process for consumers can improve market performance of individual SKUs. Adjusting from "brick-and-mortar" to "brick-and-click" is therefore a consequent channel strategy for long-term market success, even though research indicates that this may cause potential short-term cannibalization effects [31].

Standard grocery stores, as well as drugstores, mass merchandisers and warehouse clubs indisputably remain important channels. In addition, the quality of distribution (i.e., distribution depth) is an equally important distribution dimension for consideration. Hence, collab-

orating with retailers who run their logistics and inventory efficiently, thereby avoiding regular stock-outs, is an advantage. This can ensure a stable in-store presence and sales consistency, ultimately improving distribution velocity and market performance.

In this study we use US data and it is well known that market access to the US is a state by state affair, typically involving importers, distributors/wholesalers, and retailers (three-tiers). This complex and costly system requires thorough research as to which potential geographic market to aim for, and which importer/distributor adds the most value. Considering our research, it matters what distribution prospects a US wine distributor offers, i.e. the type of channels they have access to.

Adding to this, our research also indicates that the product offering in terms of the brand, price, packaging type, country-of-origin, or the grape variety, are important characteristics which can influence consumer and retailer demand, and therefore stimulate distribution velocity and overall market performance.

In conclusion, only very few businesses have the resources to pursue intensive distribution. The vast majority of SMEs in the wine industry would likely choose a more selective approach, by building relationships with a few importers/distributors serving a defined geographic market with a limited number of retail chains and stores. This highlights the need for marketing to compensate for limited distribution, by using effective distribution strategies and offering a product/brand that leverages consumer and trade demand. This research contributes to such efforts.

5.4 Future research

This research was limited to the US, globally the most important wine import market with a particular regulation (three-tier system). It also focused only on imported wines. Future research should aim to replicate the study and assess other wine markets. Those should also include markets with a strong domestic wine supply and few imports, such as Italy or France. It is an important question for international wine marketers if the general structure of distribution velocity as well as the characteristics associated with over- and underperformance can be generalized across markets. Furthermore, the temporal stability of over- and underperformance should be investigated by analyzing data sets over many years. It should be assessed whether such positive (negative) deviations in market share might be predictive for future growth (decline). In addition, seasonality effects may be tested in the context of distribution velocity of wine [32].

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Fractional responses with spatial dependence of Portuguese wineries' domestic market sales to an exogenous shock (Covid-19)

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Abstract. This paper uses firm-level data to investigate the resilience of the Portuguese wine sector's domestic market in the aftermath of the exogenous shock arising from Covid-19. To address this objective, this article applies a fractional response model. The results allow us to confirm that the impact of the pandemic crisis depends on firm structure and behaviour reflected by variables such as firm size, age, export intensity, market channel as well as on the geographic location of firms. This suggests the need for the development of innovative regional clusters and calls for managers and policy-makers to consider the heterogeneity of wineries and dissimilar effects of contingency measures at the municipal level during an exogenous shock.

Keywords: wine, fractional response model, spatial dependence, exogenous shock, firm performance.
JEL classification: C31, C34, D22, L22, Q12.

1. INTRODUCTION

Based on business and consumer surveys, recent studies show that containment measures established at the onset of the pandemic determined either temporary or permanent closure of businesses, mobility restrictions, and losses in income, which led to an increase in economic uncertainty, affecting worldwide wine consumption [1]. The perception of an economic crisis caused a change in purchasing behaviours, namely in spending [2] and preference towards non-premium and mid-range wines [3]. Moreover, the pervasive effect of the pandemic, which sprawled geographically almost without limitations, varied between countries, and among companies, according to different lockdown measures, demand elasticities, and reliance on sales channels [4].

Overall, the repercussions of the pandemic caused significant losses for wine-producer countries, especially in domestic market sales and exports [5] with effects that are likely to last throughout the coming years [6]. Depending on the business model adopted by each country, wine industries may differ in the impacts on and perceptions of the extent of the crisis [7]. Therefore, the level of resilience and ability to adapt to a disrupted business environment impacted by an exogenous shock depends on the structure and behaviour of firms in their location.

At the firm level, the impacts of the pandemic varied according to its market sales focus [8]. Smaller wineries were particularly affected by the pandemic's impact on the on-trade channel, mostly sustained by tourist activities (e.g., bars, hotels, and restaurants) as well as those more dependent on selling directly to consumers at the winery [9]. All this led to a sharp decline in points of sale and local wine consumption in various wine-growing destinations [4].

Regarding the location of wineries, the pandemic had differentiated regional impacts at the national level because of both higher production volumes and collective recognition mechanisms (e.g., the tradition of high quality). The discrepancies at regional levels also affected the resilience of firms, due to the influence of location on performance [10]. Wineries tend to cluster in the same geographic area which affects their production capabilities [11]. Therefore, while some regions have shown stronger resilience, others have struggled more during the pandemic also due to different levels of local constraints, suggesting that a firm´s location might have influenced its economic resilience.

Some agglomeration externalities develop naturally due to spatial proximity between wine producers. For instance, the performance of neighbouring wineries can encourage the diffusion of marketing-related externalities for the entire region [12,13] This poses additional considerations with implications for managers and, even more so, for regulating bodies. Geographical clusters in the Portuguese wine industry are highly directed to collective promotion in third countries and exploring regional tourism activities.

Whilst such strategies have improved the position of the industry at an international level, there are a few more opportunities that this paper highlights, which, if taken, would make firms more resilient. These are particularly relevant during a crisis caused by an exogenous shock. In this context, researchers have highlighted the importance of a firm's resilience in mitigating the impacts caused by an exogenous shock such as a financial crisis, natural disaster, or pandemic. Previous research has informed that those firms that resist retaining business stability, particularly, throughout a disruption tend to sustain sales losses, reduced market share, and diminished revenue [14]. In particular, small businesses, which represent most of the Portuguese wine industry, are deficient in several critical factors (e.g., knowledge, resources, or liquidity) that ensure business resiliency to implement the required adjustments necessary to endure, following a considerable economic shock [15].

Firms with lower debt ratios tend to be able to recover more quickly due to available resources to employ different strategies and control losses [16]. Therefore, the analysis of the economic performance of wineries is typically accomplished by examining the progress of financial indicators, such as the returns on assets (ROA) [17-19] or other operational indicators, such as earnings before interest, taxes, depreciation, and amortizations (EBITDA) [20].

Despite the earlier efforts to investigate the economic impact of Covid-19 on the firm's economic performance [21-23], there is a paucity of studies that analyze the real variation of sales during the pandemic, a gap this research seeks to fill by investigating the domestic wine sales of Portuguese wineries which have been particularly affected by the negative spike in sales in the on-trade sector comparing 2020 and 2021 to 2019, by as much as 45% and 53%, respectively [24]. Portugal (4.6 mhl, -0.6% / 2020) reduced its wine consumption levels in 2020 and 2021, not only compared to 2019 but also to its previous five-year averages [4]. Contrarily, the sale of wine through off-trade distribution channels (e.g., supermarkets) in 2020 rose 6.4%, up to approximately 12 million litres, and 9.4% in 2021 compared to 2019, amounting to more than 17 million litres. On average total domestic demand witnessed a sharper decrease in value rather than volume in 2020 and 2021 in comparison to 2019, with a difference of roughly 32 p.p. and 33 p.p., respectively. These indicators show that Portuguese wineries were deeply impacted by the effects of Covid-19, highlighting the importance of on-trade and direct-to-consumer channels which suffered the most during the pandemic, comparable to other Old World countries due to distancing measures and stringency of travel restrictions [25,26].

This study´s results can be extrapolated to Old World countries given the overall average dimension of companies, mostly comprised of small-to-medium size business structures, and highly fragmented [7]. Also, the distribution system implemented by wineries to reach the market is associated with winery size and is highly correlated to geographic origin [3]. This posits limitations in market positioning which relate to export intensity but underlines the importance of wine tourism,

which has progressively become a significant revenue stream [27]. Moreover, Portugal embodies a typical market structure of monopolistic competition which tends to influence the level of differentiation of wineries, and business performance.

In the case of winery losses due to the Covid-19 pandemic, analyzing changes in domestic sales losses provides a vision of how a short-term exogenous shock impacted the ability of a firm to reach new customer demand. In this research, the percentage change of a winery´s sales is the economic variable, which was estimated to capture two pandemic time frames, (2020-2019 and 2021-2019), and which occurs as a fraction and percentage, which from an econometric perspective, is not considered as a probabilistic outcome, but yet has 'both two-corner solution outcomes and continuous outcomes in the interval [0, 1]' [28]. Therefore, for the most part, traditional models are unsuitable for estimation. The method applied in this article offers a reliable estimator for the fractional response variable in the presence of a spatially lagged (explanatory) variable, that accounts for the interdependent relationships between neighbouring firms. According to [29], there is a lack of studies including spatial dependence in fractional models. As far as we are aware, no study of the wine industry has yet attempted to do so.

In summary, this paper uses firm-level data to investigate the Portuguese wine sector´s economic resilience in the aftermath of the exogenous shock arising from Covid-19. To address the main aim of this research, two complementary issues have been dealt with: (a) to determine the economic characteristics of firms that influenced their resilience in the aftermath of the Covid-19 waves in 2020 and 2021 and reflected in the fall of sales in the domestic market; (b) to analyze the previous issue using a fractional response model that combines the spatial/geographic dependence factor of wineries.

Methodologically, this research applied a two-part fractional response model with spatial dependence, which allows overcoming, at the same time, two of the main drawbacks of the existing literature which are conditioning appropriate interpretations and policy recommendations. First, the relevance and advantages of using appropriate fractional response models over other regression models, which are unable to cope with values in the interval [0, 1] and not with an excessive number of boundary values in the dependent variable. Second, the importance of including a spatially lagged term in the analysis to account for the role of the firm´s geographical location in economic performance. The combination of these two issues constitutes a methodological advancement in achieving robust findings that allow a better understanding of the firm´s behaviour (specifically those in the wine sector), namely the propensity and intensity of firm-level economic resilience in the aftermath of an exogenous shock triggered by Covid-19.

This study provides important managerial implications for the resilience of wineries in facing a disrupted business environment impacted by an exogenous shock and improves management decision-making in a post-pandemic and recovery phase. Additionally, it provides new scientific background on the estimation and utility of fractional response models.

The remainder of this paper is organized as follows: Section 2 develops the econometric approach to the research problem, section 3 presents the econometric function, the data, and the results, and Section 4 concludes.

2. ECONOMETRIC APPROACH

The study analyzes two estimations taking into account variations in domestic sales losses between 2019 and 2020 and between 2019 and 2021, to capture changes in the behaviour of companies along two different stages of the pandemic. In both models, the dependent variable is the relative loss of a firm's sales in the domestic market. It fills the condition , in which a value of represents wineries that showed no sales losses, and conversely a value of represents a loss of 100% of total sales. Therefore, since the main goal is to estimate , econometric models that assume a linear relationship between the explanatory and the dependent variable may produce predicted values that lie outside the meaningful boundaries [0, 1], including the marginal effects.

To overcome such difficulty, alternative approaches are presented in the literature. Censored models, such as Tobit models may represent an alternative approach [30], [31]. However, they require piled-up observations in both limits of the interval, which is unlikely the case for our dependent variable. The most likely scenario for wineries is that the majority of firms experienced a drop in sales, even though a significant proportion did not report any loss (firms in this last category are represented by a '0' in the interval [0, 1]).

2.1 The fractional response model

An appropriate solution for the estimation approach is the use of fractional response models, as recommended by [32], to guarantee predictions in the meaningful interval that can be properly interpreted. They proposed a thorough answer to this issue, by considering the following expression:

$$E(y_i \mid x_i) = G(x_i\beta) \quad (1)$$

where $G(\cdot)$ is a known function satisfying $0 \leq G(z) \leq 1$ for all $z \in R$. The dependent variable is represented by y_i, whereas x_i denotes the vector of explanatory variables. The use of this approach ensures that the predicted values of y lie in the [0, 1] interval. In applied research, two main solutions for $G(\cdot)$, as a cumulative distribution function (cdf), are typically used, namely the logistic function, (fractional logit) and the standard normal distribution function, (fractional probit), which ought to be estimated through non-linear techniques.

Considering this, the fractional response models allow the estimation of sales losses, with predicted values inside the relevant boundaries, and are typically estimated through non-linear least-squares methods or quasi-maximum likelihood approaches.

A further issue that could occur when modelling firms' sales losses in the pandemic crisis might be the existence of sample selection bias, specifically since not all firms have reported losses. Since the value of total exports did not suffer a downturn [24], some firms might even have registered increased sales.

Despite the Heckman selection model offering a plausible solution to the expectable selection problem, it cannot cope with the previously identified issue of predicted values outside the meaningful interval [0, 1]. Furthermore, it requires the dependent variable to be normal for the assumptions to hold, and it does not account for neglected heterogeneity across the sample. Having this methodological scenario, [33] offers an appropriate solution, namely the use of two-part models. By using their proposed framework, the model is divided into two components: a binary and a continuous one. The binary component is used to estimate the occurrence of the event (0 for firms without domestic sales losses, and 1 for firms with registered domestic sales losses), and the extent of the domestic sales losses is estimated in the continuous part of the model, through a fractional regression model. Here, only firms who registered domestic sales losses are included, which solves the problem of selection. Furthermore, using a fractional response approach to model the continuous part also solves the issue of predicted values outside the meaningful interval.

Thus, following [33], the first part of this model is defined by a standard binary choice model, modelling the probability of observing a positive outcome,

$$y^{\star} = \begin{cases} 0\ , y = 0 \\ 1\ , y \in (0\ ,1) \end{cases} \quad (2)$$

$$P(y^{\star} = 1|x) = E(y^{\star}|\mathrm{x}) = F(x\beta_{1P}) \quad (3)$$

where $F(\cdot)$ is the distribution function, usually the logistic function or the standard normal, β_{1P} refers to the parameters of the first-part equation. Here, the propensity to have registered sales losses is modelled.

The second part of this model considers only the positive outcomes in equation 4 and models the magnitude of non-zero outcomes. When modelling for sales losses, this means considering only firms who registered losses and thus modelling the intensity of the loss. The second part may be defined by:

$$E[(y|x,y \in (0,1)\ ] = M(x\beta_{2P}) \quad (4)$$

where β_{2P} refers to the parameters of the equation of the second part. Consequently, $M(x\beta_{2P})$ may be estimated through the QML method. Considering equations 3 and 4, and following [34], $E[(y|x)$ is then defined by:

$$E(y|x) = E[(y|x,y \in (0,1)] \cdot P[y \in (0,1)|x] = M(x\beta_{2P}) \cdot F(x\beta_{1P}) \quad (5)$$

Considering the fractional response nature of the variable of interest, the quantity of boundary observations, as well as the sample selection issues, this two-part model approach produces meaningful and consistent results.

The interpretations of the obtained estimations should consider the conditional expectation of the dependent variable, i.e., $E(y|x)$. Thus, the computation of the average marginal effects (AME) of each model is required [20]. In the two-part FRM modelling, following [33], the AMEs are given by:

$$AME_{X_k} = \frac{\delta E(y_i|x_i)}{\delta X_k} = \frac{\delta M(x_i\beta_{2P})}{\delta X_k} F(x_i\beta_{1P}) = \frac{\delta F(x_i\beta_{1P})}{\delta X_k} M(x_i\beta_{2P}) \quad (6)$$

In the case of dichotomous explanatory variables, the AMEs are given by the trivial difference of the adjusted predictions, i.e., the difference in the probability when that variable is observed and when it is not observed.

2.2 The fractional response model with spatial dependence

The role of the firm's location is typically studied within the framework of spatial econometrics by including a spatially weighted matrix that accounts for the distance between firms in a regression [35-37]. The main rationale is that the output of a firm depends on (and influences) the activities of neighbouring firms. This may occur due to the existence of spatial spillovers

generated by proximity [38], such as innovative regional clusters or transfer of knowledge between neighbouring producers.

Despite its relevance, the integration of spatial dependence into fractional response models is a rare phenomenon in the literature, with a handful of contributions extending the existing framework of fractional regression models. Specifically, [39] proposes considering additive errors as a way to include the spatial lagged term in the function. More recently, in the framework proposed by [29], spatial dependence is introduced through a spatial lag of the fractional dependent variable, inside a nonlinear function, as an extension to the [32] approach. This is the Fractional Response Spatial Lag Model (FRSLM) and may be defined as:

$$Y_i = G(\alpha \Sigma_{j \neq i} w_{ij} Y_j + X_i \beta) + u_i \quad (7)$$

In this specification, a link function $G(*)$ is defined so that predicted $E(Y_i)$ values are bounded to the meaningful [0, 1] interval. Spatial dependence is included within the defined function, where $w_{ij}Y_j$ represents the spatially lagged variable, provided from a row-standardized spatial weight matrix w_{ij}, (W*W) in which all values are non-negative and represent the weight of the distance between each pair of firms i and j. Moreover, $X_i\beta$ is the matrix of the explanatory variable multiplied by the respective regression parameters.

The FRSLM approach is relevant in our case, as wine is an industry in which geographic location plays a crucial role in determining the behaviour and strategic decisions of a firm [30,32].

3. ECONOMETRIC FUNCTION, DATA, AND RESULTS

3.1 Econometric function

The market characteristics of the Portuguese wine industry allow us to define an econometric production function that represents the technology of all firms, due to technological homogeneity, which should be dependent on a set of intrinsic characteristics and interaction with neighbours, i.e., spatial dependence [12].

The explained variable is the domestic market sales losses of wineries, measured through the loss in 2020 and 2021 in comparison with 2019 (a fraction between 0 and 1). For the selection of the explanatory variables, the wine literature employing the resource-based view (RBV) of the firm framework usually considers factors such as size, which can be either measured as the number of paid employees [40] or the value of total assets [41]. Size is typically identified as a positive driver of performance, since wineries can benefit from reaching economies of scale, due to higher availability of resources.

The age of a firm is also a relevant factor as it serves as a proxy for experience ([41-43]. The impact of age is not clear in the literature, as it could boost performance by the benefits of reputation or hamper it through the rigidness of strategies employed and lack of innovative dynamism [44].

Among other relevant factors affecting the performance of wineries, [45,46] the marketing budget is likely to impact the ability of firms to engage in innovative strategies, such as communication or promotion in third countries.

Export intensity, typically measured as the share of exports to total sales, refers to the strategic positioning of a firm in the international market. It is intrinsically linked with performance [31,43,47], as most successful exporting firms are generically associated with higher value.

Furthermore, the dependence on the on-trade channel affected losses, through the closure of most wine tourism activities during the lockdown [9,7]. To control for such phenomena, a dummy variable is included, taking a value of 1 if a firm has any form of tourism activity (tasting room, restaurant, wine store, or accommodation facilities) and 0 otherwise.

Finally, the inputs required for a firm´s operations are considered as control variables, by including the value of the supplies and services as a proxy [10,48].

As mentioned by [29], there is a lack of studies that include spatial dependence in fractional response frameworks. The present paper includes the spatially lagged variable in the econometric function. A positive signal of such a variable indicates that firms that are located near their competitors struggled more than those who are isolated. Conversely, a negative sign suggests that regional clustering is a positive driver of resilience.

Following equation (7) and the set of characteristics presented above, the function that explains sales losses in Portuguese wineries is given by:

$$\begin{aligned} SalesLoss_i = {} & G(\alpha \Sigma_{j \neq i} w_{ij} SalesLoss_j + \beta_1 Ln(Employees)_i \\ & + \beta_2 Age_i + \beta_3 Ln(Marketing)_i + \beta_4 ExportIntensity_i + \\ & \beta 5 WineTourism_i + \beta_6 Ln(SuppliesServices)) + u_i \end{aligned} \quad (8)$$

3.2 Data

The dataset for this study is composed of Portuguese firms within the 11021 NACE code to ensure technological homogeneity (the same production function applies to all included firms). Data is retrieved from the official fiscal reports of wineries for the years 2019, 2020 and

2021 to monitor the extent of losses during the pandemic. Careful screening of the data available for all variables for both years provided a final sample of 290 wineries in 2019 and 2020 and 270 in 2021 covering mainland Portugal.

Figure 1 shows the distribution of the dependent variable (sales losses) and it highlights the methodological relevance of analyzing the phenomena with the use of fractional response models as well as the superiority of two-part models and provides key insights into the overall situation during 2020 and 2021.

Figure 1 displays the histograms of losses for the years 2020 and 2021. First, the figure shows a high prevalence of zero-observations, which means firms that did not report any domestic sales losses. In 2020, 31.14% of the total sample, whereas in 2021 the number was 48.88%.

Second, a quick look shows that the effects of the pandemic were much larger in the year 2020. The average drop in domestic sales in 2020 was 16.34%, whereas, in 2021, the drop was significantly lower, 11.86%. Additionally, the histogram provides a further reading. In 2021, the concentration of firms near the left margin, i.e., reporting zero loss, is much larger than in 2020. Of the 290 firms that were active in this period, we see that 121 reported domestic sales losses lower than 10% in 2020. This means 41.72% of the firms. In 2021, the number of firms that registered domestic sales losses lower than 10% was 181, a whopping 67.04 % of the total of firms This shows that the resilience of Portuguese wineries was a fact, alongside the speed of recovery.

Table 1 presents the descriptive statistics of the dependent and explanatory variables of the estimated econometric function.

At first glance, both pandemic years, 2020 and 2021, exhibited an average drop in domestic sales in comparison to 2019 of, approximately, 16% and 12%, respectively. Yet, the average annual turnover exhibited a different behaviour, first decreasing from 2019 to 2020 but stepping up in 2021 in comparison to 2019, which suggests an increase in sales value. This sets the generic scenario for domestic sales losses caused by the pandemic crisis.

In terms of firm characteristics, the heterogeneity of Portuguese wineries is observed with the size of firms ranging from just 1 employee to 638 of the largest producer. Similarly, disparities in age are also visible, with ages ranging from 8 to 104 years old (averaging 24 years). The mean expenditure per firm on promotion (marketing) was € 204,937. Exports are an important driver of wineries′ growth. 64.71% of the firms are exporters. In terms of value, exports account for

Table 1. Descriptive statistics.

Variable	Mean	Std. Dev.	Min.	Max.
Sales Loss (2020/2019)	0.1634	0.1896	0	1
Sales Loss (2021/2019)	0.1186	0.1857	0	1
Turnover 2019 (euro)	3,282,168	1,12E+07	147	1.46E+08
Turnover 2020 (euro)	3,145,864	1.08E+07	768	1.37E+08
Turnover 2021 (euro)	3,766,341	1.25E+07	84	1.56E+08
Employees (#)	16.8581	44.7994	1	638
Age (years)	24.9273	18.4095	8	104
Marketing expenditures (euro)	204,937	1,265,488	0	2.02E+07
Export intensity	0.1956	0.2622	0	0.9978
Wine Tourism	0.2768	0.4482	0	1
Supplies and services (euro)	611,562	2,594,145	2,538	3.85E+07
Spatial Lag (2020/2019)	0.1654	0.0435	0.0281	0.2787
Spatial Lag (2021/2019)	0.1951	0.1036	0.0122	0.4851

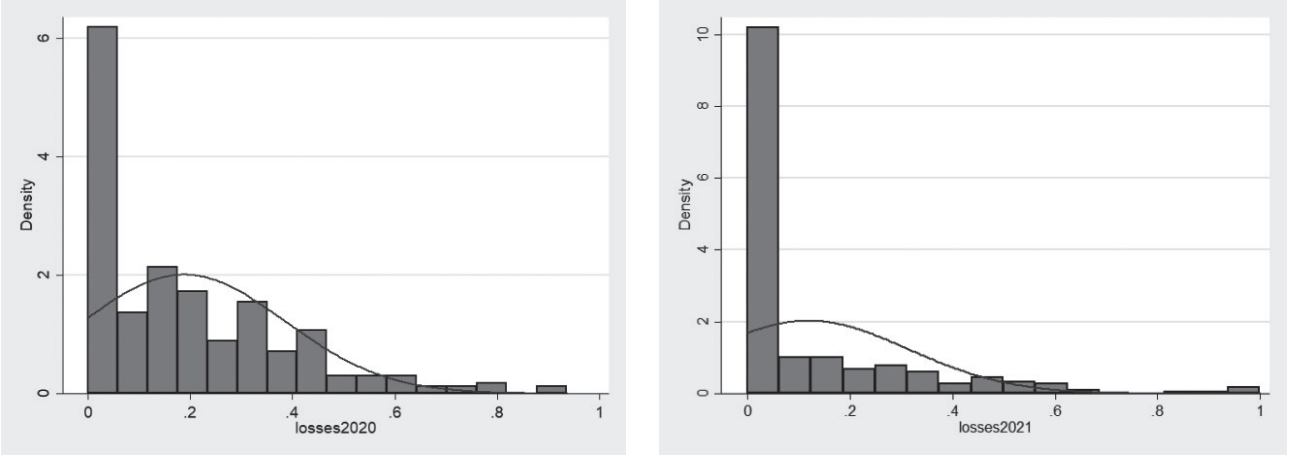

Figure 1. Histogram of sales losses (0-100%): 2020; 2021.

an average of 19.56% of the firm's total turnover, and 27.68% of the wineries have some sort of wine tourism activity (wine shop, tasting room, guided tours, etc.). The mean value of supplies and services (water supply, electricity, oil, etc.) was € 611,562.70.

Additionally, we estimated the Variance Inflation Factor (VIF) to detect the existence of multicollinearity in our datasets. By the rule of thumb, 10 takes on a critical value for the presence of multicollinearity. This hypothesis is dismissed since the mean VIF is 1.62 in 2020 and 2.11 in 2021 in which the maximum value is 2.98 (for the variable "employees") in 2020 and 4.04 (for the variable "supplies and services") in 2021.

3.3 Results

Considering that more than 31% and 49% of all the firms analyzed in 2020 and 2021, respectively, did not report any loss at all, the possibility of sample selection bias ought to be tested and accounted for. The rationale is that the intrinsic reality of those firms that did not suffer any losses might be substantially different from those that did report losses during the period.

Table 2 provides the results of the econometric estimations referring to the two-part fractional model[1] as it provides superior results in terms of statistical robustness [20,33].

Both estimated periods (2020-2019 and 2021-2019) share similar results in terms of signal and significance in the main equation (which models the intensity of sales losses), except for the size of the firm and age. It is noticeable, however, that there are interesting differences among both selection equations (i.e., probability/propensity of having a loss in sales). Among these, the size of a firm (measured through the number of employees), marketing budgets and services supplies are deemed significant determinants of having a loss between 2020 and 2019, whereas, in the second period, which represents the subsequent pandemic time frame, these variables did not significantly affect sales losses in the domestic market. This suggests different phenomena: (i) larger firms were more prone to having registered sales losses during the first year of the pandemic; (ii) among the firms who did register losses, larger firms were less affected (i.e., the level of loss was lower for larger firms); and (iii) 2021, on-trade sales increased independently of size, age, and marketing budgets.

Table 2. Econometric estimations of the Two-part fractional model.

Variables	Dependent variable: Sales Loss			
	2020/2019	2021/2019	2020/2019	2021/2019
	Main equation		Average marginal effects	
Ln(Employees)	-0.1800*	0.0704	-0.0338*	0.0106
	(0.0978)	(0.0711)	(0.0182)	(0.0109)
Age	0.0097***	-0.0004	0.0018***	-0.0006
	(0.0033)	(0.0039)	(0.0006)	(0.0006)
Ln(Marketing)	0.0912	-0.0129	0.0171	-0.0019
	(0.0645)	(0.0174)	(0.0121)	(0.0126)
Export intensity	0.7894***	1.1378***	0.1418***	0.1712***
	(0.2941)	(0.4225)	(0.0553)	(0.0653)
Wine Tourism	0.3557**	0.2971*	0.0667**	0.0447*
	(0.1517)	(0.1574)	(0.0284)	(0.02341)
Ln(SuppliesServices)	-0.3089***	-0.1860**	-0.0579***	-0.0280**
	(0.1128)	(0.0932)	(0.0212)	(0.1419)
Spatial Lag (LossW)	2.9411**	8.8978***	0.5519**	1.3388***
	(1.2854)	(1.2222)	(0.2427)	(0.1343)
Selection equation				
Ln(Employees)	0.5579**	0.3338		
	(0.2256)	(0.2110)		
Ln(Marketing)	0.2982**	-0.0060		
	(0.1193)	(0.0444)		
Export intensity	-0.6992	-0.3792		
	(0.6522)	(0.5928)		
Ln(SuppliesServices)	-0.7587***	-0.0824		
	(0.2324)	(0.1723)		
Dummy Port wine	2.2375**	1.9565*		
	(1.0718)	(1.0635)		
Model statistics				
Log-likelihood	-83.3423	-45.5388		
Pseudo R^2	0.2297	0.6826		

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively. Standard errors are reported in parentheses.

Furthermore, in both selection equations, the results suggest that larger firms, with higher marketing expenditure and heavier structure of operational costs, were struck harder in the first year of the pandemic, with a higher probability of having registered domestic sales losses than their smaller, more flexible counterparts. However, it is interesting when the interpretation goes to the continuous part of the model, which models not the probability to register domestic sales losses but the dimension of domestic losses. In the main equation, we see that larger firms were hit with lower impact. The same goes for the supplies and services variable, which reinforces the previous reading.

These results mean that larger firms have an overall stronger reaction and adaptation capability to a crisis,

[1] To check for divergences in results in the Two-part fractional model we compared its estimations with two other models: the fractional logit, and the Two-step Heckman. In Appendix 1 – Table A we present the first two models and report in the text the results of the Two-part fractional model.

which is in line with the findings by [49]. Moreover, our findings confirm [21] results, demonstrating that smaller firms are more likely to have registered higher losses during the pandemic than larger firms, which were capable of achieving economies of scale.

Results show that export intensity is positively linked with the size of the loss in sales (but has no significant effect on the probability of having sales losses). This happens since the response variable captures changes in domestic market sales, and the wineries that are more involved in export activities are also likely to be more dependent on the external markets' on-trade channel (generally higher value wines), which suffered more from the restrictions imposed during the pandemic, a behaviour similar to the domestic market. Consequently, the export intensity remains a strong driver for the dimension of sales losses in 2021, hinting that a dependence on the on-trade channel affects the recovery of wineries.

Wine tourism activities are identified as positive drivers of sales losses. This is explained by the travelling restrictions during the lockdowns. Since the sales of these firms are dependent on wine tourism sales (direct sales), their losses were stronger than those of the firms that did not have wine tourism activities, which is in line with [9] findings.

The two-part fractional response model requires the analysis of the AMEs for accurate interpretations of the true effects of the explanatory variables in the dependent variable. Overall, the results confirm the existing RBV framework literature in terms of determinants of performance. The overall effect of size (employees) is negative, which signals that achieving economies of scale in the Portuguese wine industry was a factor that determined greater resilience during the pandemic. This is in line with the previous findings regarding performance studies [15,16,43,50] but more relevantly, with the suggestion that smaller firms struggled more during the pandemic [4]. This can be explained by the lower exposure to the on-trade channel that larger firms could have when compared with smaller competitors.

Older firms showed higher intensity of domestic sales losses *Ceteris paribus*, a firm that is 10 years older than others suffered greater intensity of sales losses, being nearly 2% more. This confirms that older firms might show higher rigidness in processes and therefore display lower resilience than younger firms. Another explanation could be that the oldest firms in the sample are Port wine producers, who are also highly dependent on wine tourism activities, in the domestic market. This is most interesting given that in the selection model for companies´ sales losses between 2021 and 2019, when the pandemic was still thriving but showing some signs of receding, Port wine producers' sales losses were still significantly affected.

The industry-level scenario set for the Portuguese wine industry states that in 2020 and 2021, exports grew in both value and volume [24] despite the pandemic. However, in our sample, the intensity of exports shows a positive sign towards the intensity of domestic sales losses. Therefore, it is likely that wineries that are more dependent on the on-trade channels in the domestic market are dependent on the same channel in the international market.

The dependence on the on-trade channel is also evaluated through the wine tourism dummy, which shows, as expected, a positive relationship with the intensity of domestic sales losses. *Ceteris paribus*, having wine tourism activities meant that that firm experienced on average, a 6.67% higher loss than a firm that does not engage in tourism activities. This is explained by the fact that tourism was one of the most affected sectors, witnessing a disrupted environment that imposed mobility restrictions that drastically reduced flows of tourists as well as suffering temporary or permanent closure of businesses [9]. In 2021, that impact was not dissipated, but a reduction in both the coefficient and the significant level shows that the less stringent lockdown period, i.e., 2021, translated into less severe losses.

The supplies and services variable is a proxy for inputs that are required to carry out production (such as water, gas, electricity, etc.) and it is negatively related to the intensity of the losses, meaning that firms with larger structures reported lower domestic sales losses than smaller firms. In 2021, the impact was mitigated, with a reduction in both the coefficient and the significant level.

The spatially lagged variable reveals a positive relationship with the intensity of sales losses. This suggests that proximity relationships (usually envisioned as regional clusters) implied a domino effect during the crisis. Most agglomerations of firms comprise small-to-medium-size wineries with a high dependence on tourism, which determines performance-wise regional homogeneity in response to exogenous shocks. This underscores the importance of innovation and marketing efforts to enhance brand recognition, which have been shown to increase a winery´s resilience to such a ubiquitous and destructive phenomenon [9]. In 2021 there was a reinforcement of the spatial component.

4. CONCLUSION

The Covid-19 crisis impacted most industries worldwide through the imposed restrictions that governments

took to contain the spread of the virus. This highly challenging environment triggered paradigm shifts in most industries, in response to demand and supply disruptions as well as future economic uncertainty. The wine industry is a good example of such an impact, with a negative spike in consumer demand and a quick shift in buying behaviour [3,51], which tended towards cheaper and lower quality wines, with a profound impact on domestic market sales, as this study illustrates.

Recent research in the wine literature has pointed out that the resilience of the wine industry is dependent on the strategies of government and regulatory bodies as well as firm-level capabilities in response to exogenous shocks [3]. Despite its relevance, no studies to date have analyzed the extent of the impacts of the pandemic on firm-level performance, through the analysis of financial indicators, which this study tried to accomplish.

The results of this study reveal two main trends that directly answer the research issues posed in the introduction. First, not all firms suffered from the impacts of the pandemic. While some firms lost their domestic sales almost entirely, some firms did not feel the impact of the pandemic.

Moreover, this paper identified several firm structure and behaviour variables that explain such discrepancies, such as firm size, age, export intensity, and dependence on the on-trade channel. As an illustration, this research demonstrates that in a context of crisis, increasing export intensity leads to a rise in the loss of sales in the domestic market, which is related to a substitution effect of the on-trade sales by exports due to contingency measures, which affect direct-to-consumer sales within the domestic market. Therefore, strong policy measures are needed to tackle this issue, namely through the development of digital platforms, both collective and individual, that allow increasing the direct sale of wines in national markets, namely in companies that are outside the large distribution system. This issue is interrelated with a broader requirement to develop and apply downstream business models that are not as developed in Portugal as well as in traditional Old World countries [3].

Second, this study´s results exemplify the negative effect of the concentration of small average size firms that perform in a fragmented way and apparently without associative support. Public policies that strengthen associative relations and cooperation between firms would allow greater economic resilience of small businesses to external shocks such as a pandemic. So, it seems that agglomeration is not sufficient to promote entrepreneurial resilience and ultimately it can lead small businesses to compete for a direct-to-consumer market that is contracting. The variable "wine tourism" reveals precisely this, i.e. that companies most exposed to direct sales, are those that suffer most through the reduction of sales in the domestic market, in the absence of alternative means of selling (e.g. online). Furthermore, the spatial effect can also be a consequence of other factors such as the heterogeneous impact of government contingency measures at the municipal level that affected wineries differently, particularly those serving local demand.

Therefore, this study indicates the need for the development of regional robust clusters. Such examples could involve the development of cooperative practices between neighbouring firms, such as knowledge sharing, in overcoming some obstacles that firms and regions might encounter as well as promotion. Expanding the geographical range of sales in the on-trade channel could improve resilience when a specific region is more affected than others by an exogenous factor.

Overall, this paper provides some practical insights that have the potential to be further developed, such as the study of regional differences, particularly in the behaviour of wineries within each wine region. Additionally, it reveals that firms should focus on sharing knowledge, research, development activities, and other innovative ventures, in line with [52]. Moreover, proper strategy design and market positioning could be key to ensuring resilience in challenging circumstances, as suggested by [53].

This paper is not without limitations. Future research could be improved by defining clear lines between wine regions since this paper showed that there are likely to be significant structural differences between different wine regions in Portugal.

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The grapes in Italian wines: assessing their value

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Abstract. The goal of this work is to assess the impact of grape varieties on the prices of Italian wines. As an important share of this wine is exported worldwide, we look at international markets. We gauge this influence by estimating a hedonic price model based on a sample of 2315 Italian still wines reviewed in Robert Parker's Wine Advocate. The work expands results offered in literature so far as it considers quite a large number of international national and autochthonous varieties used for producing both red and white wines. Moreover, we propose an original perspective by exploring the different impacts of ageing on wine prices according to the different grape varieties utilized. Results show that, besides the well-known Italian geographical divide, many grape varieties significantly associate with different price levels. Overall, this impact is larger in the case of red wines than for the white ones. Furthermore, for the formers there are few well known varieties associated with positive price premiums, while for white wines, less widespread autochthonous varieties gain higher prices. Last, we found that successful ageing process involve both native varieties of northern and southern Italy as well as international ones.

Keywords: Italian wine, grape variety, hedonic price model, Price Premium.

1. INTRODUCTION

Wine is a hedonic good for which many quality attributes influence consumers' choice and willingness to pay [1]. These quality attributes are both intrinsic and extrinsic and some of them are search while others are experience or credence [2,3]. As a result, the market is deeply segmented and quite complex making it not trivial for producers to select an effective and coherent basket of quality features that fits each market segment. Furthermore, demand is influenced by fashion trends thus evolving very fast, while supply is much slower as it faces important constraints and rigidities. One of them is actually represented by the time length required for changing grape varieties in order to meet quick changes in consumers' taste. Grape varieties deeply interact with the place of production. As a matter of fact, grape variety is often embedded in the concept of terroir, especially in the so-called Old Wine World (OWW), and in countries where wine identity and unicity converge to form its typicity communicated to consumers via Geographical Indications (GIs). This is especially true in the case of autochthonous grapes

usually cultivated in small areas for producing niche wines [4-7]. Differently, in the New Wine World countries, international varieties are more widespread in order to meet more globalized consumer preferences.

Italy is one of the main traditional producing and exporting countries of the OWW. Here, thank to climate, geography and history, an extremely large number of grape varieties evolved and are still used for producing wine [8]. As a consequence, here market segmentation and product identity are largely based on grape varieties, some of which are spread all over the country while others are locally based and contribute to form the uniqueness of its many terroirs; besides, in the last decades, also international varieties are largely cultivated following global consumers' trends [9].

In any case, grape variety is at the very base of wine nature and is one of the main features on which consumers' choices are made [10]. The grape(s) with which the wine is made contributes to its sensorial quality and as such represents an experience attribute [11]. This is true in both cases of the so-called monovarietal and varietal wines, as well as for blended ones[1].

Disclosing grape variety(ies), hence, plays a key role in the functioning of the market. The variety(ies) used shall be indicated on the label in the case of monovarietal and varietal wines while for Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) wines this information is optional and subject to indications provided by the Rule of production[2].

All this said, it is clear that wine makers (should) base their choice on the grape variety(ies) looking at consumers' preferences while respecting the environmental constraints posed by the place of origin. It is, hence, clear that information about the value of grape varieties is a key input in any marketing strategy, from product design to pricing and for decisions on target markets and distribution channels and so on and so forth.

Wine literature provides some knowledge relative to the value of grape varieties. Some authors confirm that, generally speaking, the grape blend has a major impact on price [6,12,13]. Others found positive price premiums (PPs) for international varieties compared to national ones when used for producing Italian wines [14-16]. Seccia et al. (2017) [8] also found higher price rewards for wines produced with minor autochthonous grape varieties compared to widely used autochthonous grape varieties; however, they did not find price differences between international and autochthonous varieties. Schamel and Ros (2021) [17] also studied the influence on price of some varieties from Friuli Venezia Giulia. According to these authors, the only variety which receives a positive PP, thanks to its unique indigenous character, is Picolit; on the contrary, other monovarietal wines, made with Friulano, Malvasia, Chardonnay and Pinot Grigio grapes, get lower prices.

The analysis presented in this paper estimates the PPs associated to a large number of grape varieties used for Italian wines and, as such, expands the results of the previous works done in this field which offer estimations limited to one or few varieties. We build a hedonic price model (HP) and estimate coefficients relative to a large sample of red and white Italian wines reviewed by Robert Parker's Wine Advocate website. Furthermore, for red wines we estimate an additional hedonic price model that takes into account the interaction between the single grape variety and the vintage in order to detect the price impacts of ageing on different grape varieties.

The paper is organized as follows: Section two gives methodological information. Section three presents results while some comments and the concluding remarks are in Section four.

2. METHODOLOGY

The evaluation of the market values of grape varieties used for making wines relies on the hedonic price model. This is a well assessed and largely used methodology for evaluating the contribution of different product attributes on the final market value. The methodology has been applied in different sectors including a variety of food products [18,19] as well as wine [20-23]. The formalization of the method is due to Rosen (1974) [24]. The core idea follows Lancaster intuition that any good is a basket of attributes each of which contributes to satisfy consumers' needs [25]. The final price of the good is, hence, conceived as the sum of the implicit partial prices associated to its attributes.

A vast array of wine attributes has been employed in previous estimates of hedonic price functions in order to explain wine prices [26]. Outreville and Le Fur (2020) [27] provide a classification and summary description of most previously estimated hedonic price models for wine, while Oczkowski and Doucouliagos (2015) [28],

[1] According to the Italian law the definition of monovarietal wine is reserved to wines produced using only one among the seven varieties listed in annex 4 of the Ministerial Decree of August 13, 2012: namely Cabernet franc, Cabernet Sauvignon, Cabernet, Chardonnay, Merlot, Sauvignon and Syrah. As for the definition of varietal wine, this is reserved to wines produced with one or more of the seven varieties indicated above and without any certification of origin.

[2] More in details, for these wines the variety can be disclosed in the label only when at least 85% of the wine comes from the mentioned vine. In case two varieties are used, the label must show both in order of importance. Furthermore, GIs are allowed to disclose the variety(ies) even if this (these) is (are) different from the ones listed above.

through a meta-regression analysis, examine the empirical support for the hypothesized hedonic theoretical relation between the price of wine and its quality. Since the quality of a bottle is unknown until it is uncorked and the wine drunk, consumers' choices and willingness to pay depends on the reputation of that wine which is strictly related to various quality clues [29,30]. As one of the major features affecting quality, this analysis focuses on the grape with which the wine is made of. The previous Section of this papers reports on the contributions made so far by other authors on the role of the grape in the generation of wine value, here we add that different tendencies are identified in consumers' appreciation for international, national and local varieties [31,32] and that their price impact appears to differ across markets [26].

The place of origin, defined at different levels (Country, Region, area), is also a valuable quality clue. Several authors [33] [34], in estimating implicit prices for Italian wines, have taken into account the following three levels (from the higher to the lower) of quality/typicality which are identified by the Italian Law: designation of origin controlled and guaranteed (DOCG), controlled denomination of origin (DOC) and typical geographical indication (IGT). Two additional recent papers also explore the role and value of the place of production and of the GI: Fedoseev et. al (2023) and Souz Gonzaga et al. (2022) [35,36]. Information conveyed by GIs span from the place of production, the grapes used, the production method, the reputation associated to the GI name and established through times. These different layers of information are often intertwined one to each other, so that it is not easy to disentangle the role of each one.

Despite the difficulty in objectively and consistently assessing the sensory quality of wine, a favourable rating assigned by wine experts might generate a price premium [28,26]. Many studies include experts' evaluations among the explanatory variables of HP models [7,37,15]. Schamel and Ros, 2021 [17] confirm the important role of current quality ratings and of individual wine reputation in determining wine prices. Oczkowski (2016) [38] shows for Australian wines that prices are better explained by quality ratings than by measures of weather fluctuations, so that the weather impact on prices is better captured through quality ratings. However, even if experts' tasting is usually blind, the causal relation between evaluation and prices remains ambiguous and other authors estimate the reverse relationship [39].

Moreover, the vintage is often included in hedonic price estimates [22,35]. Its influence on wine quality and prices is double; first, the vintage expresses climate variables, second, it brings quality transformation through ageing. Both are, to some extent, wine specific and, as such, are related to the production area and to the grape variety and to the production method.

Oczkowski (2022) [26] recommends that quantity sold and producer size should not be included in hedonic price functions as these variables, affecting production costs and not consumer's utility, are inconsistent with the Rosen framework [24]. Although some counter arguments have been proposed to justify their inclusion in the hedonic price model, Oczkowski (2016) [38] and Cacchiarelli et al. (2016) [30] argue that consumers might perceive production from small producers desirable for its sense of rarity, exclusivity and status. However, these arguments are not supported by explicit theoretical developments [26].

We propose a hedonic model in which the price of a given wine (P) is a function of product attributes xj as follows:

$$P=f\,(x_1\ldots,\, x_j) \tag{1}$$

Here, the model specification was carried out by considering: the focus variables, the type of wine (i.e., red and white), results obtained with preliminary analyses on the functional form of the equation, multicollinearity as well as heteroskedasticity. Through Ramsey RESET (Regression Equation Specification Error Test), we explored a series of possible transformations of the dependent variable (e.g., log, inverse square root). The results of the test indicated that the semi-logarithmic functional form was suitable. The semi-logarithmic form allows us to interpret the $100^*(\exp^{Coef} - 1)$ percentage variation of the price as associated to a one-unit increase of each quality attribute, independently from all the others [30,40].

Based on price distribution for red and for white wines (e.g., see Table 1) and, above all, considering a likelihood ratio test for the equality of the coefficients for this dataset, which easily rejected the hypothesis of no differences by wine color, the analysis was conducted separately for red and white wines. Multicollinearity was checked through the VIF (Variance Inflation Factor). Heteroskedasticity proportional to the predicted values was tested via Goldfeld–Quandt statistics [41], and afterwards White's robust estimation strategy to obtain the parameter standard errors was used to solve this problem.

The selected model has been formulated as follows:

$$\log P = \alpha_0 + \alpha_1 \mathrm{Col} + \alpha_{2m} Var_m + \alpha_3 Mono + \alpha_{4k} Vint_k + \alpha_5 WASc + \alpha_{6z} GI_z + \varepsilon \tag{2}$$

where:

- P: is the final market price.

- *Col*: is wine color. As two different models have been estimated separately for white and red wines, the dummy variable Col is only present in the red wine model in order to distinguish red and rosé wines, these last ones have been included in the red wine model as grape varieties are the same for both red and rosé wines. Red is the benchmark.
- Var_m: is a group of dummy variables indicating the main grape variety used for making the wine. Only wines where one variety represents at least 85% of the wine are considered while more blended wines are excluded from the analysis as in these cases the variety does not represent a remarkable feature of the wine and it is not disclosed in the label (see footnote 2). For red wines the following varieties have been considered: Sangiovese, Nebbiolo, Barbera, Aglianico, Primitivo, Nerello mascalese, Pinot nero, Nero d'Avola, Cabernet (includes both Cabernet Franc and Cabernet Sauvignon), Dolcetto, Merlot, Negroamaro, Lagrein, Montepulciano, Syrah. Less common varieties (i.e. less frequent in our sample) have been aggregated in one variable called "others" which serves as benchmark[3]. The white wine varieties included in the analysis are Pinot grigio, Chardonnay, Vernaccia di San Gimignano, Vermentino, Fiano, Sauvignon, Greco bianco, Falanghina, Pinot bianco, Garganega, Grillo, Carricante, Arneis, Friulano, Trebbiano d'Abruzzo; again, a variable "other" has been added aggregating the remaining varieties and acting as benchmark[4] .
- *Mono*: is a dummy indicating whether the wine is monovarietal. This has been inserted to see whether monovarietal wines per sè, irrespective of the specific variety used, get higher prices.
- $Vint_k$: are the dummies for the three vintages considered (2013, 2014 and 2015 that is the benchmark). As the vintage usually has an impact on price and this may be related to some varieties more than to others, we also seek at disentangling the value of ageing from that of the variety by building an additional model (see below).
- *WASc*: is the score assigned to each wine by Wine Advocate. WA evaluations are provided by experts after blind tastings. We assume that the score reflects the sensorial quality of the wine; this means that the model provides estimates of the PP associated to the variety, quality being equal. Furthermore, all variables other than the variety provide reference values which help to interpret results for the interest variables. WA scores span from 59 to 100[5].
- GI_z: denotes the certification of origin. The different certifications form the so-called Quality Pyramid and, hence, set an explicit vertical differentiation [42]. The GI carries different valuable information to consumers which we include the three levels established by the Italian law, from the higher to the lower level of quality/typicality: Controlled and Guaranteed Designation of Origin (DOCG), Controlled Designation of Origin (DOC) and Typical Geographical Indication (IGT), which here serves as the benchmark.

Since the impact of quality attributes on price may differ across price levels, as confirmed in previous works [43,44,14], we investigated the price distributions for both red and white wines. Figures 1a and 1b show the distributions of prices through a probability density function, which is a powerful tool to describe several properties of a variable of interest [45]. Although these functions seem basically unimodal (at 20 and 14 euros, respectively), they also present a few additional, much less pronounced, modes (see in the higher quantiles) and a stretched shape of the right-side tail of the distribution. Such distributions suggest exploring the relationships between price and the selected quality clues along the different quantiles, and particularly at the two extremes, as they might change significantly. As a consequence, both an OLS and a QR model were run to go deeper into the analysis of market segmentation. While the former shows how the various quality clues affect prices, on average; the latter detects additional patterns (location, scale and skewness shifts) related to the effects of the covariates and, thus, allows to investigate consumers' behavior at different price levels [46]. Quantile regression, which is not affected by outliers of the

[3] The list of the benchmark varieties for the red subsample is as follows: Alicante bouschet, Bombino n., Bovale, Calabrese montenuovo, Cannonau, Carignano, Casavecchia, Cesanese, Ciliegiolo, Cinsault, Croatina, Frappato, Freisa, Gaglioppo, Graciano, Greco n., Grenache, Grignolino, Magliocco, Malvasia nera, Marcigliana, Marzemino, Monica, Nerello cappuccio, Nero di Troia, Nocera, Pallagrello n., Pelaverga, Perricone, Petit verdot, Piedirosso,Pinot grigio, Pugnitello, Refosco, Rossese, Ruchè, Sagrantino, Schiava, Susumaniello, Teroldego, Tintilia, Uva di Troia, Vespolina.

[4] The list of the benchmark varieties for the white subsample is as follows: Aglianico, Albana, Ansonica, Asprinio, Bellone, Biancolella, Bombino b., Catarratto b., Coda di Volpe, Cortese, Forastera, Gewurztraminer, Grechetto, Gruner Veltliner, Guardavalle, Incrocio Manzoni, Inzolia, Kerner, Malvasia, Malvasia istriana, Malvasia puntinata, Mantonico, Manzoni bianco, Moscato giallo, Muller Thurgau, Nascetta, Nasco, Nero d'Avola, Nosiola, Nuragus, Pallagrello b., Passerina, Pecorello, Petite Arvine, Pigato, Ribolla gialla, Ribona, Riesling, Roscetto, Sylvaner, Torbato, Trebbiano Toscano, Verdeca, Verdicchio, Verduzzo friulano, Vernaccia, Viognier, Vitovska, Zibibbo.

[5] Grades also include half points (0.5). In some cases, a "+" is added which in our analysis leads to 0.5 points upward shift. We are aware that this somehow distorts the evaluation. However, the distortion is minimum and the "+" were very few in our sample

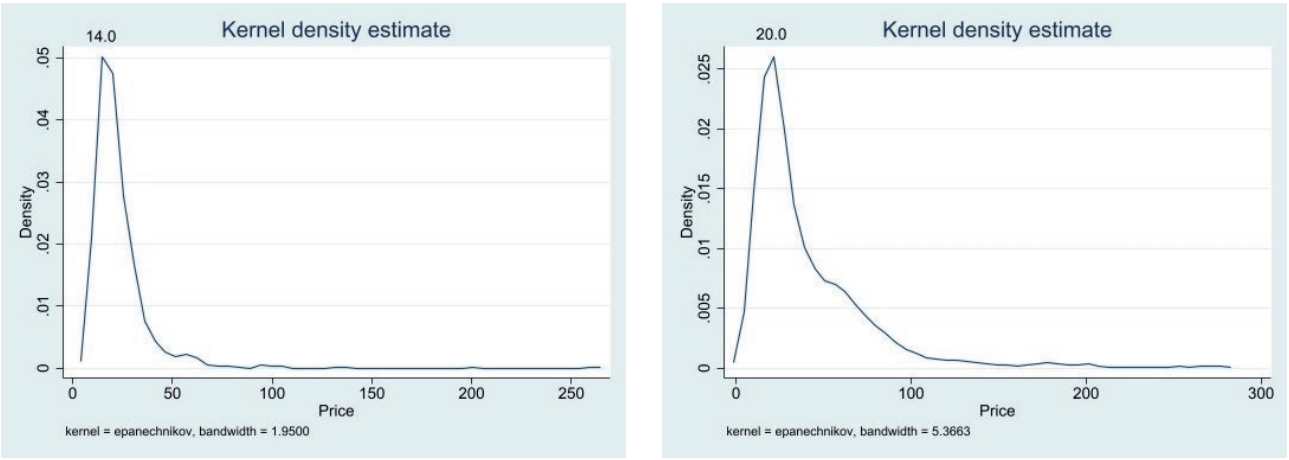

Figure 1. a) Prices distribution for red wines. b) Prices distribution for white wines. Source: elaborations on data from Wine Advocate by Robert Parker.

dependent variable, provides robust estimates of coefficients, and, in case of not-normal distribution of the errors, more efficient estimators compared to the OLS ones [47].

Furthermore, based on the idea that quality performance may vary over time [29[6]], we estimate a further HP model where grape varieties interact with ageing. This allows to see for which varieties the ageing process brings more value. This model, referred only to red wines for which ageing is more common and relevant, is as follows:

$$\log P = \alpha_0 + \alpha_{1mk}\, Var_{m^*}\, Vint_k + \alpha_{2zk}\, GI_{z^*}\, Vint_k + \varepsilon \qquad (3)$$

in which, again: *m*= the name of grape variety; *k*=the vintage; and *z*=the kind of GI. The interaction terms between variety and vintage allow us to estimate whether and to what extent ageing is a successful selective process associated to specific varieties. We also included interaction terms between the different certifications of origin and the vintage which allows us to assess how ageing affects the value of GIs. Equation (3) was estimated via OLS.

Information used for estimating the models have been drawn in 2019 from the online guide Wine Advocate (WA) by the world-famous wine guru Robert Parker. The website is based in the USA but it is active in more than 37 countries around the world and accounts for more than 50 thousands subscriptions.

Wine Advocate provides users with many info on the reviewed wines, such as: the name of the wine, the color, the typology (sparkling, still, sweet, etc.), the country of production, the certification of origin, the grape variety(ies), the vintage, the score obtained according to the guide experts testing, main markets where the wine is present, the name of the producer, the final price in US dollars (VAT included)[7] . The prices disclosed by the guide are quite reliable and stable as they are neither influenced by the kind of retailer nor by seasonality [48].

At the moment when we took the data, the guide reviewed about 37thousands Italian wines. From these we selected a sample of 2315 still wines made out of the main Italian grape varieties. All sparkling wines have been excluded. The sample includes 1506 red and 54 rosé wines – these have been pooled together in one subsample referred to as the "red sample" – plus, it includes also 755 white wines that are kept in a separate sub-sample. Blended wines (i.e. wines with no individual variety accounting for at least 85% of the wine) were excluded due to the minor role played by the variety for such wines. Wines for which information about the grape varieties used was not available and/or easily visible to the consumer were excluded. All the wines considered are GIs. Italian territories are all well represented in the sample, however, among white wines northern Regions are more frequent, while the red ones come mainly from central Italy. Vintages considered are 2013, 2014 and 2015; the selection follows the criterion of the most possible balanced presence of the three different years, also considering the different attitude to ageing of red and white wines.

[6] The author calculated regional reputation indicators based on their relative quality performance through time for three vintage periods in order to examine how different regions performed over time.

[7] In some cases, exact prices were available, while in some others the average value of the available range has been calculated.

3. RESULTS AND DISCUSSION

3.1 The sample

Table 1 shows the distribution of the wines by price classes and the average value in each class. It emerges that average prices differ significantly (41.5$ for the reds and 23.0$ for the whites), furthermore the red ones are more concentrated in higher price segments while the whites are relatively more present in lower price segments, adding scope for keeping the two models separate (a similar approach and results can be found also in [14,8]).

As for WA evaluations, Table 2 shows that the wines included in the sample obtained a minimum score of 78/100 and concentrates in the 87/88 points class. However, the red wines gained on average a higher appreciation (89.7 vs 88.7) and are more concentrated in the upper score classes compared to the whites, none of which reaches the so-called excellence (corresponding to the 96-97 score class).

Table 3 presents the descriptive statistics relative to the grape varieties; in each subsample there are 15 varieties divided in international[8], national[9] and autochthonous[10].

First, it must be noted that Sangiovese and Nebbiolo, respectively a national (N) and an autochthonous (A) variety, together account for more than one half of the red sub-sample while in the white wine sub-sample the distribution of the varieties is much smoother. The large presence of Sangiovese wines reflects the major role of this grape in Italy, while the presence of many wines made with Nebbiolo grapes reflects the bias of the guide in favor of these wines. Similarly, it must be noted that the small presence of Montepulciano grapes, a variety well widespread in Italy, reflects the poor appreciation of the guide for these wines. International varieties (I) altogether are much more widespread in white wines than in red ones (28% vs 9%). Autochthonous varieties are well present in both sub-samples with many different grapes, each one with a limited number of wines, with the only exception of Nebbiolo recalled above and for which it is worth pinpointing the extremely high average prices.

Descriptive statistics related to the vintage are presented in Table 4. Wines produced in 2013 are the majority for the red wines subsample, while younger wines (2015 vintage) are prevalent in the case of white wines[11]. Average prices of red wines for the vintages 2013 and 2014 are much higher than those of white wines (respectively 49$ vs 20$ and 41$ vs 24$) while for the vintage 2015 the gap is smaller (29$ vs 23$).

Table 5 shows the distribution of wines in the sample according to the kind of GI. DOCGs are more frequent for red wines and much less for the whites where, instead, DOCs prevail. The share of IGTs is lower in both sub-samples but still significant. It is also interesting to notice that the price range is wider for red wines compared to that of the whites. Average price of DOCG wines is very high for red wines, but it is not so for the whites where both DOCs and IGTs gain higher prices basically thanks to the wines made with international grapes among which there are not DOCG. Lastly, as it has been observed also in other studies, red IGT bottles are worth much more than DOC, thus, somehow reversing the so-called quality pyramid [14,49].

Table 1. Wines by price classes.

price classes	red and rosè wines			white wines		
	number of wines	%	average price ($)	number of wines	%	average price ($)
< 9,99	21	1.3	7.7	25	3.3	8.2
10 - 14,9	150	9.6	12.4	155	20.5	12.4
15 - 19,9	265	17.0	17.0	203	26.9	17.1
20 - 25,9	230	14.7	21.9	149	19.7	21.8
25 - 29,9	142	9.1	26.6	86	11.4	26.8
30 - 39,9	187	12.0	34.0	81	10.7	33.2
40 - 49,9	120	7.7	43.6	25	3.3	44.3
50 - 75,9	258	16.5	60.8	22	2.9	59.0
76 - 99,9	95	6.1	85.1	4	0.5	86.5
> = 100	92	5.9	152.8	5	0.7	160.5
total wines	1560		41.5	755		23.0

Source: elaborations on data from Wine Advocate by Robert Parker.

Table 2. Wines by evaluations and prices.

evaluation classes	red and rosè wines				white wines			
	number of wines	%	average price ($)	average evaluation	number of wines	%	average price ($)	average evaluation
78-85	58	3.7	19.3	84.1	43	5.7	15.8	84.6
85.5-86.5	82	5.3	21.6	86.0	54	7.2	18.4	86.0
87-88	474	30.4	24.4	87.6	300	39.7	18.8	87.6
88.5-89.5	211	13.5	33.1	89.0	117	15.5	23.1	88.9
90-91	308	19.7	39.2	90.4	142	18.8	24.7	90.4
91.5-92.5	157	10.1	52.0	92.0	63	8.3	30.1	92.0
93-94	189	12.1	72.6	93.4	29	3.8	48.6	93.3
94.5-95.5	51	3.3	112.9	95.0	7	0.9	82.6	94.6
96-97	30	1.9	119.6	96.4	0	0.0	0.0	0.0
total wines	1560		41.5	89.7	755		23.0	88.7

Source: elaborations on data from Wine Advocate by Robert Parker.

[8] International varieties were originally imported from other countries and more recently started to be cultivated also in Italy. Among these, there are Merlot, Cabernet sauvignon, Chardonnay, etc.

[9] National varieties originate in a specific Italian region but afterwards spread in other regions or even throughout the Country. Examples are Sangiovese and Trebbiano.

[10] Autochthonous varieties are cultivated in limited areas and are deeply rooted in that place. Examples are Lagrein, Aglianico and Falanghina.

[11] Almost one fourth of the wines in the sample has been reviewed for different vintages; in such cases only the more recent vintage has been here considered.

Table 3. Wines by variety and price.

grape varieties	red and rosè wines: international (I)/national (N)/ authochtonous (A) grape varieties	number of wines	%	average price ($)	grape varieties	white wines: international (I)/national (N)/ authochtonous (A) grape varieties	number of wines	%	average price ($)
Sangiovese	N	553	35.4	40.1	Pinot grigio	I	66	8.7	19.4
Nebbiolo	A	330	21.2	67.9	Chardonnay	I	62	8.2	35.6
Barbera	A	87	5.6	26.5	Vernaccia di San Gimignano	A	59	7.8	15.4
Aglianico	A	62	4.0	22.9	Vermentino	A	53	7.0	21.1
Primitivo	A	54	3.5	23.2	Fiano	A	50	6.6	21.6
Nerello Mascalese	A	51	3.3	44.9	Sauvignon	I	50	6.6	29.8
Pinot nero	I	45	2.9	38.0	Greco bianco	A	47	6.2	22.3
Nero d'avola	A	42	2.7	19.0	Falanghina	A	34	4.5	16.4
Cabernet (Franc and Sauvignon)	I	39	2.5	52.3	Pinot bianco	I	34	4.5	30.2
Dolcetto	A	29	1.9	18.4	Garganega	A	26	3.4	20.3
Merlot	I	25	1.6	75.8	Grillo	A	25	3.3	19.2
Negroamaro	A	25	1.6	17.7	Carricante	A	24	3.2	28.3
Lagrein	A	22	1.4	31.5	Arneis	A	21	2.8	19.5
Montepulciano	N	21	1.3	13.1	Friulano	A	19	2.5	25.0
Syrah	I	19	1.2	50.5	Trebbiano d'Abruzzo	N	16	2.1	18.3
Altri vitigni	I/N/A	156	10.0	23.0	Altri vitigni	I/N/A	169	22.4	22.5

Source: elaborations on data from Wine Advocate by Robert Parker.

Table 4. Wines by vintage and price.

vintage	red and rosè wines: number of wines	%	average price ($)	white wines: number of wines	%	average price ($)
2013	713	45.7	49.1	176	23.3	19.9
2014	427	27.4	40.9	251	33.2	24.1
2015	420	26.9	29.2	328	43.4	23.2
total wines	1560	100.0	41.5	755	100.0	23.0

Source: elaborations on data from Wine Advocate by Robert Parker.

Table 5. Wines reviewed by GI and price.

GIs	red and rosè wines: number of wines	%	average price ($)	white wines: number of wines	%	average price ($)
DOCG	706	45.3	55.2	160	21.2	19.9
DOC	591	37.9	26.9	449	59.5	24.1
IGT	263	16.8	37.6	146	19.3	23.2
total wines	1560	100.0	41.5	755	100.0	23.0

Source: elaborations on data from Wine Advocate by Robert Parker.

3.2 Results of the estimations of the hedonic Price Model for red wines

Overall, the model seems to capture the price-variety relationship as witnessed by the R2 and pseudo R2 of the OLS and QR, respectively. The first equals 0.6141 and the second ranges from 0.357 to 0.4073 (Table 6). These are quite high values also compared with similar works reported in the literature [50,51].

OLS estimation shows that, on average, the grape variety has an impact on the price of the wine. This is true for most varieties included in the model. The quantile regression estimates indicate that these impacts differ in the different market segments, thus suggesting different behaviors and price formation patterns in the different segments. More in details, international varieties gain positive PP in all market segments and these are larger as price goes up; Merlot leads with a PP of+80% in the OLS. The only exception is Syrah which gains no PP. As for national varieties, Sangiovese grape gains a positive PP that goes from +15%, in the lowest quantile, to +25% in the highest quantile. Differently, Montepulciano grape has a strong negative influence on the price which increases in higher market segments (values range from -20 to -28%). Results for autochthonous varieties are more mixed with both positive and negative PPs. Generally, autochthonous varieties cultivated in northern regions associate with positive PPs (Nebbiolo and Lagrein and, partially, Dolcetto) even if in some cases the bias decreases as price increases, while in other cases the tendency is opposite.

Differently, the varieties linked to southern regions basically gain lower prices, even if the patterns of the size of the PPs is much varied. These are the cases of Nero d'Avola, Negroamaro, Aglianico and Primitivo for which negative PPs span from about 10% to 20%. The only notable exception is Nerello Mascalese, which gains quite large positive PPs at all price levels (19-35%). Our results confirm, at the same time, that both varieties and places of production (both at Regional and local level) play a relevant role in the creation of the value of

a wine and that they are intertwined one with the other so that it is not an easy task to disentangle the two features as well as that of the GI the wine belongs to. One more indication of the strong impact of the grape on red wines is also confirmed by the higher values associated to monovarietal wines: the coefficients for this variable are significant at all price levels and the positive PPs increase with price (from 24% to 33%).

Coming to the impacts of vintage and WA evaluation, both have significant impact on prices beside that of the variety. Older wines generally get higher prices, and the differentials are generally larger in higher market segments. As for the evaluation, better evaluated wines gain much higher prices: on average +13% every 0.5 increase in the score assigned. The differentials are slightly larger in lower market segments as if consumers rely more on the guide for relatively cheaper wines than for the expensive ones for which they spend more time for gathering information through different sources. The coefficient of the variable Color (Col) is not significant, indicating that red and rosé wines per sè do not gain different prices.

Finally, also the certification of origin affects final prices. Considering that the coefficients of the dummy variables (DOCG and DOC) are to be interpreted as a price premium compared to the reference wines (IGT), estimates confirm evidence emerged from the descriptive statistics: IGTs value more than DOCs in all market segments. Despite their high average price, DOCG wines are associated to larger positive price premium only in the low and medium segments, while this is not so in Q75, indicating that in the highest quantiles other attributes (e.g. producer, grape variety) play a more relevant role.

It is here worthwhile underlining that the variables included in the model generate impacts on price which are similar in magnitude, confirming that grape variety is a relevant and valued quality attribute among others.

Results of the estimates for the value associated to the ageing of red wines are reported in Table 7. In this regression the 2015 vintage has been chosen as the reference. Overall, the model captures a relevant share (R^2= 0.386) of price variability and several interaction terms between vintages and grape varieties (and GIs) are statistically significant, thus confirming that ageing plays an important role in the red wines market [52]. More specifically, this analysis shows clearly that ageing is idiosyncratic with respect to grapes, with some varieties gaining more value than others as time goes by. Wines produced in 2013 with Nebbiolo, Nerello Mascalese, Cabernet, Pinot Noir and Sangiovese are associated to PPs which range from 33% to 133% compared to the same grape varieties in the 2015 vintage. Successful ageing process involve native varieties of both northern (Nebbiolo) and southern Italy (Nerello Mascalese) as well as international grape varieties such as Cabernet and Pinot Noir. In some cases, only 2013 associates with larger PPs while 2014 coefficients are not significant. It is worth to pinpoint that, due to the short time series observed, the "vintage effect" may be interpreted as the consequence of specific climate outcomes rather than as the effect of ageing. This is, probably, the case of Nero d'Avola which has a negative significant coefficient only for 2014.

Table 6. HP estimations for red wines[1,2].

variables	OLS	Q25	Q50	Q75
Merlot	0.804*	0.732**	0.659*	1.524*
	(0.139)	(0.287)	(0.091)	(0.146)
Cabernet	0.531*	0.322*	0.423*	0.944*
	(0.099)	(0.069)	(0.105)	(0.085)
PinotNero	0.384*	0.219*	0.278***	0.461*
	(0.087)	(0.067)	(0.142)	(0.129)
Syrah	0,2312	0,0833	0,0986	0,6242
	(0.155)	(0.129)	(0.146)	(0.165)
Sangiovese	0.223*	0.151*	0.202*	0.254*
	(0.044)	(0.045)	(0.048)	(0.055)
Montepulciano	-0.216*	-0.197**	-0.228**	-0.277***
	(0.092)	(0.097)	(0.134)	(0.181)
Nebbiolo	0.594*	0.486*	0.531*	0.751*
	(0.048)	(0.051)	(0.053)	(0.074)
Barbera	0.174*	0,0747	0.155**	0.218*
	(0.055)	(0.049)	(0.065)	(0.074)
Lagrein	0.568*	0.537*	0.531*	0.579*
	(0.081)	(0.058)	(0.059)	(0.116)
Dolcetto	-0,0227	0,0534	0,0202	-0.109***
	(0.064)	(0.155)	(0.061)	(0.067)
Nerello Mascalese	0.347*	0.190*	0.266*	0.336**
	(0.085)	(0.040)	(0.075)	(0.138)
Nero d'Avola	-0.169*	-0.12***	-0.219*	-0.138**
	(0.067)	(0.080)	(0.077)	(0.073)
Negroamaro	-0.179**	-0.180*	-0.1983	-0.209***
	(0.084)	(0.078)	(0.175)	(0.143)
Aglianico	-0.115***	-0,0915	-0.173*	-0,1341
	(0.071)	(0.110)	(0.066)	(0.134)
Primitivo	-0,0924	0,0050	-0.087**	-0,1245
	(0.065)	(0.071)	(0.042)	(0.097)
Monovarietal	0.245*	0.237*	0.278*	0.331*
	(0.027)	(0.025)	(0.025)	(0.037)
Vint2013	0.220*	0.129*	0.218*	0.318*
	(0.028)	(0.033)	(0.030)	(0.040)
Vint2014	0.249*	0.198*	0.294*	0.262*
	(0.031)	(0.029)	(0.029)	(0.041)
WA Score	0.131*	0.135*	0.132*	0.122*
	(0.005)	(0.005)	(0.005)	(0.007)
Colour	0.135**	0.126***	0,0920	0,0629
	(0.065)	(0.064)	(0.078)	(0.124)
DOCG	0.122**	0.176*	0.150***	0.0171***
	(0.049)	(0.044)	(0.051)	(0.068)
DOC	-0.129*	-0,0392	-0.085**	-0.199*
	(0.041)	(0.034)	(0.041)	(0.058)
_cons	-0.999*	-0.999*	-0.999*	-0.999*
	(0.608)	(0.530)	(0.579)	(0.793)
R2	0,6141	0,357	0,4051	0,4073
Obs		1560		

[1] Table reports coefficients after their exponential transformation and standard errors (in brackets).

[2] Statistically significant respectively at: * < 0.01, ** <0.05, ***, <0.10.

Source: elaborations on data from Wine Advocate by Robert Parker.

Table 7. HP estimations for red wines ageing[1,2].

variables	OLS	Std. Err.
Nebbiolo14	1.745*	(0.143)
Nebbiolo13	0.937*	(0.081)
NerelloMascalese14	0.978*	(0.127)
NerelloMascalese13	1.339*	(0.286)
Sangiovese14	0.130	(0.141)
Sangiovese13	0.326*	(0.075)
Cabernet14	0.102	(0.300)
Cabernet13	1.357*	(0.158)
PinotNero14	0.289	(0.307)
PinotNero13	0.705*	(0.112)
NerodAvola14	-0.171***	(0.097)
NerodAvola13	0.122	(0.156)
Barbera14	0.246	(0.135)
Barbera13	0.052	(0.110)
Aglianico14	-0.088	(0.094)
Aglianico13	-0.105	(0.151)
Primitivo14	-0.168	(0.157)
Primitivo13	0.139	(0.142)
DOCG14	-0.039	(0.142)
DOCG13	0.453*	(0.080)
DOC14	-0.224*	(0.064)
DOC13	-0.269*	(0.061)
IGT14	0.008	(0.111)
IGT13	-0.079	(0.077)
cons	23.395	(0.028)
R2	0.386	

[1] Table reports coefficients after their exponential transformation and standard errors (in brackets).
[2] Statistically significant respectively at: * < 0.01, ** <0.05, ***, <0.10.
Source: elaborations on data from Wine Advocate by Robert Parker.

Finally, the interaction terms between vintage and the different types of GIs show that ageing exclusively plays a positive relevant role for DOCG wines, while increasingly negative PPs emerge for DOCs, probably due to their lower average quality which may be not well suited for wine ageing.

3.3 Results of the estimations of the hedonic Price Model for white wines

Despite the lower variability of prices, the HP model estimated on the 755 white wines provides a sound picture of the price-variety relationship and confirms the presence of a significant impact on prices of the grape variety. Values of the R2 and pseudoR2s (Tab. 8) are lower than for red wines, but still well acceptable, being respectively 0.325 in the OLS and in the range 0.161-0.189 in the QR [45,51].

Overall, estimated PPs are lower for white wines than for the red ones for all the variables observed. However, concerning grape varieties there are many which have significant impacts on price. Chardonnay and Sauvignon, two international varieties, gain positive PPs, while the third one, Pinot Grigio, associates with lower prices. The first gets larger PPs in higher market segments, while the second gets higher positive differentials in lower market segments. Negative PPs estimated for Pinot Grigio are significant for medium to high prices. The only white national variety included in the sample, Trebbiano di Abruzzo, gets, on average, large negative PPs. Autochthonous white varieties generally are less worth than the benchmark wines with the only exceptions of Carricante, whose prices are higher, and of Vermentino and Arneis, whose coefficients are not statistically significant. All in all, results say that the market for white wines is more fragmented as it tends to attach more value to minor autochthonous varieties as compared to more common ones included in the benchmark.

As observed for red wines, also in the case of white ones, we observe that those from southern regions associate with lower prices. The tendency of white wines to differentiate less their prices is also confirmed, respectively, by DOCG and DOC which are not more valuable than IGT and by the PP associated to Monovarietal wines; that is still positive but smaller and only significant at Q50 (+5.5%). Following the tendency, recently established also for Italian white wines, to being aged, at least to some extent, PPs are observed also for this variable. However, these are more limited and with mixed signs (here also the benchmark is 2015): they are positive for 2013 but negative for 2014, probably also due to the mixed impact of the weather in that year, that Wine Spectator defined as "challenging" especially for white wines (www.winespectator.com) [53]. Last, the WA evaluations affect prices also for white wines but, again, to a lesser extent (on average +9% for each additional 0.5 score), furthermore, in this case the impact is larger in higher market segments indicating that reviews impact in a different way for red wines than for white ones.

Table 8. HP estimations for white wines[1,2].

variables	OLS	Q25	Q50	Q75
Sauvignon	0.184**	0.134***	0.147***	0,137
	(0.072)	(0.075)	(0.074)	(0.109)
Chardonnay	0.188**	0,172	0,063	0.302***
	(0.072)	(0.105)	(0.048)	(0.149)
Pinot grigio	-0,043	-0,032	-0.090***	-0.129***
	(0.047)	(0.054)	(0.055)	(0.074)
Pinot bianco	0,010	-0,128	-0,007	-0,031
	(0.092)	(0.161)	(0.089)	(0.141)
Trebbiano d'Abruzzo	-0.248**	-0,229	-0.293*	-0,199
	(0.113)	(0.290)	(0.061)	(0.304)
Vernaccia di San Gimignano	-0.347*	-0.338*	-0.386*	-0.341*
	(0.085)	(0.087)	(0.112)	(0.071)
Fiano	-0.121***	-0.131***	-0,141	-0,168
	(0.075)	(0.081)	(0.099)	(0.141)
Falanghina	-0.221*	-0.161*	-0.216*	-0.320*
	(0.067)	(0.050)	(0.053)	(0.096)
Carricante	0.138***	0.166*	0,188	0,045
	(0.078)	(0.054)	(0.109)	(0.108)
Grecobianco	-0,087	-0,072	-0,110	-0,060
	(0.081)	(0.087)	(0.103)	(0.084)
Grillo	-0.154**	-0.155*	-0,125	-0.145**
	(0.079)	(0.046)	(0.132)	(0.069)
Friulano	0.174***	0.192*	0.189*	0,103
	(0.074)	(0.057)	(0.063)	(0.063)
Garganega	-0.132**	-0,036	-0.156*	-0.258*
	(0.060)	(0.079)	(0.058)	(0.057)
Vermentino	0,014	-0,003	-0,085	0,021
	(0.065)	(0.076)	(0.079)	(0.090)
Arneis	-0,074	0,051	-0.199**	-0,069
	(0.095)	(0.101)	(0.102)	(0.171)
Monovarietal	0,035	0,034	0.055***	0,008
	(0.033)	(0.029)	(0.029)	(0.043)
DOCG	0,055	0,041	0,123	0,052
	(0.073)	(0.067)	(0.075)	(0.066)
DOC	-0,030	0,029	-0,029	0,006
	(0.042)	(0.042)	(0.037)	(0.055)
Vintage2013	0,031	0,060	0.093**	0,052
	(0.037)	(0.042)	(0.037)	(0.038)
Vintage2014	-0,010	-0.063***	0,015	0,043
	(0.038)	(0.037)	(0.036)	(0.045)
WA Score	0.099*	0.071*	0.093*	0.103*
	(0.008)	(0.007)	(0.007)	(0.008)
_cons	-0.995*	-0.964*	-0.993*	-0.996*
	(0.751)	(0.632)	(0.631)	(0.707)
R2	0,325	0,161	0,173	0,189
Obs		755		

[1] Table reports coefficients after their exponential transformation and standard errors (in brackets).
[2] Statistically significant respectively at: * < 0.01, ** <0.05, ***, <0.10.
Source: elaborations on data from Wine Advocate by Robert Parker.

4. DISCUSSION AND CONCLUSIONS

The value added of the analysis presented in this paper consists in assessing the market value of a large number of grape varieties used for making Italian wines.

The estimated HP models show that grape varieties impact on the prices of both red and white wines and that these impacts are, overall, comparable to that of other quality attributes and in some cases are even larger. The observed PPs are mixed, indicating that some grapes increase prices while others have a negative effect. Furthermore, results of the QR models signal that the impacts of the grape varieties are different at different price levels, with some grapes that are comparatively more valued in the higher market segments while for others the opposite holds.

Overall, the market for red wines is more differentiated with some grapes that get higher prices and associate with larger PPs than that used for making white wines.

On average, international varieties gain large positive PPs which increase with price; the differentials are particularly large for white wines, with the notable exception of Pinot Grigio which gets negative PPs. Among national varieties, only Sangiovese, the most reviewed grape variety in WA, is associated to positive PPs; while prices for Montepulciano and Trebbiano d'Abruzzo gain negative PPs. Many autochthonous varieties gain positive price premiums, especially in the case of red wines from northern regions, while for white wines and for many varieties rooted in southern regions results are more mixed and are often in favor of less common varieties included in the group used as benchmark. The well-known divide between Italian southern and northern-central regions is here confirmed even if southern wines are improving their market positioning. All in all, the market seems to be somehow polarized between international and autochthonous varieties while the only rewarding nationwide grape is Sangiovese.

Our results confirm that both varieties and places of production (at Regional as well at local level) play a relevant role in the creation of the value of a wine. Varieties and places of production are strictly intertwined one with the other. Hence, to disentangle the two features, as well as that of the GI the wine belongs, it is not an easy task. In particular this is true in our sample that includes many wines where the grape and the region/area of production are strictly associated. More efforts will be required on this by future research in terms of sample selection and estimation techniques.

The analysis also confirms that the certifications of origin are worthy to consumers even if the so-called quality pyramid is reversed for red DOC and IGT wines. This result is well consistent with the many cases of IGTs that have taken advantage of flexibility in terms of grape content, image and geographical identity, adjusting quicker and better to changes in the consumers' preferences, fashion trends and strategies of competitors worldwide [49,30].

One additional insight provided by the analysis is that ageing, on average, adds value to wines even if it is, as expected, idiosyncratic with respect to grapes. In fact, as time goes by some red varieties gain more value than others. Successful ageing process involve native varieties of both northern and southern Italy, as well as international grape varieties. In some cases, more than one year is required for value to arise, and this holds both for varieties and for GIs. Interacting age with grape variety helped in getting more insights. However, look-

ing only at three vintages does not allow to disentangle the effect of ageing to that of climate at regional level in each specific year. More meaningful results on this point will require exploring a longer time span and expressing climate with regional/local variables.

Last, our results indicate that evaluations provided by experts (WA scores) are valuable to consumers but that this value is not smooth in the different market segments. Comparing the PPs associated to the white and to the red wines in the different quintiles, and considering their different price levels, we see a nonlinear relation. In particular, PPs associated to the experts' evaluations are lower for the cheapest wines (Q25 and Q50 in the white wines sample), then increase (Q75 for whites and Q25/Q50 for the reds) and afterwards they decrease again at the highest price levels (Q75 for the red wines).

Our suggested interpretation of this nonlinear relation is paved in different strands of the literature and starts from acknowledging that obtaining information costs money and, under this respect, it is a typical transaction cost [54]. So that for the purchase of low-priced wines it is not worth incurring in these costs (even consulting/paying the guide represents too high a cost); as the price range increases, the transaction cost represented by consulting the guide reduces in relative terms and it is therefore worth sustaining (and in fact the PP of the score increases); finally, for even more expensive wines it is not only worth referring to the guide but it becomes possible and convenient to incur in further costs to collect additional information from other sources so that the PPs associated to WA reduce a little [55,56].

The results here presented contribute to a better understanding of the wine market with respect to the values associated to different grape varieties some of which are highly appreciated by consumers while others are not. This is a core variable in the firms' decision process both for farmers and wineries. In fact, selecting the grape varieties for making wine has long lasting implications for the whole production process that leads to wine supply. Last but not least, it involves many different actors along the chain (from nurseries to retailers) that shall coordinate altogether their strategies.

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Social or environmental consciousness? Exploring the consumption of cooperative wines among European citizens

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Abstract. Although the role of wine cooperatives in supporting sustainability has been deeply analysed on the supply side, the study of consumers' perception and behaviour when choosing these wines is still scarce. This paper analyses the attitudes, preferences and the willingness to pay (WTP) of European consumers, both when they purchase cooperative-produced wines and in their attitude to consuming these wines. Their preferences between cooperative-produced and organic wines were compared with the aim of understanding whether they prioritise the social aspects of the cooperatives or the environmentally friendly aspects of organic production. A survey among 3,295 individuals in different European countries was carried out. The data were firstly analysed by means of univariate tests to assess consumers' heterogeneity and by a bivariate probit model to explore the drivers of attitude and behaviour; then a multinomial logit and a random parameters logit framework were adopted. We found an association between familiarity with cooperative and organic wines and thus the propensity to buy these products and a higher WTP for organic than cooperative wines. Our findings suggest that producing organic wines might be a strategy for wine cooperatives to better target the market.

Keywords: cooperative wine, sustainability, wine consumption.

1. INTRODUCTION

Agricultural cooperatives play a significant role in influencing farms' sustainability [1]. According to Dessart et al. [2], several studies have assessed the importance of cooperatives in supporting farms' sustainability efforts. Some studies have identified the positive impacts of agricultural cooperatives. Since 1962, the economic behaviour of cooperatives has been analysed by scholars through the use of a number of different models [3]. They studied, in particular, the economic organisation of agricultural cooperatives (e.g. [4]), their governance structure (e.g. [5]), the members' economic gains (e.g. [6]) and the quality choices of cooperatives (e.g. [7]). These studies, however, also recognised some economic weaknesses, such as often poor eco-

nomic performance [8], overproduction linked to open membership [7] and underinvestment [9]. However, they pointed out the economic advantages linked to eliminating supply chain intermediaries [10]. Moreover, some scholars demonstrated that cooperatives are able to produce positive net economic results [11,12].

Furthermore, cooperatives encourage the adoption of environmentally friendly practices among members [13] and offer technical assistance to increase farmers' propensity to adopt safe production practices [14].

In addition, although studies explicitly exploring the social role of cooperatives are scarce and mainly carried out by sociologists [15,16], they demonstrated that being a member of a cooperative has a positive impact [17,18]. Besides the well-known enhancement of bargaining power effect, the opportunity to derive advantages from scale economies and to increase the value of members' raw products, specifically referring to social aspects, it is possible to point out also the opportunity to increase social interactions between members and non-members.

The presence of cooperatives covers a significant part of the wine production sector [19]: for example, according to ISMEA [20], more than 55% of Italian wine production comes from cooperatives, which, therefore, could play a role in the improvement of wine farm sustainability [21,22]. The close relationships that cooperatives create with grape producers may support the change of farm practices, including supporting the adoption of more sustainable methods of grape growing, may enhance positive external social impacts [23] and may increase economic performance [11,24].

However, the relevant role that cooperatives can play in supporting sustainability does not seem to be completely recognised by consumers who seem to be solely aware of cooperatives' social contributions. Furthermore, consumers do not seem to prefer wines produced by cooperatives, which they consider to be unsatisfactory in terms of quality. Although consumers have become increasingly aware of and sensitive to sustainability issues, it seems that cooperatives are assigned the pure role of social sustainability.

Consequently, the first purpose of our study was to explore consumers' attitudes and preferences towards wines produced by cooperatives in different geographical contexts. It aimed to analyse the attitudes, preferences and the willingness to pay (WTP) of European consumers, both when they purchase cooperative-produced wines and in their attitude to consuming these wines.

The second purpose was to compare consumers' preferences for cooperative-produced and organic wines to determine whether they prefer the cooperatives' social role or the environmentally friendly aspects mainly represented by organic wines. We analysed these aspects on a convenience sample of European consumers, both those familiar and clearly not familiar with cooperative-produced wines in order to identify differences in their replies. Our research combines wine consumers' social, economic and environmental points of view; consequently, it is fundamentally different from traditional studies devoted to the evaluation of wine consumption. Moreover, in line with Brucks [25], our study focuses on subjective knowledge and investigates factors that affect subjective (potential consumers') knowledge, which is a different approach in comparison with studies analysing knowledge as a generic concept.

In our study, the analysis was carried out, first, by means both of univariate tests to assess consumers' heterogeneity and by a bivariate probit model. Then a multinomial logit (MNL) and a random parameters logit (RPL) framework were adopted to study the choice experiment (CE). This latter part of the study allowed us to further analyse and point out possible preference heterogeneities across respondents, and then to elicit the WTP.

The remainder of the paper proceeds as follows. A literature review and theoretical framework descriptions are offered in Section 2. Section 3 presents the methodological approach together with the data specification, while Section 4 describes and discusses the main results. Finally, Section 5 is devoted to presenting the implications together with several concluding remarks.

2. LITERATURE REVIEW

The wine choices of consumers present a level of complexity unparalleled with any other food product [26]. Because the type of wine supplied in supermarkets and other shops is extremely varied according to different characteristics and due to the lack of both wine education and experience, a vast majority of wine consumers base their choices on the information they can find on the bottles [27,28]. Several studies have analysed consumers' preferences concerning the traditional features usually reported on bottles, but the reasons that motivate consumers to buy and consume wines produced by cooperatives have not attracted the attention of many scholars.

While the supply side of cooperative wines has been deeply analysed among scholars, empirical studies exploring consumers' behaviour, habit and preferences towards these kinds of wines are still scarce [29]. Moreover, the great part of these studies pointed out consumers' negative judgements about the quality of cooperative wine. The poor reputation of wine cooperatives was largely identified by Elster [30] and Garrido [31]. Scha-

mel [32] pointed out that the assumption of lower quality is reflected by the lower price point. Garrido [31] stated that the low quality that is conventionally associated with wine produced by cooperatives could be a direct consequence of their inability to avoid the opportunistic behaviours of their members. However, Botonaki and Tsakiridou [33] analysed consumers' intentions to purchase a higher priced cooperative wine with a quality certification and indication label, and they identified positive feedback from respondents and consequently the opportunity to develop wine cooperative production.

Since a growing number of scholars are still highlighting the strengths and advantages of this organisational model among wine production [11,34,35], it seems useful to analyse the factors that affect consumers' preferences for wine made by cooperatives. The literature on this topic is fairly scarce. On the one hand, some studies confirm that negative prejudice towards wine cooperatives still exists, among European consumers in particular [36,37,32]. Wine cooperatives are often cited as unable to pursue branding and differentiation strategies [38,39] and meet consumers' growing demand for high quality and variety [40]: this may explain why a not negligible share of consumers negatively judge the cooperative wine label at all price points [41]. On the other hand, some studies reveal that European consumers are apparently shifting towards more positive opinions on cooperatives and the wines they produce, as confirmed by quantitative studies performed in Austria [42], Germany [43] and Italy [44]. Furthermore, according to recent literature, the adoption of optimal communication and branding strategies seems to be beneficial for the image of wine cooperatives [45-47].

The literature provides several examples of CE to study preferences for various attributes and quality of wine, but, to the best of our knowledge, only one study has used this methodology to investigate interest in wine from cooperatives [37]. Furthermore, no studies have examined respondents' preferences towards cooperative wines in comparison to organic wines with the aim of understanding if consumers are more attracted by the social aspects represented by the cooperation production model or the environmentally friendly methods of production alone.

3. DATA AND METHODS

The aim of this study is twofold: it is focused on the factors affecting knowledge about and consumption of organic and/or cooperative-produced wine, on the one hand, and on consumers' propensity to buy wines produced by cooperatives, investigated by the mean of the CE, on the other hand. Due to the twofold aim of the study, the methodological approach adopted is described in two sub-sections: 3.2 and 3.3.

3.1 The survey

Similarly to the survey carried out by Lockshin et al. [28], this study was based on a data set that collected information on a non-probability sample of 3,295 individuals residing in different European countries: Germany (417), England (412), France (418), Spain (424), Slovenia (814) and Italy (810). These countries were chosen in order to consider a wide range of wine consumers living in different but contextually and culturally similar countries. Data were collected from January to February 2020 through an anonymised online survey conducted by a professional survey and market research company using registered panels in the selected countries [48,49].

Before submission, the questionnaire was translated into different languages and a pilot survey was conducted on 50 consumers from different European countries. This pre-test resulted in a few minor changes in the formulation of questions. Moreover, the alternatives in the choice sets were shown in colour pictures to the respondents, according to the good practice in conducting CE recommended by Lockshin et al. [28] and Loureiro and Umberger [50].

The survey was made up of two main parts that allow for the analysis of respondents' preferences, habits, subjective knowledge and attitudes. In the first part of the survey, each respondent was asked for demographic information, such as gender, year of birth, municipality of residence, education level (a categorical variable for the education degree reached), occupational status (a factor variable for several types of occupational condition) and participation in specific jobs connected with the wine sector (such as producer, enotechnician, restaurateur, trader, sommelier and bartender). This first part of the survey was also devoted to investigating the individual's wine consumption habits (favourite alcoholic drinks, frequency of wine consumption and places of wine purchase) and their subjective knowledge about and consumption of both organic and cooperative-produced wines. Moreover, the respondents were asked to provide a rank, in terms of perceived quality, to different wines. The second part of the survey included questions related to a CE aimed to deepen respondents' attitudes. In the CE experiment, five attributes and their levels were used to describe a white wine, which was described as one produced from the Sauvignon Vert grape in terms of geographical area of origin. It was also specified as

Table 1. Attributes and their levels adopted in the CE design.

Attributes	Levels
Origin (3 levels)	Friuli Venezia Giulia/Other Italian regions/Other European countries
Winescape (2 levels)	Yes/No (i.e. presence of landscape beauties/absence of landscape beauties)
Cooperative produced (2 levels)	Yes/No
Wine quality certification (3 levels)	"table wine"/PDO/organic
Price (€/750 ml bottle) (3 levels)	4.00/8.00/12.00

"winescape" or not, from a cooperative production or not, with a quality certification or not and the price was provided (see Table 1). These attributes were selected during a preliminary focus group discussion with wine producers, consumers, researchers and institutional decision makers and were chosen from a set of characteristics identified as relevant by a group of experts of wines produced by cooperatives. The whole CE design was based on 19,770 choice observations (6 choices completed by each of the 3,295 interviewees). A detailed description of the attributes' levels and the CE characteristics is reported in Section 3.3.

3.2 Habits and subjective knowledge: the econometric analysis

Our analysis was devoted first to study consumer habits and their subjective knowledge about organic and/or cooperative-produced wines. This first part of the study focused on a detailed description of the sample, both the whole sample and the sub-samples at the country level, and a statistical evaluation of the heterogeneity, across countries, of respondents' consumption preferences, habits, and knowledge of organic and cooperative-produced wines. Descriptive statistics allow for the comparison of the respondents' characteristics selected from different countries and to evaluate their heterogeneity in terms of declared habits, preferences and knowledge. In particular, the chi-squared test was used to evaluate the association between country of origin and to separately evaluate the consumption habits and preferences, the purchase place, and the individual ranking of perceived quality attributed to different types of wines. The same approach has been adopted to evaluate the distribution of subjective knowledge of organic and cooperative-produced wines across countries. The individuals' knowledge about these types of wines has been evaluated preliminarily in relation to different individual factors, such as gender, age, education level, occupational status and specific jobs linked to the wine sector. This exploratory analysis used a univariate test (chi-squared test) to assess the association between the subjective knowledge of organic and cooperative-produced wines and individual consumption and purchase behaviour.

The aim was to determine if respondents' familiarity with these specific types of wine is related to individual characteristics. Several aspects related to the individual attitudes towards wine and other alcoholic beverages have been subsequently verified in a multivariate statistical framework.

The choice of generalised linear models with probit link function was straightforward given the binary results for individuals' declared knowledge. However, to evaluate in a multivariate framework the knowledge of both organic and cooperative-produced wines, a seemingly unrelated probit model [51] was considered. This model has been estimated using the biprobit Stata command, which fits a maximum likelihood two-equation model for two binary outcomes. This bivariate probit model represents an appropriate approach to investigate two correlated outcomes: the likelihood of knowing the organic and the cooperative-produced wines. In general, in a discrete choice context, the analysis of correlated decisions is commonly addressed by extending the probit model to the estimation of more than one equation, leading to bivariate (i.e., two equations) or multivariate (i.e. three or more equations) probit equations [52]. However, we adopted this modelling approach since it is suitable for seemingly unrelated outcomes. The two equations estimated were based on the same linear predictors to compare the effects of individual and contextual factors on the two outcomes. The estimated equations may be expressed as follows:

$$y^*_{i1} = \boldsymbol{\beta}^{\mathbf{T}}{}_1 \boldsymbol{x}_i + \varepsilon_{i1} \text{ and } y_{i1} = 1 \text{ if } y^*_{i1} > 0, 0 \text{ otherwise}$$

$$y^*_{i2} = \boldsymbol{\beta}^{\mathbf{T}}{}_2 \boldsymbol{x}_i + \varepsilon_{i2} \text{ and } y_{i2} = 1 \text{ if } y^*_{i2} > 0, 0 \text{ otherwise}$$

$$[\varepsilon_{i1}, \varepsilon_{i2}] \sim N_2(0,0,1,1,\rho)$$

where y_{i1} and y_{i2} are the binary variables representing an individual's knowledge of organic and cooperative-produced wines, respectively; $\boldsymbol{x}_i$ is the vector of the

common set of covariates; $\boldsymbol{\beta}^{\mathbf{T}}{}_1$ and $\boldsymbol{\beta}^{\mathbf{T}}{}_2$ are the two vectors of unknown parameters, and ε_{i1} and ε_{i2} are the random terms assumed to be jointly normally distributed with zero means, unit variances, and correlation term ρ. Therefore, the identification of a correlation coefficient ρ that is significantly different from zero indicates the existence of a correlation between the random components of the two equations, or the unexplained heterogeneity of the knowledge of the two wine types. All the individual and contextual aspects declared in the first part of the survey (country of residence, education level, occupational condition, type of job connected with the wine sector, consumption habits and purchase preferences and frequency) have been included in the linear predictors to address the likelihood of the individual subjective knowledge of organic and/or cooperative-produced wine. Applications of bivariate probit models can be found in several fields of research, including a few studies in the tourism sector [53,54].

3.3. Attitudes: The statistical analysis of the CE experiment

The second part of the analysis investigated the respondents' attitudes toward and their WTP for cooperative-produced wines and used a CE to deepen the level of knowledge and the preferences regarding cooperative-produced wines in terms of the perceived utility as a result of the attributes of cooperative-produced wines. The consumer theory of Lancaster [55], the information processing and decision making in psychology [56], and the random utility model of McFadden [57] represent the statistical economic frameworks for the CE used to estimate behavioural models of consumer choice. Within this context an individual is supposed to choose from a set of alternatives and select the one that allows them to reach the highest utility level. In a CE, the alternatives are decomposed into their key attributes, and a range of levels is associated with each one, which may be combined experimentally into different choice sets. Moreover, the overall utility of an alternative can be decomposed into separate utilities for its attributes, and it becomes a function of alternative characteristics. Finally, the utility function of each respondent is the sum of a deterministic term (a function of the factors that affect the respondent's utility) and a stochastic random term (unobservable to the researcher). In discrete choice modelling, the respondents' utility and the attributes of competing alternatives are not directly observable as alternatives are exhaustive, mutually exclusive and in finite number. The respondents are supposed to maximise their expected utility. While in the conditional logit model, consumers' preferences are assumed to be homogeneous, in the random parameter model (RPL), the assumption of homogeneity of preferences is relaxed.

Five attributes were selected to describe a white wine described to respondents as one produced from the Sauvignon Vert grape (listed in Table 1). The "geographical area of origin" was represented in three ways: *Friuli Venezia Giulia*, a region in the north-eastern Italy, bordering Austria and Slovenia, *other Italian regions* and *other European countries*. According to Gil and Sánchez [58], there was a shift from the designation of an area of excellence in viticulture (e.g. Friuli Venezia Giulia Region) to an increasingly indistinct, generic and broad area (e.g. Other Italian regions, Other European countries). The "winescape" attribute refers to a cultural/viticultural landscape with a combination of well-maintained vineyards, wineries and supporting activities necessary for production [59,60] nestled in a pleasant landscape indicative of an environmentally friendly production method. The presence of the "winescape" attribute is regarded as able to guide consumers' preferences [61] and to develop meaningful social experiences for the wine tourist [62]. It was noticed that associating wine to evocative landscape induces higher preference for tasted wine [63], because of a number of subjective subconscious factors [64], which are not easily quantifiable in market shares. The landscape characteristics were identified through two photographs, one with a generic vineyards context, which in the eyes of the interviewees was intended to evoke poorly sustainable management methods, and the other depicting a beautiful landscape as mentioned above.

As regards the "quality certification", three types were considered in the survey: *table wine*, *protected designation of origin (PDO)*, and *organic*. The level *table wine* refers to the most basic wine [65], while *PDO* refers to wines that are made in defined geographical areas and are considered of higher quality. PDO is a geographical indication aimed at differentiating the origin of the wine and giving a signal of quality to the consumer [66]. Finally, we decided to include the *organic* level in this attribute to analyse the attitude towards this type of wine among consumers of different European countries, given the literature debate in this regard. According to [67], on average, the organic production method seems not to affect the likelihood of consumers' choices. However, empirical evidence has demonstrated consumers' heterogeneous taste for this attribute and the existence of significant market segments with higher preference for organic wine. The combination of these different levels for the quality certifications attribute is not a novelty among previous studies [68].

The attribute "price" presented three levels, ranging from €4.00-12.00 per bottle (750 ml), chosen considering

the Institute of Services for the Agricultural and Food Market (ISMEA) periodical analysis of prices for white wines (€ per hectolitre) [20].

Given these attributes and their levels, a fractional factorial orthogonal design produced 18 alternatives (options), which were randomly combined into 6 choice sets involving the comparison among different bottles of wine with varying levels of attributes. The presence of dominant alternatives was taken into account by researchers' review and tested for during the pre-test of the questionnaire [69]. However, no choice tasks with dominant alternatives were identified. During pre-test also the presence of perceived correlation among attributes, which could cause scenario rejection, were analysed [70].

To simulate a realistic purchase scenario, attributes were presented graphically as wine labels on a wine bottle. In the choice task, each respondent was required to select an alternative among three different bottles, defined according to the attributes, or the "opt-out" alternative, which was included to provide the possibility of no selection. Each respondent was asked to consider each choice task as a separate situation and was also informed that the chosen wine bottle had no difference in any other aspects, except for the declared attributes. The occasion for the purchase was mentioned: respondents were asked to buy a bottle of white wine produced with Sauvignon Vert for a meal at home. Since different purchase occasions evoke different levels of involvement in a purchase situation, we decided to specify the purchase occasion to avoid biased responses.

Choice sets were shown to the respondents as colour pictures. Table 2 shows the text associated with a choice set presented to respondents in our survey.

Consumers' attitude towards cooperative wine has been analysed by means of an MNL model extended to a RPL, estimated using the NLogit 6® version of Limdep

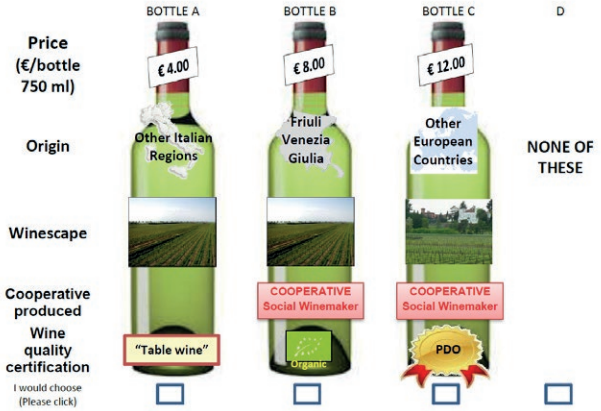

Table 2. Example of a choice set (English version).

software. This model was based on the following linear utility function:

$$U_i = \beta_0 + \beta_1 FVG_i + \beta_2 Italy_i + \beta_3 Winescape_i + \beta_4 Cooperative_i + \beta_5 PDO_i + \beta_6 Organic_i + \beta_7 Price_i$$

where the constant β_0 refers to the opt-out choice, "FVG" and "Italy" are the dummies for production in the *Friuli Venezia Giulia* region or in *other Italian regions*; "Winescape" is the dummy for the *winescape* attribute; "Cooperative" is the dummy for the cooperative-produced wine. "PDO" is relative to the *PDO* quality, and "Organic" refers to the *organic* wine. Finally, "Price" is the variable related to the price levels, which are assumed to be continuous. The β_s coefficients can be considered as the marginal contributions of each attribute on the consumer utility function. Only the significant interactions have been taken into account in the final model. The random term was assumed normally distributed. The analysis also allowed for the estimation of the premium price (or WTP) for each attribute level by dividing β coefficients by β_{price} (WTP = - β/β_{price}).

4. RESULTS AND DISCUSSION

This section presents the results obtained in all steps of the analysis, starting with a detailed description of respondents' characteristics and habits, reported in subsection 4.1. The descriptive analysis explores the individual factors and then correlates them with their familiarity with organic and cooperative wine, which is further assessed both through univariate analysis and through the adoption of a seemingly unrelated probit model, whose results are reported in Section 4.2. Section 4.3 focuses on individuals' propensity towards the cooperative-produced wines, analysed by means of a RPL model applied to the CE data.

4.1 Interviewee characteristics and wine consumption preferences

The first part of our analysis describes the sampled interviewee in terms of their social, economic and demographic aspects, considering their distribution across countries also. In this phase, the results of univariate analysis are reported to evaluate the association between the knowledge of biological and cooperative wine and individual aspects.

The 3,295 interviewees were distributed across the following European countries: Italy, Slovenia, Spain, France, England and Germany. Italy and Slovenia were

Table 3. Descriptive statistics on some socio-demographic characteristics as percentages of the whole sample.

	DE	*EN*	*FR*	*IT*	*SLO*	*ES*	*TOT*
Males *(%)*	49.40	43.69	46.65	47.79	55.04	50.94	49.29
Age classes (%)							
16–24	12.71	8.25	14.12	10.86	26.04	8.02	14.57
25–44	34.05	46.36	36.60	44.08	47.54	46.94	43.37
45–64	37.89	36.17	36.12	30.62	23.84	38.44	32.26
65+	15.35	9.22	13.16	14.44	2.58	6.60	9.80
Education level (%)							
Primary school	7.43	3.16	1.68	0.74	7.86	4.48	4.25
Secondary school	40.05	2.91	5.98	7.41	46.07	7.78	20.39
Some high school	15.59	21.84	39.24	5.68	5.04	10.14	13.63
High school degree	19.66	29.61	30.38	51.48	14.99	29.72	30.23
University degree	11.99	36.17	20.81	33.21	21.25	36.32	26.77
Other	5.28	6.31	1.91	1.48	4.79	11.56	4.73
Occupation (%)							
Entrepreneur	7.91	10.68	4.78	7.28	8.85	12.03	8.47
Employee	47.72	60.68	51.20	40.12	50.74	52.36	49.26
Self-employed	4.08	1.46	1.20	5.31	3.19	5.66	3.66
Retiree	19.42	10.19	16.26	13.09	5.40	5.42	11.05
Student or housewife	15.11	10.19	19.14	27.16	22.85	13.68	19.70
Other	5.76	6.80	7.42	7.04	8.97	10.85	7.86
Job type (%)							
Producer	6.95	11.65	4.55	4.69	6.51	6.84	6.56
Enotechnician	6.71	7.04	5.02	2.74	4.67	4.01	4.64
Restaurateur	11.51	10.19	5.50	5.43	12.41	6.84	8.71
Trader	5.52	9.22	5.02	3.95	4.18	6.37	5.31
Sommelier	6.95	7.28	3.59	3.46	3.81	3.07	4.43
Bartender	8.87	11.89	5.50	6.67	8.97	12.26	8.74
Other	53.49	42.73	70,82	73.06	59.45	60.61	61.61
Total: n (%)	417 (12.66)	412 (12.5)	418 (12.7)	810 (24.6)	814 (24.7)	424 (12.9)	3295

represented by larger samples, as reported in Table 3. This table describes the distribution of the interviewees, in the whole sample and in the countries' subsamples, by sex, age, education level, occupational category and some job types. The data set was characterised by the following: 49.29% male, a mean age equal to 42.39 years and more than the 75% in the age class 25-64. The respondents were older than 16 at the time of the interview, with a mean age ranging from 36.5 for individuals from Slovenia to 45.7 for those from Germany. More than 50% had a high school diploma or a university degree, and over 60% were employed or self-employed. Moreover, about 38% of interviewees were occupied in jobs related to the wine sector (producers, enotechnicians, traders, etc.).

The sample, although not statistically representative, presented different distributions for key socio-demographic variables across countries (see Table 3), reflecting the heterogeneity of both those who consume wine (see Figure 1) and their choices to consume organic or cooperative-produced wines.

The interviewees were asked about their wine consumption and purchase behaviour. The different demographic attributes are shown for each country in Figure 1. In particular, they were asked about their consumption preferences (Figure 1A), their frequency of wine consumption (Figure 1B), their usual place of wine purchase (Figure 1C), and their ranking of four wine categories (Figure 1D).

In general terms, 41.9% of respondents preferred wine, and 32.4% preferred beer (1A). The preference for wine was highest (52.3%) among Italian respondents, who also had the lowest preferences for spirits and any

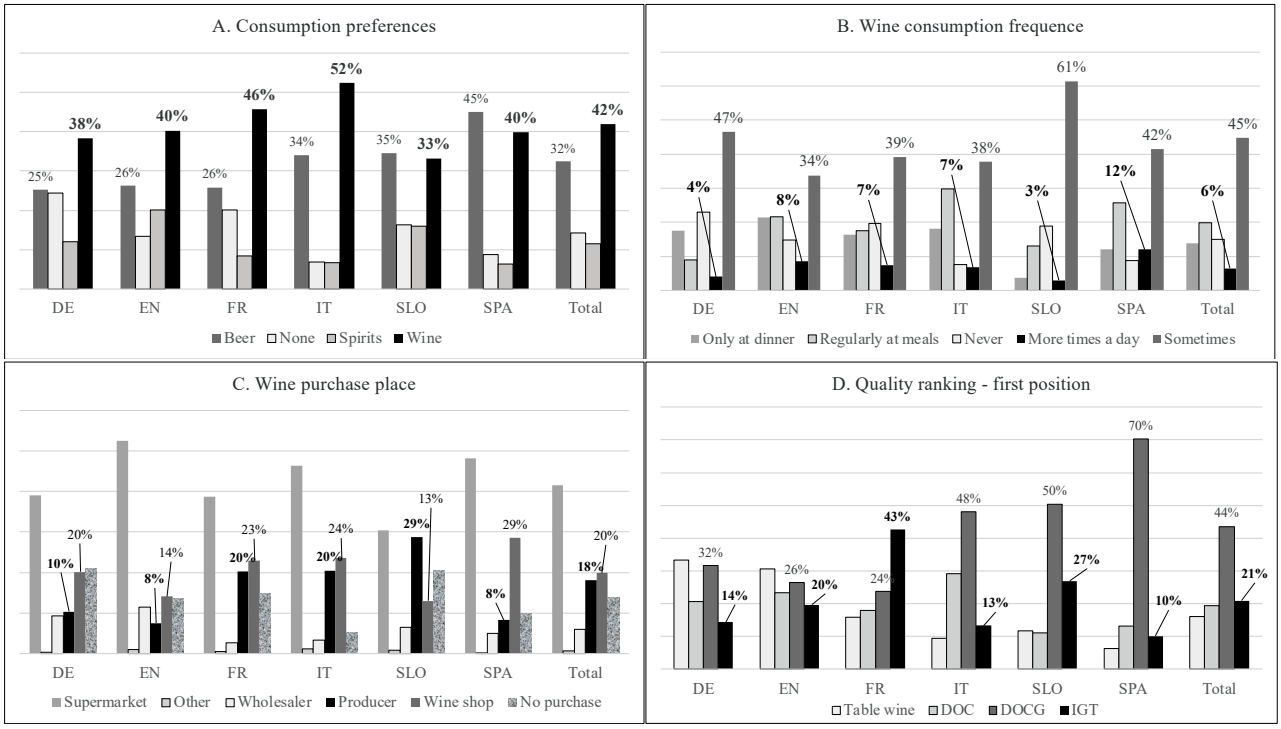

Figure 1. Descriptive statistics by country. Percentages of individuals by (A.) consumption preferences (bold % for "wine"); (B.) wine consumption frequency (bold % for "more times a day"); (C.) wine purchase place (bold % for "producer") and (D.) first position in subjective wine quality ranking (bold % for "IGT"). All the factors considered are significantly associated with country of residence (Pearson p-value).

other alcoholic beverages. Drinking preferences clearly depict a significant heterogeneity across countries, which is coherent with the declared wine consumption frequency (1B). In terms of frequency, 44.9% of respondents declared that they drink wine occasionally, while 14.9% said that they never drink it. While the Italian sample presents the highest percentage of regular wine drinkers at meals, respondents from Spain are more likely to drink it several times per day. Of the total respondents, 41.55% purchase wine in a supermarket, while those who purchase wine from a producer are more likely to come from wine-producing countries, such as Italy, France and Spain. As expected, all the aspects related to consumption, purchase and quality were significantly correlated with the country of residence (p-value<0.01 for the Pearson chi-squared tests in all two-way contingency tables). The differences displayed by respondents from different European countries were statistically relevant in terms of their subjective knowledge of organic wines and cooperative-produced wines, as reported in Figure 2. Almost one-half (49.4%) of respondents claimed to know organic types of wines, while fewer (43.5%) claimed to know about wines produced by cooperatives. Italy, France and Slovenia were the most likely (69.4%, 53.8% and 41.5%, respectively) to know about wines made by cooperatives. Such a result may be explained by aspects related to the production sector. Individual and contextual factors affecting knowledge of these specific types of wine are described in the next section, both by means of univariate analysis and in a multivariate generalised linear model.

4.2 Organic and cooperative wine: Statistical assessment of consumers' factors of familiarity

A relevant focus in this study regards the evaluation of the individual and contextual factors affecting the knowledge of organic and/or cooperative wine. Subjective knowledge was assessed simply by asking to respondents if they knew organic or cooperative produced wines, then this set of two binary outcomes allowed to deepen the role of individual and contextual factors on the probability of knowledge of these types of wines jointly. In the sample, 49.4% of respondents declared themselves familiar with organic wine, but this percentage is substantially different across countries (Pearson chi-squared test 111.9 with p-val-

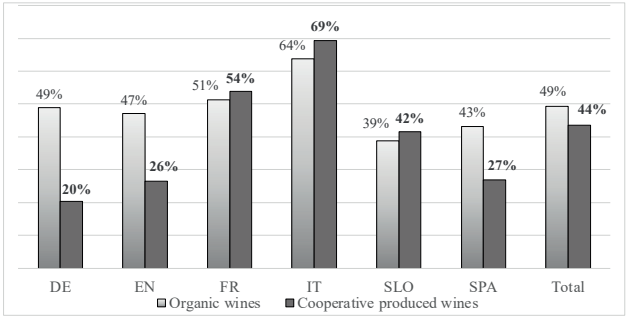

Figure 2. Percentages of respondents who declared to know organic wines (light grey) and cooperatively produced wines (dark grey and bold percentages), by country. The knowledge resulted to be significantly associated with country of residence (Pearson p-value).

ue<0.000), ranging from the lowest in Slovenia (38.8%) to the highest in Italy (63.8%) (Figure 2). Familiarity with organic wine appears to be significantly correlated with some individual aspects, as reported in Table 4. A higher familiarity with organic wine characterised individuals from Italy, in the 25-44 age class, with a high school diploma or university degree, who are employed, who declared that wine is their preferred drink, who drink wine sometimes, buy wine at the supermarket or in specialised stores and who rank Controlled and Guaranteed Designation of Origin (in Italian "Denominazione di Origine Controllata e Garantita" - DOCG) in the first position.

Figure 2 also shows the distribution across countries in relation to familiarity with cooperative-produced wines. The country of residence is also relevant in terms of familiarity with this type of wine (Pearson chi-squared test 427.2, p-value<0.000), which ranges from the lowest in Germany (20.4%) to the highest in Italy (69.4%).

Some individual characteristics beyond the country of residence were also associated with familiarity with cooperative-produced wines (see Table 4). Males in the 25-44 age group with a high school diploma or university degree, who are employed, who prefer to drink wine, who purchase wine at the supermarket, who drink sometimes, and rank DOCG wines in the first position were more likely to be familiar with cooperative-produced wines. Knowledge about organic and cooperative wines was associated with some jobs related to the wine sector.

Similarities between the respondents' familiarity with organic wines and cooperative-produced wines justified the adoption of the bivariate model for the probability of knowledge, which is useful to evaluate the effect of individual and contextual factors in potentially associated equations: familiarity with organic wine and with cooperative wine.

In fact, familiarity with organic and cooperative-produced wines has been analysed in a multivariate framework, by means of a multivariate probit model estimated using the Stata biprobit procedure as suggested in Mullahy [51]. This command allowed for the estimation of a two-equation seemingly unrelated probit model to assess the effects of factors on the joint conditional probability of knowing organic and/or cooperative wines. The estimated coefficients in the two equations, together with standard errors and significance levels are reported in Table 5.

The first interesting evidence is the significant correlation between the random parts of the two model equations, which suggests an association between the random/unexplained components of the subjective knowledge about the two types of wine. Several similarities can be observed, also, in terms of factors affecting the knowledge, except for some aspects related to the contextual trading and producing differences across countries and/or relative to the specific jobs connected to the wine sector. While all countries have a lower probability of knowing about cooperative-produced wines, with respect to Italy, only respondents from England, Slovenia and Spain are less likely to know about organic wines. Age and sex do not affect familiarity with organic and cooperative wines, but higher education levels (i.e., university degree) are positively associated with the knowledge of both wine types. Entrepreneurs and employees are more likely to be familiar with both organic and cooperative wines. This last category is significantly more known by retirees also. Producers, traders and bartenders are more familiar with cooperative wines; restaurateurs and traders are more likely to know about organic wines. Consumption preferences and habits are clearly associated with a propensity towards organic and cooperative-produced wines; they are more likely to be known by individuals who consume wine, even not regularly, and by those who prefer wine with respect to beer or other alcoholic drinks. Moreover, preferences in terms of drinks correlated with knowledge of cooperative-produced wines.

4.3 Sustainable consumption choices: The random parameters logit model results

To investigate factors affecting individual choices an RPL model has been adopted. Its formulation is a one-level multinomial logit model, for individuals i = 1,...,N in choice setting t, and it is somewhat similar to the random coefficients model for linear regressions. This model is widely used for the analysis of discrete CE data. Table 6 reports on the RPL estimation results.

Table 4. Descriptive statistics and test of association between individual factors and knowledge about organic and/or cooperatively produced wine.

	Knowledge about organic wines		Knowledge about cooperative-produced wines	
	Percentage	p-value	Percentage	p-value
Gender		-		<0.05
Males	50		51.85	
Females	50		48.15	
Age classes		<0.01		<0.01
16–24	11.36		12.07	
25–44	46.56		45.64	
45–64	32.13		30.84	
65+	9.95		11.44	
Education level		<0.01		<0.01
Primary school	2.83		2.44	
Secondary school	15.05		16.33	
Some high school	11.18		11.86	
High school degree	33.42		34.75	
University degree	32.86		31.26	
Other	4.67		3.35	
Occupation		<0.01		<0.01
Entrepreneur	10.38		10.47	
Employee	54.05		51.50	
Self-employed	3.69		3.91	
Retiree	10.81		12.28	
Student or housewife	16.15		16.75	
Other	4.91		5.09	
Job type				
Producer	10.63	<0.01	11.65	<0.01
Enotechnician	7.31	<0.01	7.75	<0.01
Restaurateur	12.41	<0.01	12.35	<0.01
Trader	9.21	<0.01	10.12	<0.01
Sommelier	7.13	<0.01	7.82	<0.01
Bartender	12.29	<0.01	13.19	<0.01
Consumption preferences		<0.01		<0.01
None	4.98		4.82	
Beer	29.18		31.61	
Wine	56.39		54.36	
Other drink	9.46		9.21	
Consumption frequency		<0.01		<0.01
Never	3.93		4.88	
Sometimes	38.82		37.61	
At dinner	19.96		19.61	
At meals	26.66		26.87	
Several times a day	10.63		11.03	
Purchase place		<0.01		<0.01
Supermarket	36.00		34.26	
Wholesaler	7.56		8.09	
Specialised store	27.40		25.40	
Producer	24.26		27.84	
Other	0.68		0.70	
No purchase	4.12		3.70	
Quality ranking, First position		<0.01		<0.01
Table wine	12.65		13.05	
Controlled Designation of Origin - DOC	21.38		21.63	
DOCG	45.58		43.34	
Typical Geographical Indication - IGT	20.39		21.98	

The random parameters were chosen according to the significance of the derived standard deviation by running a number of RPL models including different random parameters as suggested by Hensher et al. [71]. Several RPL model specifications were tested and two variables (i.e. "winescape" and "cooperative") presented a significant level of heterogeneity. Winescape and cooperative were consequently considered random parameters in the RPL model and were assumed to have a normal distribution [71].

The RPL model shows an acceptable interpretative capacity (McFadden Pseudo R-squared = 0.16). All the coefficients are statistically significant ($p<0.05$). The same applies to the interaction terms with the sole exception of the interaction term "Cooperative x Female", which describes the interaction between female gender and cooperative wine variables. As expected, the price estimated coefficient is negative.

The most relevant characteristics affecting the interviewees' utility are the place of production and the presence of the European Union PDO quality label. Similarly to other studies [72], respondents proved to be particularly interested in the origin of the wine. However, cooperative production is able to increase respondents' utility. The negative value of the evocative landscape may be due to a poor visual representation of this attribute in the CE experiment.

Table 5. Estimation results of the seemingly unrelated probit model on knowledge about organic and cooperative-produced wines.

	Organic wines		Cooperative-produced wines	
	Coeff.	SE	Coeff.	SE
Country (Italy, base category)				
Germany	-.0620	.0904	-1.3459***	.09830
England	-.4727***	.0876	-1.3843***	.0949
France	-.1132	.0875	-.2670***	.0884
Slovenia	-.3653***	.0779	-.5015***	.0783
Spain	-.6201***	.0849	-1.3130***	.0899
Sex (1, male)	.0207	.0506	.0512	.0520
Age class (16–24, base category)				
25–44	.1063	.0806	.0607	.0820
45–64	.0877	.0860	.0920	.0882
>64	.0513	.1307	.2548	.1374
Education (none, base category)				
Secondary school degree	.0392	.1336	.1908	.1409
Some high school	-.0205	.1418	.2160	.1759
High school diploma	.2215	.1328	.1892	.1410
University degree	.3837***	.1343	.2796**	.1418
Other	.4309***	.1637	.2160	.1759
Occupation (student/no occupation, base category)				
Entrepreneur	.2993***	.1049	.4047***	.1072
Employee	.1897***	.0707	.2380***	.0738
Self-employed	-.0536	.1409	.1202	.1441
Retiree	.0326	.1176	.3888***	.0944
Other	.0025	.1055	.0477	.1103
Job type (dummies)				
Producer	.1961	.1379	.3915***	.1363
Enotechnician	.1697	.1519	.0943	.1465
Restaurateur	.3575***	.1033	.1347	.1023
Trader	.3894**	.1619	.5642***	.1580
Sommelier	-.0984	.1602	.0352	.1594
Bartender	.1945	.1060	.3595***	.1074
Preferences (none, base category)				
Beer	.1815	.1034	.3596***	.1099
Wine	.5432***	.1056	.5208***	.1127
Other alcoholic drinks	.1590	.1146	.3089**	.1221
Consumption frequency (no consumption, base category)				
Sometimes	.6664***	.1021	.4209***	.1059
At dinner	1.1223***	.1223	.9308***	.1261
At meals	1.0754***	.1157	.8312***	.1194
Several times a day	1.4557***	.1519	1.2696***	.1525
Constant	-1.3292	.1642	-1.0763***	.1693
athro	.4311*** (.0343)			
ρ	.4062 (.0286)			
Wald test for rho=0 (chi2 test)	158.21 (p-value <0.000)			

The opt-out option effect is negative and statistically significant, indicating a utility loss due to the "no buy" alternative.

The structure of the adopted model pointed out random parameters for the winescape and cooperative attributes, assuming that their heterogeneity was explained by the employee and female covariates. On the one hand, this structure of mixed effects is confirmed by the parameters' significance. On the other hand, the effects of the remaining attributes are invariant across individuals. The model specification was based on the assumption of normally distributed random parameters.

The respondents' WTP wine with a PDO label is equal to €3.07. The WTP Friuli Venezia Giulia Region wine is €2.77, while the choice of a bottle from other EU countries decreases respondents' utility since it leads to a negative WTP (€-5.91). With regards to the organic wines, respondents showed a willing to pay an increase equal to € 1.88 for organic wines in comparison to table wines.

In terms of the winescape attribute, the findings show a negative WPT (€ -2.71), on average. However, this willingness becomes positive for people who are employees (€1.96) and for females (€ 1.07) reducing total negative resulted WTP.

With reference to the cooperative wines, the WTP is on average positive (€ 1.15), meaning that the interviewees are willing to pay a premium price for this type of wine. It is interesting to note that the model highlights the presence of several market segments that cooperative wines may target. The propensity to buy cooperative wines increases in the case of people who are employees. On the contrary, females seem to be less attracted by this kind of production.

Table 6. Estimation results of RPL model.

The choice alternatives	Coeff.	SE	z	P-value	WTP (€/ bottle 750 ml)
Random parameters in utility function					
Winescape	-.2941***	.0480	-6.13	.0000	-2.71
Cooperative	.1243**	.0588	-2.11	.0347	1.15
Non-random parameters in utility functions					
Opt-out	-1.5306***	.0461	-33.22	.0000	
Price	-.1084***	.0035	-31.36	.0000	
Friuli Venezia Giulia	.3005***	.0245	12.24	.0000	2.77
Other EU	-.6412***	.0358	-17.92	.0000	-5.91
PDO	.3329***	.0252	13.22	.0000	3.07
Organic	.2040***	.0303	6.72	.0000	1.88
Heterogeneity in mean					
Winescape: Employee	.2122***	.0515	4.12	.0000	1.96
Winescape: Female	.1164**	.0478	2.43	.0150	1.07
Cooperative: Employee	.1847***	.0587	3.15	.0017	1.70
Cooperative: Female	.0904*	.0546	1.66	.0978	0.83
Dist. of Random Parameters – Std. Dev.					
Normal: Winescape	.8918***	.0304	29.34	.0000	
Normal: Cooperative	1.1660***	.0314	37.17	.0000	

***, **, * Significance at 1%, 5%, 10% level.

5. CONCLUSIONS

In response to our initial targets, which were to explore consumers' attitudes and preferences towards wines produced by cooperatives and the level of appreciation of both the social role of cooperatives and the environmentally friendly aspects of organic wines, our analysis discovered that the knowledge of organic wines and wines produced by cooperatives is significantly tied to and affected by similar individual and contextual factors. The structure of the survey across different countries allowed for consumers' heterogeneity to be wider in terms of attitudes, consumption and purchase habits towards wine.

Results of this study contribute to a very limited literature examining how consumer preferences differ across wines produced by cooperatives. The findings of this exploratory study suggest the usefulness of different methodological approaches in examining the wine cooperatives market and in assessing the relevance of each aspect of sustainable consumption behaviour.

In addition, our analysis points out, on the one hand, that the negative prejudice towards wine cooperatives seems to persist; on the other hand, it shows that more and more consumers seem to be willing to choose a wine produced by a cooperative. The increasing quality level of these wines and the social sustainability aspects related to cooperatives may be reasons to prefer these wines. In this sense, enhanced communication through labelling and the adoption of quality certifications might improve the image of wine cooperatives.

As wine consumers evolve and become more demanding of quality as well as of sustainability, cooperatives could further enhance their fundamental contribution in satisfying these needs by improving enological level providing adequate technical assistance, and, consequently, by contributing to enhancing the local community, through economic activities [73] and through territory development according to sustainability.

Our findings offer useful information for the marketing of wine cooperatives seeking to promote the sale of their wines by differentiating their products in a highly competitive market. In these types of markets, in fact, wine differentiation is an important aspect in favour of cooperative longevity and marketing sustainability efforts (e.g. through specific information/labels) and could be a potential means of achieving this goal. The detailed results provide cooperatives with indications about what kind of consumers would be interested in buying their wines, providing them with practical recommendations on how to better market their wines. In addition, this study may contribute positively to the debate on the relationship between the preferences of wine cooperative consumers and their organic choices. The results describe how familiar consumers are with organic and cooperative-produced wines, pointing out the opportunity for wines produced by cooperatives to better target the market segments that mainly choose organic products [74].

The positive and statistically significant premium price attached to wine produced by cooperatives shows that cooperatives could charge an additional premium on wine if they produced using sustainable practices. Maybe they could also attract new consumers by communicating more effectively the characteristics of their wines. Organic products command a premium price with consumers. With this knowledge, cooperative producing wines will be better equipped to handle eventual specific investment decisions, while both differentiating their wines in a saturated market and reducing their environmental footprint. This could be particularly useful for smaller cooperatives, which often have tighter financial situations and the decision to make investments in cleaner technologies is often risky due to huge upfront capital costs.

In evaluating these findings, however, readers should recognise that our research has some limitations. The first is related to the sample considered: this study is

limited by its convenience sample and its consequent inability to generalise findings to consumers other than respondents. According to Vecchio [75], this limit reduces market implications of our findings. Two other limitations refer to the experiment. First, considering that including other countries was very expensive for our research, the use of a limited number of countries could be considered a limitation of this study. Further research in less similar countries should be conducted in order to improve our knowledge about the potential consumers' attitudes and preferences in different contexts.

Second, given the scope of the survey data, not all aspects of cooperative wines have been included in this study (e.g. cultural and socio-political aspects), according to Demossier and Viecelli [76]. Therefore, we suggest that future studies incorporate consumer opinion on a larger spectrum of cooperative wine characteristics and expand on the number or type of sustainability attributes also. In addition, since studies about pandemic impacts on wine consumption are still scarce [77,78], it would be interesting to investigate preferences after the pandemic, in order to evaluate possible consumers' modifications in wine consumption behaviour or in propensity towards sustainability aspects during and after the pandemic.

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Climate Cha(lle)nges in global wine production and trade patterns

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Abstract. The global wine trade is interested by significant changes since a few decades, due to new productive scenarios induced by climate change and to (rapidly) evolving trade and policy regimes. We investigate how these changes are altering trade dynamics. Following a gravity-type approach, we find that higher temperatures are beneficial for the terms of trade, and are boosting trade values. As for policy interventions, the impact of technical measures on trade values is heterogeneous across objectives: While technical measures tend to friction trade, the environment-related policies show pro-trade effects.

Keywords: climate change, environmental measure, technical barrier to trade.

1. INTRODUCTION

The rapid and dynamic evolution in the global trade of wine, documented by Mariani et al. [1] more than ten years ago, has been observed also in the last decade with relevant changes in the relative importance of groups of countries. According to the data from the UN Comtrade, wine imports grew in the period between 1996 and 2008, due to increased consumption in non-producing countries [2], and recovered in 2011 after a reduction in 2009, due to the international economic crisis [3]. In particular, trade between Old World Producers has drastically reduced in favour of a relevant increase in imports from New World Producers, which have gained growing market shares[1] [5,6].

Changes in trade patterns are likely to be affected both by different types of policy interventions and new productive scenarios due to climate change. Policy interventions are numerous and growing in the wine sector [7]. The

[1] Main producing countries of wine are generally classified in Old World producers, such as France, Italy, Spain, with an old tradition in the production of wine and New World Producers, such as Argentina, Australia, Chile, New Zealand, that emerged more recently as great producers of wine [4].

average tariff level fluctuated widely over twenty years[2] and non-tariff measures increased exponentially after 2009 to prevent adulterations and frauds [8, 9]. New World Producers tend to implement bilateral measures and Old World Producers in general adopt multilateral measures and tariffs[3] [12]. The use of different types of policy interventions across countries may reflect different adaptation strategies to new productive scenarios due to climate change. Over recent decades, Old World Producers benefited of better growing season temperatures and New World Producers observed climatic regimes more favourable to the production of wine[4] [14, 15]. In this regard, tariffs and multilateral measures may allow Old World Producers to protect domestic production from foreign competition. Vice-versa, bilateral measures may favour market access and strength bilateral partnerships of New World Producers to allocate their growing production. The opening of new regions (benefiting of better climatic regimes) to viticulture and changes in policy interventions would determine new productive scenarios and trade dynamics [16].

Although previous studies reveal that climate change is likely to affect trade (e.g., [17,18]) with substantial differences across producing regions of wine (e.g., [14,19]), it seems that the impact of climate change on wine production and trade patterns has not been investigated, nor quantified at global scale. In addition, while the equivalency of tariffs and non-tariff measures has been quantified (e.g., [7]), and the role of specific technical measures has been assessed in previous studies (e.g., [10, 20]), a few studies deepen on the role of environment-related policy interventions and trade dynamics under climate change. The limited empirical literature calls for more investigation: are varying climatic conditions able to shape wine production and trade? Which is the role of environment-related policy interventions in shaping trade patterns? By addressing these research questions, we would understand how climate change and related policy interventions could affect global production and trade of wine.

The aim of the article is two-fold. A preliminary objective is to conceptualise and empirically test how climate change could affect global production and trade of wine. Second, through a gravity-type approach (e.g., [21,22]), the article explains how bilateral trade reacts to changes in specific determinants of trade (i.e., climatic conditions, policy interventions), net to the effect of country-specific characteristics of importers and exporters.

The next Section describes data used in the analysis with a detailed focus on the prevailing climate observed in main producing regions of wine of countries under investigation. Section 3 conceptually discusses the relationship between climate change and the production and trade dynamics in the wine sector. Section 4 provides empirical evidence on how climate change and policy interventions affect the wine trade. Concluding reflections are left in Section 5.

2. DATA DESCRIPTION

The empirical application observes over two decades (from 1996 to 2015[5]) a sample of 14 countries that account for more than two-third of the volume of wine production (70% in 2016, Global Wine Markets, 1860 to 2016 database)[6].

2.1. Climate data

We collected region-specific climate data from different sources and countries from 1961 to 2015[7]. Indeed, the average climate at the national level may be not representative of the climate conditions characterising the main producing regions of wine of that country. This is particularly true for large countries, such as the United States or Australia, where the production of wine is focused on specific viticultural regions. For instance, the average temperature in the main wine producing regions is 3.0 °C higher than the average national temperature in the United States and 4.8 °C lower in Australia. Differences of less than 1 °C are observed in the Old World Producers, exception made for Italy whose average national temperature is 12.1 °C, 1.6 °C lower than

[2] Data are from World Integrated Trade Solution (WITS).

[3] Bilateral NTMs are policy measures regulating trade between a certain country- pair. They differ from multilateral NTMs that are measures implemented by a country on imports from any trade partners [10, 11].

[4] Other than structural changes in climate conditions of main producing regions, also exchange rate changes, wine retailing regulation changes, and the massive growth in China's demand for wine imports may have contributed to New World production and export growth [13].

[5] Thanks to a recent update of trade and climate data, we extend the timeframe of the analysis until 2021 as a sensitivity analysis.

[6] The selected countries are Argentina, Australia, Brazil, Canada, China, France, Germany, Italy, New Zealand, Russian Federation, South Africa, Spain, the United Kingdom, the United States. They ensure representativeness in term of income group (developed and developing countries, according to the 2020 country classification of the United Nations) and geographical location (low-latitude and high-latitude regions), covering different climatic zones (both Northern and Southern Hemisphere). The sample of countries does not include Chile, one of the world's top ten in terms of both wine production and exports [23], because of the lack of climate data at the regional level.

[7] The longer time period used for climate data allows to build climate normal or climatologies (i.e., 30-years averages) of temperature and precipitations: in 1996 (the starting point of the final dataset) climate normal is based on a real 30-years average.

Table 1. Average annual temperature (°C) at the national and regional level, 1996-2015.

Country	Region/State	National	Regional
Italy (avg.)		12.1	13.7
	Piemonte		10.1
	Puglia		15.7
	Sicilia		17.3
	Toscana		13.9
	Veneto		11.4
France (avg.)		11.1	11.6
	Alsace		10.4
	Bordeaux		13.6
	Burgundy		11.0
	Champagne		10.3
	Languedoc-Roussillon		12.7
	Provence		11.2
Spain (avg.)		13.5	13.4
	Andalucia		16.4
	Castilla y Leon		11.7
	Castilla-La Mancha		13.8
	Catalonia		13.6
	Galicia		13.2
	Rioja		11.9
Germany (avg.)		8.9	9.6
	Baden		9.5
	Mosel		9.2
	Pfalz-Rheinhessen		10.1
	Rheingau		9.7
United States (avg.)		7.2	10.2
	California		15.2
	New York		7.8
	Oregon		9.1
	Washington		8.7
Australia (avg.)		21.8	17.0
	New South Wales		18.9
	South Australia		17.1
	Victoria		15.1

Source: elaboration on data from Climatic Research Unit (CRU) of University of East Anglia, Agri4Cast of the European Commission, National Oceanic and Atmospheric Administration (NOAA) of the National Centers for Environmental Information (NCEI), Bureau of Meteorology of the Australian Government.
Notes: For each country, the first line of table reports the average annual temperature at the national level (under column 'National') and at the regional level (under column 'Regional').

the average temperature in some of the main producing regions of wine (Table 1).

Country-specific climate data are collected for the 14 countries in the sample from the Climatic Research Unit (CRU) of the University of East Anglia[8] [25]. Annual climate normals of temperature and precipitations are built using these historical weather data and serve as baseline climate information. Region-specific[9] climate data are collected from Agri4Cast of the European Commission for countries in the European Union[10] (i.e., Italy, France, Spain, Germany), from the National Oceanic and Atmospheric Administration (NOAA) of the National Centers for Environmental Information (NCEI) for the United States[11], and from the Bureau of Meteorology of the Australian Government for Australia[12]. We collected the mean air temperature (°C) and the mean precipitation (mm/day) for the most famous wine producing regions of Italy (i.e., Piemonte, Veneto, Toscana, Puglia, Sicilia), France (i.e., Alsace, Champagne, Bordeaux, Burgundy, Languedoc-Roussillon, Provence), Spain (i.e., Andalucia, Castilla-La Mancha, Castilla y Leon, Catalonia, Galicia, Rioja), and Germany (i.e., Baden, Mosel, Pfalz-Rheinhessen, Rheingau). Monthly average temperature (in °F) and precipitation (in inches) for the main wine producing States of the Unites States (i.e., California, Oregon, Washington, New York) have been gathered from the US Climate Divisional Database of the NOAA[13]. Monthly historical weather observations, both temperature (in °C) and precipitation (in mm) have been retrieved for the main wine producing region of Australia (i.e., Victoria, New South Wales, South Australia).

[8] The CRU dataset is a gridded historical dataset derived from observational data, widely accepted as a reference dataset in climate research [24]. It provides quality-controlled temperature and rainfall values from thousands of weather stations worldwide.

[9] Historical (at least 30 years) region-specific climate data are not available for other countries in the sample. Region-specific climate indicators are available, for instance, Anderson and Nelgen [26], but they are collected only for three years (i.e., 2000, 2010, 2016). For this reason this data source is not suitable for our analysis that aims at capturing the impact of long-run changes in climate conditions in the main wine producing regions.

[10] The Datasets of the MARS Crop Yield Forecasting System and Software, developed by Agri4Cast of the European Commission, provides access to daily meteorological observation from weather stations interpolated on a 25x25 km grid. Daily data have been aggregated at the annual level to facilitate the comparison with climate data from the CRU of University of East Anglia and with wine production and trade data.

[11] The NOAA of the NCEI is responsible for preserving, monitoring, assessing, and providing access to climate and historical weather data and information of the United States.

[12] The Bureau of Meteorology of the Australian Government is the national weather, climate and water agency that, through regular forecasts, warnings, monitoring, and advice spanning the Australian region and Antarctic territory, provides one of the most fundamental and widely used services of the Australian Government. Monthly weather data have been aggregated in annual climatologies of temperature and precipitation.

[13] Average temperature and precipitation have been reported to °C and mm respectively and then aggregated annual climatologies of temperature and precipitation.

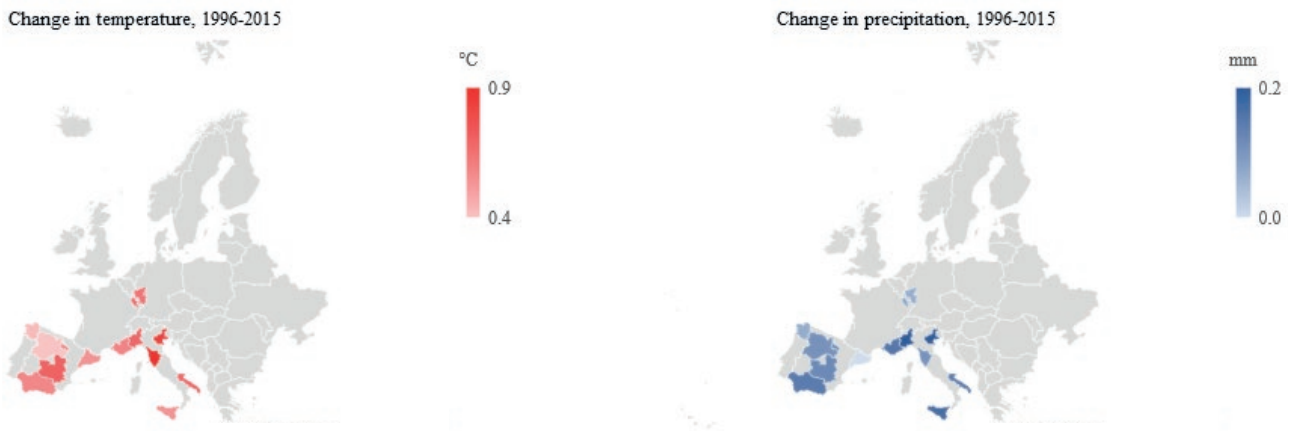

Figure 1. Change in climate normals between the period 1996 and 2015 in the most famous wine producing regions of Old World Producers. Source: elaboration on data from Agri4Cast of the European Commission. Notes: Detrimental changes in red (e.g., increase in temperatures/reduction in precipitation), beneficial changes in blue (e.g., reduction in temperatures/increase in precipitation). The most famous wine producing regions of Old World Producers are Piemonte, Veneto, Toscana, Puglia, Sicilia for Italy, Alsace, Champagne, Bordeaux, Burgundy, Languedoc-Roussillon, Provence for France, Andalucia, Castilla-La Mancha, Castilla y Leon, Catalonia, Galicia, Rioja for Spain, Baden, Mosel, Pfalz-Rheinhessen, Rheingau for Germany [23].

Italy, France, and Spain are the top three producers of wine worldwide [27]. The climate in the most famous wine producing regions of these countries has a major influence on their leadership.

Wine is produced in all the Italian regions but, historically, the most significant in terms of quality and quantity of production are Toscana (on average 13.9 °C), where the warm and temperate climate of the coastal areas and the increased diurnal temperature variation of the inland areas coexist, Piemonte (on average 10.1 °C), characterised by a temperate climate favoured by the Alps and Apennines, and Veneto (on average 11.4 °C), benefitting of the cooler, alpine-influenced climate of the northeast corner of Italy (Table 1). Sicilia and Puglia, characterised by a near-perfect environment for the wine production (i.e., hot Mediterranean climate, persistent sunshine, occasional sea breezes), were traditionally great wine producing regions of Italy, although consumers' preferences shifted towards wine produced in the northern Italian regions since the late 20th Century. Over the period 1996-2015, the average annual temperature and precipitation in the most famous producing regions of Italy registered a limited and homogeneous increase: i.e., between 0.5 and 0.9 °C and between 0.1 and 0.2 mm per day on average (Figure 1).

The French climate is very heterogeneous across the main wine producing regions contributing to the great diversity of French wines. The northern region of Champagne is one of the coolest wine-growing regions of the world with an annual average temperature of 10.3 °C (Table 1). The eastern regions of Alsace and Burgundy have a continental climate, warm during summers and cold during winters. The maritime climate of the southwest of Bordeaux is mainly due to the proximity to the Atlantic Ocean and the various rivers, which ensure the highest annual regional temperature (on average 13.6 °C, Table 1). The south regions of Languedoc-Roussillon and Provence are characterised by a Mediterranean climate. The long-run changes in climate show no differences across regions: since 1996 until 2015, the annual temperatures have grown by 0.55 °C and the annual rainfall levels have increased by 0.15 mm per day on average (Figure 1).

In Spain, the greatest wine production occurs in Castilla-La Mancha, but the most famous wines are produced in regions with very heterogeneous climate: the cool Galicia, the Mediterranean Catalonia, the sunny Andalucia, the warm and dry Castilla y Leon and Rioja. The greatest increase in the average annual temperature during 1996-2015 is observed in Castilla-La Mancha (+0.7 °C), whereas the increase in the other regions is between 0.4 and 0.5 °C; the average annual precipitation per day is mostly unchanged (Figure 1).

According to the data from the Wine Searcher, the most famous wine producing regions of Germany are Rheingau and Mosel, characterised by a cool, northern continental climate with an average annual temperature of 9.7 °C and 9.2 °C respectively (Table 1). Periods of past warming improved the quality of Rheingau wines [28] and of Mosel wines [29]. However new producing regions, such as Baden and Pfalz-Rheinhessen, are emerging favoured by changes in climate trends.

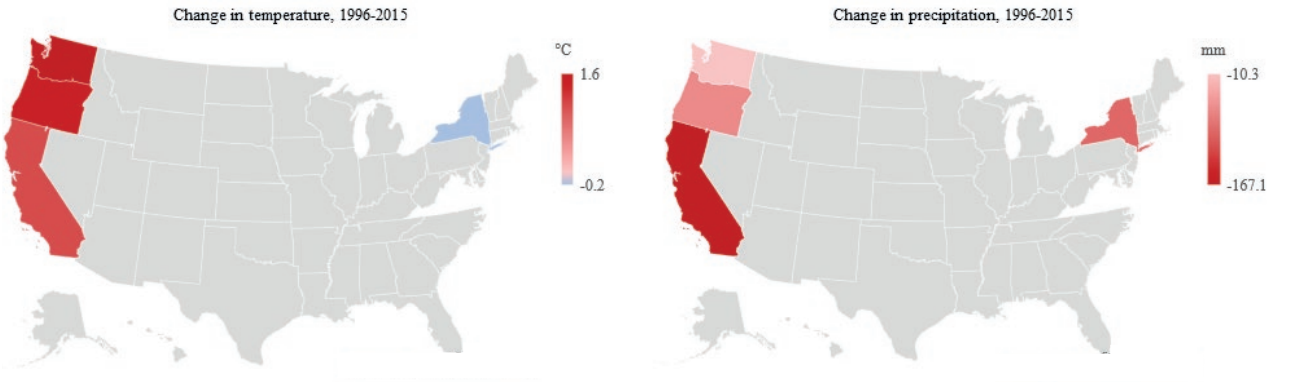

Figure 2. Change in climate normals between the period 1996 and 2015 in the main wine producing States of the United States. Source: elaboration on data from the National Oceanic and Atmospheric Administration (NOAA) of the National Centers for Environmental Information (NCEI). Notes: Detrimental changes in red (e.g., increase in temperatures/reduction in precipitation), beneficial changes in blue (e.g., reduction in temperatures/increase in precipitation). The main wine producing States of the United States are California, Oregon, Washington, New York.

According to the data from the National Association of American Wineries and the Wine Searcher, the vast majority of the US wine production occurs in the Pacific Northwest of the United States. Covering 85% of the US wine production, California is the largest and most important wine State, followed by Washington and Oregon that respectively count over 20,000 hectares and 13,500 hectares of planted vineyards. These are amongst the world's youngest and most promising wine States, where pedoclimatic characteristics are determinant for the quantity and quality of wine production [17]. The coastal California wines benefit of the warm and dry climate of northern latitudes and of the proximity to the cool waters of the Pacific Ocean [30], despite during the last two decades California has become 1 °C warmer and drier (-167.1 mm per year) (Figure 2). Similar climate conditions occur also in Oregon, where the proximity to the Pacific Ocean ensures warm temperatures and high rainfall levels. Most of the Washington wine production occurs in the eastern part of the State, characterised by a continental climate, where the proximity to the local rivers (e.g., the Columbia) contributes to moderate both summer and winter temperatures (that may drop till -26°C). In Washington, long-run changes in temperatures (+1.6 °C) are stronger than in California (+1.0 °C) or in Oregon (+1.4 °C), but the State has registered a drop of only 10.3 mm per year between 1996 and 2015 (Figure 2). Totally different climate conditions characterised New York State, according to the Wine Searcher data the third US wine-producing State in terms of production volumes. Differently from the northwest States, the average annual temperature of New York State has reduced (-0.2 °C) over the last twenty years (Figure 2). Most of the wine of New York State is produced in proximity of the coast, rivers, lakes able to reduce the severity of winter temperatures characterising the north-eastern United States. The great water availability allows to face the progressive reduction of annual rainfall levels (-91.0 mm per year) of the last period (Figure 2).

The Australian international competitiveness of the wine sector is firmly established and commensurate with its ideal wine-growing climate [31]. According to the data from Wine Australia and Wine Searcher, about half of the Australian annual wine is produced in South Australia, especially in the south-eastern corner of the State where the presence of two large gulfs and the proximity to the Southern Ocean make the cooler and less arid climate suitable to the wine production. The climate of South Australia has been interested by limited changes during the last two decades (+0.4 °C and -22.2 mm per year, Figure 3). A cool, ocean-influenced climate also characterises Victoria the third most productive wine region of Australia, behind South Australia and New South Wales. The New South Wales is characterised by different climate conditions due to its territorial extension: the coastal areas, experiencing mild temperatures and great rainfall (+225.0 mm per year between 1996 and 2015, Figure 3), are the most suitable to produce wine.

2.2. Production, trade, and policy data

To estimate the relationship between climate change and wine production, we collected country-specific annual data on the wine production and consumption (in 1000 hl) from the OIV database. We obtained the volume of countries' excess of production (in 1000

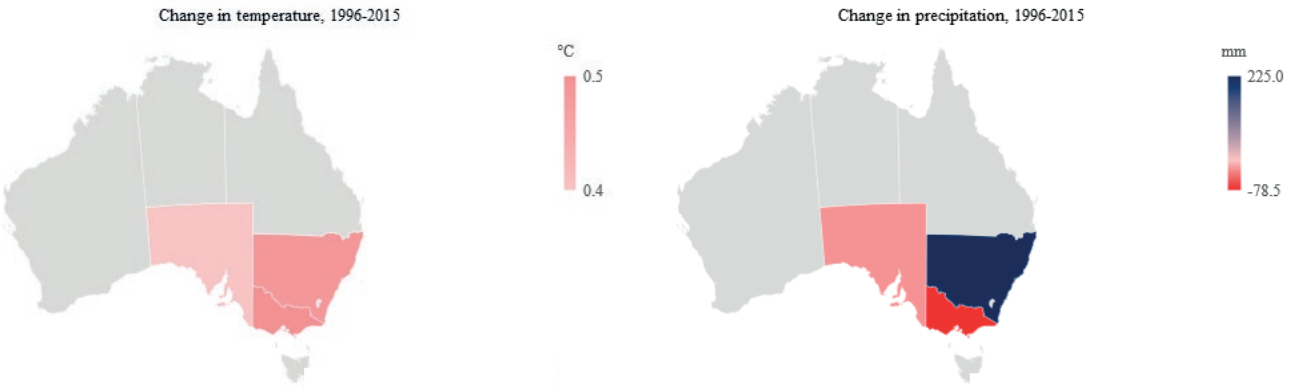

Figure 3. Change in climate normals between the period 1996 and 2015 in the main wine producing regions of Australia. Source: elaboration on data from the Bureau of Meteorology of the Australian Government. Notes: Detrimental changes in red (e.g., increase in temperatures/reduction in precipitation), beneficial changes in blue (e.g., reduction in temperatures/increase in precipitation). The main wine producing regions of Australia are Victoria, New South Wales, South Australia.

hl) as the absolute difference between production and domestic consumption: this variable is a proxy of countries' export capacity. Annual data on bilateral imports of wine (in US$) for each country-pairs in the sample are collected from the UN Comtrade database. Trade data are aggregated at the four-digit level of the Harmonised System classification and use wine of fresh grapes (HS 4-Digit 1996: 2204). Bilateral imports of wine in the sample are 91.33 on average[14]: the United States and Germany are relevant traders (Table 2). As expected, the Old World Producers, especially France, Italy and Spain, have the largest volumes of wine production and consequently a higher export capacity. The value of exports is particularly high for France and Italy. The production volumes of Germany (9.30 million hl) are comparable to those of Australia (10.93 million hl), but its export capacity is much higher (10.68 million hl as compared to 6.36 million hl) but less valuable (27.78 million US$ as compared to 95.85 million US$) (Table 2).

To estimate the relationship between trade policy measures and wine trade, we collected tariff data from the World Integrated Trade Solution (WITS) software and non-tariff measures data from the Global Database on Non-Tariff Measures of UNCTAD[15]. In the sample, 40% of trade relationships are regulated by Technical Barriers to Trade (TBT, a type of non-tariff measures) and only three type of TBT deals with environment-related issues (33% of cases). The TBT B14 (i.e., authorisation requirement for TBT reasons) requires that the importer should receive authorisation, permits or approval from a relevant government agency of the destination country, for reasons such the environmental protection. The TBT B15 (i.e., registration requirement for importers for TBT reasons) requires that importers should be registered in order to import certain products: to register, importers may need to comply with certain requirements, documentation and registration fees; it also includes the cases when the registration of establishments producing certain products is required. The TBT B21 (i.e., tolerance limits for residues of or contamination by certain substances) is a measure that establishes a maximum level or tolerance limit of substances, which are used during their production process but are not their intended ingredients. It is worth noting that the TBT B140 is implemented by Australia, Brazil, the United States (8% of cases in the sample), the TBT B150 by Argentina, Brazil, China, Russia, the United States (22% of cases in the sample), the TBT B210 by the United States (7% of cases in the sample).

3. ON THE RELATIONSHIP BETWEEN CLIMATE CHANGE AND WINE PRODUCTION AND TRADE

The literature on the relationship between climate change and production and trade dynamics is large

[14] In the sample, we have (structural) zero trade flows (i.e., 0.5% in total exports and 5.6% in bilateral trade of wine). Structural zero trade flows may be associated with data recording issue or may occur when bilateral trade is expected to be low, for instance between distant countries [22]. The dependent variable in the model in equation (1) is the (log) value of exports increased by a very small, arbitrary, value to accommodate zeros and allow for consistent estimates in the presence of a dependent variable assuming null values [32]. The use of the GPML to estimate the model in equation (4) allows to solve the problem of zero trade values in the dependent variable (i.e., the value of wine imports) [33].

[15] More details are provided in the Appendix A.

Table 2. Average wine production and trade data, 1996-2015.

	Production (million hl)	Excess of production (million hl)	Exports (million US$)	Bilateral trade (million US$)
Average	29.45	14.53	13.64	91.33
Italy	49.20	22.49	226.19	24.74
France	50.00	19.34	328.97	30.34
Spain	36.24	23.65	98.76	10.38
Germany	9.30	10.68	27.78	175.52
United States	21.05	4.63	39.88	268.26
Australia	10.93	6.36	95.85	22.94

Source: elaboration on data from OIV.
Notes: Excess of production volumes obtained as the difference between production and domestic consumption. France, Germany, Italy, Spain are Old World Producers, Australia and the United States are New World Producers.

Table 3. Marginal impact of climate and change in countries' wine production and terms of trade.

	Volume of wine production		Value of wine exports	
	Marginal impact (%)	Change in avg. production (mln hl)	Marginal impact (%)	Change in avg. exports (mln US$)
Temperature (+1 °C)	2.28*** [2.05; 2.51]	+0.7	4.11*** [1.88; 6.34]	+5.6
Precipitation (+1 mm)	-0.01** [-0.02; 0.00]	0.0	-0.04 [-0.15; 0.07]	-

Notes: Marginal impacts are obtained applying equation (B.2) on coefficients of variables in level and squared reported in table B.1, evaluated at average temperature (12.6 °C) and precipitation (269 mm); 95% confidence intervals are in brackets. Change in volume of wine production, volume of wine excess of production, value of wine exports considers average volumes and values (see table 2). *** Significant at the 1 percent level. ** Significant at the 5 percent level.

and varied (e.g., [34]). Previous studies start from the assumption that, for open economies, the impacts of climate change on agriculture in any region is not isolated from the impacts occurring in the rest of the world (e.g., [18,35]). Given this assumption, adjustments through production within regions and through trade patterns between regions may contribute to smooth consequences of climate change (e.g., [36]). We apply this conceptual framework to the wine sector. Methodologically, previous studies on the linkages between climate change and production and trade patterns are based on equilibrium models. They simulate the effects of adaptive measures to climate change by comparing scenarios without and with climate change (e.g., [37]) or the impacts of climate change without and with trade adjustments (e.g., [38]). Differently, we propose an econometric approach to quantify the effects of climate change on production and trade patterns. In particular, from a theoretical perspective, we combine approaches used in Ricardian trade studies (e.g., [39]) and Ricardian climate studies (e.g., [40,41]) to understand how climate change, by altering comparative advantage of regions, affects their production and trade capacity, and how regions adapt to climate change by reshaping trade patterns. Methodological details and empirical evidence are detailed in the Appendix B.

The marginal impact of climate on production and trade of wine, reported in Table 3, suggests that higher temperatures in the main producing regions of wine tend to favour both the volume of wine production and the value of wine exports. A 1 °C increase (decrease) in regional annual temperature increases (decreases) production volumes by 2.28% (+0.7 million of hectolitres on average) and export values by 4.11 % (+5.6 million USD on average). Greater rainfall levels have neither economically significant impact on the volume of wine production nor statistically significant impact on the value of wine exports.

The results complement findings from Macedo et al. [17] who conclude that temperature anomalies (short-run changes in climate) may be detrimental for the wine sector. In particular, they find that the exports of Port wine tend to be frictioned if the importing countries register temperature anomalies: the authors associate this effect to the tendency of consumers to provisionally change consumption habits during hottest periods. This analysis concludes on the long-term impact of climate change on the wine supply: if lower than anomalous, temperature increases tend to favour the volumes of wine production with a consequent positive effect on countries' export capacity and expanded export values. As argued in Gouel and Laborde [38], long-run changes in climate tend to be beneficial for net-exporters of agri-food products.

4. ON THE EFFECT OF CLIMATE CHANGE AND POLICY INTERVENTIONS ON WINE TRADE

4.1. Methodological approach

We adopt a gravity-type approach to investigate the effect of climate change and policy interventions (environment-related trade measures in particular) on the

bilateral trade of wine (e.g., [17,18]). As documented in Costinot and Rodríguez-Clare [21] and Head and Mayer [22], a theoretically founded structural gravity model[16] explains the bilateral trade (X_{ij}) as a function of the value of output in the exporting country i (Y_i), the total expenditure of the importing country j (E_j), the multilateral resistances in both countries[17] (Π_i and P_j) and the determinants of transaction costs between i and j (θ_{ij}):

$$X_{ij} = \frac{Y_i}{\Pi_i}\frac{E_j}{P_j}\theta_{ij} \quad (1)$$

where Y_i is the value of output in i, and E_j is the total expenditure of j, Π_i and P_j are, as defined in Anderson and van Wincoop [42], the multilateral resistances proxy the competitiveness of i and j, θ_{ij} includes proxies and determinants of transaction costs between i and j.

Empirically, the structural form of the gravity model in equation (3) can be expressed as an exponential function:

$$X_{ijt} = e^{\{\boldsymbol{\beta}_{it} + \boldsymbol{\beta}_{jt} + \boldsymbol{\beta}_{ij} + \boldsymbol{\theta}_{ijt}\,\delta\}}\epsilon_{ijt} \quad (2)$$

where the term X_{ijt} collects the value of bilateral trade at time t and ϵ_{ijt} is the error term. We use a three-way structure of fixed effects to control for unobserved country- and pair-specific heterogeneity [43]. The exporter-time and importer-time fixed effects, $\boldsymbol{\beta}_{it}$ and $\boldsymbol{\beta}_{jt}$, control for multilateral resistances and countries' output shares and total expenditure at time t. The time-varying country-specific fixed effects allow to capture the unobservable heterogeneity characterising the exports and importers over time [32]. Country-pair fixed effects, $\boldsymbol{\beta}_{ij}$, control for bilateral time-invariant determinants of trade, such as geographic distance, common language, contiguity, and do not impede the estimation of time-varying bilateral determinants of trade [44]. Following Macedo et al. [17] and Bozzola et al. [18], the determinants of transaction costs between i and j at time t, $\boldsymbol{\theta}_{ijt}$, include variables proxying climate change (i.e., temperature and precipitation normals[18] in the exporting countries) and policy interventions[19] (i.e., bilateral tariff levels and dummies that control for the presence of multilateral technical barriers to trade[20]); δ is the corresponding vector of regression coefficients. A set of dummies control if an importer set a technical measure on imports from its trading partner in a specific year. Since $\boldsymbol{\theta}_{ijt}$ also includes variables with the importer-time dimensions only (i.e., climate variables and multilateral technical barriers to trade), collinearity problems may arise with the vector of importer-time fixed effects. To solve this concern, we replace the importer-time fixed effects with importer fixed effects and time fixed effects.

The model (2) is estimated through the Gamma Pseudo Maximum Likelihood (GPML) estimator that is robust to heteroskedastic errors and allows to deal with zero trade flows [33]. Following Yotov et al. [32], the trade volume effects are calculated in percentage terms as follows: $TVE = (e^{\hat{\delta}} - 1)*100$, where $\hat{\delta}$ is the estimate of the structural gravity coefficient on the indicator variable of interest.

4.2. Empirical evidence

The gravity estimates are in table 4. Climatic conditions of trading partners are positively correlated with their level of bilateral exports. Consistent with the evidence from the preliminary analysis in Section 3, the effect temperature is much higher than the impact of precipitation. This is in line with empirical evidence on the trade-climate nexus (e.g., [18]). The results also support findings of Adams et al. [46], who project a 90% increase in the wine sector of California by 2100 with increasing temperatures (+ 3 °C), and of Jones et al. [14], who show how increasing temperatures have benefited wines from Germany and France but not from the South Australia. Similarly, Nemani et al. [47] suggest that climate change has been beneficial for the wine sector in coastal California.

The effect of TBT on imports of wine is, in most of cases, not detectable. The result is not surprising considering the well-documented dual effect of non-tariff measures on trade (e.g., [48]). Non-tariff measures may be both catalysts and barriers to trade and these contrasting effects may offset each other in the overall picture: this occurs for trade of agri-food products but also in the wine sector [9,49]. The direction of the effect is

[16] The subscript t for time varying variables is suppressed for ease of notation.

[17] As defined in Anderson and van Wincoop [42], the multilateral resistances proxy the competitiveness of i and j,

[18] Traditionally used in climate literature (e.g., [40, 41]), the term climate normal, a synonymous of climatologies, refer to long time averages (usually 30-years) in climate variables (e.g., temperatures and precipitations) in a given location.

[19] The use of country-pair fixed effects allows us to account for the unobservable linkages between the endogenous trade policy covariates and the error term, solving for the problem of endogeneity of trade policy variables [45].

[20] Technical barriers to trade are introduced as a general category, as specific measure pursuing a particular policy objective (i.e., the protection of the environment), as specific instrument regulating a particular aspect of trade related to environmental issues (e.g., authorisation requirement).

Table 4. Effects of climate change and policy interventions on bilateral wine imports.

Variables	Specification (i)	Specification (ii)	Specification (iii)	Specification (iv)	Specification (v)
Temperature	0.785***	0.737***	0.203	0.666***	0.752***
	(0.199)	(0.207)	(0.284)	(0.127)	(0.209)
Precipitation	0.004***	0.004***	0.006***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
TBT	0.185	-0.416***	-0.116	0.212	0.200
	(0.206)	(0.057)	(0.128)	(0.209)	(0.219)
Environmental TBT		0.686***			
		(0.213)			
TBT B14			0.508***		
			(0.167)		
TBT B15				0.125	
				(0.086)	
TBT B21					-0.311
					(0.268)

Notes: Gamma Pseudo Maximum Likelihood (GPML) estimation of the structural gravity model. The dependent variable is the value of bilateral imports (in level). The TBT-related explanatory variables are modelled as dummy variables. B14 and B15 consist, respectively, in authorisation requirement and in registration requirement for importers for TBT reasons (including environmental protection); B21 are tolerance limits for residues of or contamination by certain substances. All specifications include a constant, importer, time, exporter-time, and country-pair fixed effects, tariff levels. Robust standard errors are in parentheses. Observations are 494. *** Significant at the 1 percent level.

likely to depend on the policy objective of each measure [50,51]. Indeed, the results of the specification 'Environmental TBT', where the effect of climate-related TBT is separated from the effect of all other TBT, shows that TBT tend to hinder trade, but not if their aim is the protection of the environment (specification ii). The results confirm findings of Dal Bianco et al. [7] who argue that "*technical barriers are considerable frictions to exports*": they disentangle the effect of TBT related to 'food containers', found to be non-prohibitive, and related to 'human health', 'conformity assessment' and 'labelling', assessed as trade barriers; however, TBT aiming at protecting the environment is out of the scope of their analysis. In support of the trade-enhancing effect of environment-related TBT, Will [52] argue that WTO Member States may choose to address environmental concerns with any level of protection and type of measure, but they are required to avoid discrimination if the environmental TBT are suspected to restrict WTO free trade.

The effect of the TBT B21 is not detected. Similarly, Macedo et al. [17] find no significant effects of measures setting tolerance limits for residues and restricted use of substances on trade of Port wine. They find no effect also of import authorisation/licensing related to TBT, but their analysis stops at the intermediate level of aggregation (i.e., TBT B1). Their result may thus signal heterogeneity in the effects of measures at a more disaggregated level, as revealed by results in table 4: i.e., positive effect of authorisation requirement for importers for TBT reasons (TBT B14) and null effect of registration requirement for importers for TBT reasons (TBT B15). The objective of this measure is to fulfil the needs of domestic market, to get the taxes and charges fully, to control the illegal importation by permitting the wine importation in limited amount [53]. Although the steps to obtain the permission of importation for wine may require paperwork (time-consuming) and registration fees (negligible direct costs), the measure does not impose relevant indirect costs (e.g., changes of product characteristics and attributes or of production processes) such as in the case of the TBT B21 (i.e., reduce or avoid the presence of residues in the final product). A measure that provides specific importers with authorisation to import would advantage them over their competitors devoid of the import authorisation [54].

5. CONCLUDING REMARKS

The evolution in grapes productivity, due to changes in climate conditions, shape countries' specialisations and their comparative advantage (e.g., [18]). We investigate how wine trade has evolved in lieu of the long-run changes in climate.

Higher temperatures in the main wine producing regions are beneficial for countries' levels of production,

and favour exports (both in terms of volumes and values). Put differently, climate change alters the terms of trade. Consistent with findings from the literature (e.g., [36, 38]), the results confirmed that the impacts of climate change on grapevines yields within and between regions propagate throughout the wine supply chain, and that the production and trade patterns adjust accordingly. Indeed, climate change alters comparative advantage of regions and, thus, affects their production and trade capacity that adapt to the changed climate conditions [34].

We also controlled for the role of trade regulations. We show that technical measures have differentiated impacts, depending on the objectives of the measures. While technical measures tend to friction trade of wine (e.g., [7,17]), the environment-related TBT tend to be pro-trade.

The results of this research flag the relevance of the interrelations between the wine sector and climate change. As argued in the OIV guidelines for sustainable vitiviniculture, climate has a key role in the activities in the vine and wine sector and the "*protection, and preservation of these natural assets [solar energy, climate, water, soils] through environmentally sustainable practices are imperative for the long-term viability of vitivinicultural activities*"[21]. Policymakers should put more efforts in promoting strategies to achieve environmental, economic, and social sustainability of the grape production and processing systems on a global scale. The containment of risks to the environment should be a priority. This is in line with the objectives set during the OIV General Assembly held on Paris, 30th July 2004: i.e., "*minimize environmental impacts linked to viticulture and the transformation process, […] promote sustainable vitiviniculture from an environmental, ecological and economic standpoint*"[22]. As demonstrated by the results of our analysis, the achievement of these objectives cannot disregard the evaluation of the global production system and the adaptation of proposed strategies to the characteristics of the main producing regions.

On an international scale and considering the role of interactions between countries, potential mitigation strategies may be the adoption of environmental-friendly measures regulating trade of wine at the global level. They have proved to be economically sustainable for the implementing countries: compared to the limited compliance costs countries have to face (e.g., negligible direct costs to obtain the permission to importation of wine), the gain in monetary terms is much higher. In addition, the ultimate objective of these policy measures (i.e., the protection of the environment) makes them a win-win, socially desirable strategy. However, the research pointed out that much work should be done to harmonise standards on the maximum residue limits for the vine and wine sector, which may still constitute a friction to the free trade of wine. The debate is vivid also at the OIV, where some decisions on the issue have already been officially adopted and some other positions have been registered during various occasions[23]. For instance, the guidelines for the application of the maximum residue limits related to wine products and wine have been introduced as expected results in the OIV Strategic Plan 2012-2014.

[21] OIV Resolution CST 1/2008, "OIV guidelines for sustainable vitiviniculture: production, processing and packaging of products", available at www.oiv.int.

[22] OIV Resolution CST 1/2004, "development of sustainable vitiviniculture", available at www.oiv.int.

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A. DETAILS ON POLICY DATA

To estimate the relationship between trade policy measures and wine trade, we collected tariff data from the World Integrated Trade Solution (WITS) software. Annual tariff data are country-pair specific and available at the four-digit level of the Harmonised System classification for wine of fresh grapes (HS 4-Digit 1996: 2204). The main information collected is the simple tariff average (Sum of duties/Number of duties, in percentage), which measures the average level of nominal tariff protection. Tariff averages are provided for the Most Favoured Nation (MFN) applied rates, that is the normal, non-discriminatory, tariff charged on imports of a good (wine of fresh grapes in this case).

The Global Database on Non-Tariff Measures from UNCTAD provides data on non-tariff measures (NTMs). The database contains all NTMs aggregated at the HS 6-digit level and specific for country-pairs. According to the international classification of UNCTAD [53], technical barriers to trade (TBT) are technical NTMs implemented by a country against all its trading partners (multilateral NTMs). The UNCTAD database provides the number of TBT at three levels of aggregation: (i) chapter includes indiscriminately any TBT implemented by a country for product category under investigation; (ii) the intermediate level of aggregation; (iii) the highest level of detail involves specific types of TBT. The UNCTAD database also provides the date of entry into force of specific TBT and the date in which they expired (or will expire): this allows to track the validity of each TBT. The Table A.1 lists all the TBT regulating trade of wine between countries in the sample according to the objective of each measure. Measures refers both to technical regulations, laying down characteristics of wine (under chapters B1, B2, B3, B6, B7) and related production processed and methods (under chapter B4), and to procedures for assessment of conformity with technical regulations and standards (under chapter B8), excluding measures covered by the Sanitary and Phytosanitary (SPS) Agreement.

In the sample[24], only the United States implement tolerance limits for residues of or contamination by certain substances (TBT B21) on imports of wine. Given the multilateral nature of TBT measures, the tolerance limits apply indiscriminately to any partner exporting wine to the United States. According to data from the BCGlobal Pesticide MRL Database, in the United States tolerances are established for the combined residues of the insecticide cyantraniliprole[25], including its metabolites and degradates, in or on wine grapes[26] (i.e., 2 ppm), for emamectin including its metabolites and degradates[27] (i.e., 0.03 ppm), for fluazinam including its metabolites and degradates[28] (i.e., 3 ppm), for residues of a metiram including its metabolites and degradates[29] (i.e., 5 ppm), for the combined residues of the fungicide vinclozolin[30] and its metabolites containing the 3,5-dichloroaniline moiety (i.e., 6 ppm).

B. EMPIRICAL EVIDENCE ON THE RELATIONSHIP BETWEEN CLIMATE CHANGE AND WINE PRODUCTION AND TRADE

We use an approach based on Ricardian studies (e.g., [39-41]) to estimate the relationship between long-run climate and production and trade dynamics in the wine sector. We estimate how much climate explains observed cross-sectional variation of the wine supply[31], using the following log-linear specification:

$$Y_{it} = \boldsymbol{\beta}_m + \boldsymbol{\beta}_t + \boldsymbol{C_{rt}}\gamma + u_{it} \quad \text{(B.1)}$$

The term Y_{it} indicates the wine supply of country i at time t. We estimate different specifications using as dependent variable, alternatively, the volume of countries' wine production and the value of countries' wine exports (i.e., a proxy of the value of excess of production). The term $\boldsymbol{C_{rt}}$ includes region-specific (r) climate

[24] Countries in the sample are Australia, France, Germany, Italy, Spain, the United States for which climate data at the regional level are available.

[25] 3-bromo-1-(3-chloro-2-pyridinyl)-N-[4-cyano-2-methyl-6-[((methylamino)carbonyl]phenyl]-1Hpyrazole-5-carboxamide.

[26] Compliance with the tolerance levels is to be determined by measuring only cyantraniliprole in or on wine grapes.

[27] Compliance with the tolerance levels is to be determined by measuring only the sum of emamectin (a mixture of a minimum of 90% 4'-epimethylamino-4'-deoxyavermectin B1a and maximum of 10% 4'-epimethylamino-4'-deoxyavermectin B1b) and its metabolites 8,9-isomer of the B 1a and B1b component of the parent (8,9-ZMA), or 4'-deoxy-4'-epi-amino-avermectin B1a and 4'-deoxy-4'-epi-amino-avermectin B1b; 4'-deoxy-4'-epi-amino avermectin B1a (AB 1a); 4'-deoxy-4'-epi-(N-formyl-N-methyl)amino-avermectin (MFB 1a); and 4'-deoxy-4'-epi-(N-formyl)amino-avermectin B 1a (FAB 1a), calculated as the stoichiometric equivalent of emamectin.

[28] Compliance with these tolerance levels is to be determined by measuring only fluazinam and its metabolite AMGT (3-[[4-amino-3-[[3-chloro-5-(trifluoromethyl)-2-pyridinyl]amino]-2-nitro-6-(trifluoromethyl) phenyl]thio]-2-(beta-D-glucopyranosyloxy) propionic acid).

[29] A mixture of 5.2 parts by weight of ammoniates of [ethylenebis (dithiocarbamato)] zinc with 1 part by weight ethylenebis [dithiocarbamic acid] bimolecular and trimolecular cyclic anhydrosulfides and disulfides. Compliance with the tolerance levels is to be determined by measuring only those metiram residues convertible to and expressed in terms of the degradate carbon disulfide.

[30] 3-(3,5-dichlorophenyl)-5-ethenyl-5-methyl-2,4-oxazolidinedione.

[31] We rely on the pooled Ordinary Least Square (OLS) estimate of equation (1).

Table A.1. Technical Barriers to Trade (TBT) regulating trade of wine between countries in the sample.

Chapter	Title	Description
B1	**Prohibitions/restrictions of imports for objectives set out in the TBT agreement**	**Such prohibitions/restrictions may be established for reasons related, *inter alia*, to national security requirements; the prevention of deceptive practices; protection of human health or safety, animal or plant life or health, or the environment.**
B14	Authorisation requirement for TBT reasons	Requirement that the importer should receive authorisation, permits or approval from a relevant government agency of the destination country, for reasons such as national security, environment protection, etc.
B15	Registration requirement for importers for TBT reasons	Requirement that importers should be registered in order to import certain products. To register, importers may need to comply with certain requirements, documentation, and registration fees. It also includes the cases when the registration of establishments producing certain products is required.
B2	**Tolerance limits for residues and restricted use of substances**	**Restrictions on the tolerance limits on residues or use of certain substances contained in the final products.**
B21	Tolerance limits for residues of or contamination by certain substances	A measure that establishes a maximum level or tolerance limit of substances, which are used during their production process but are not their intended ingredients.
B3	**Labelling, marking, and packaging requirements**	
B31	Labelling requirements	Measures regulating the kind, colour, and size of printing on packages and labels and defining the information that should be provided to the consumer. Labelling is any written, electronic, or graphic communication on the packaging or on a separate but associated label, or on the product itself. It may include requirements on the official language to be used as well as technical information on the product, such as voltage, components, instruction on use, safety, and security advice.
B32	Marking requirements	Measures defining the information for transport and customs that the transport/distribution packaging of goods should carry.
B33	Packaging requirements	Measures regulating the mode in which goods must be or cannot be packed and defining the packaging materials to be used.
B4	**Production or post-production requirements**	
B41	TBT regulations on production processes	Requirement on production processes not classified under SPS. It also excludes those specific measures on tolerance limits for residues and restricted use of substances (or its subcategories).
B42	TBT regulations on transport and storage	Requirements on certain conditions under which products should be stored and/or transported.
B6	**Product identity requirement**	**Conditions to be satisfied in order to identify a product with a certain denomination (including biological or organic labels).**
B7	**Product-quality or -performance requirement**	**Conditions to be satisfied in terms of performance (e.g., durability, hardness) or quality (e.g., content of defined ingredients).**
B8	**Conformity assessment related to TBT**	**Requirement for verification that a given TBT requirement has been met. This could be achieved by one or combined forms of inspection and approval procedure, including procedures for sampling, testing and inspection; evaluation, verification, and assurance of conformity; accreditation and approval.**
B81	Product registration requirement	Product registration requirement in the importing country.
B82	Testing requirement	A requirement for products to be tested against a given regulation, such as performance level – includes sampling requirement.
B83	Certification requirement	Certification of conformity with a given regulation: required by the importing country but may be issued in the exporting or the importing country.
B84	Inspection requirement	Requirement for product inspection in the importing country – may be performed by public or private entities. It is similar to testing but does not include laboratory testing.
B85	Traceability information requirements	Disclosure requirement of information that allows following a product through the stages of production, processing, and distribution.
B851	Origin of materials and parts	Disclosure of information on the origin of materials and parts used in the final product.
B859	Traceability requirements, n.e.s.	
B89	Conformity assessment related to TBT, n.e.s.	
B9	TBT measures, n.e.s.	

Source: Elaboration on UNCTAD [53].
Notes: n.e.s. stand for not elsewhere specified.

normals[32] of temperature (T) and precipitation (P) and their squares; is the corresponding vector of regression coefficients. The terms $\boldsymbol{\beta}_m$ and $\boldsymbol{\beta}_t$ are macro-region and time fixed effects. They control, respectively, for exogenous unobserved factors at the macro-region level [55] and for exogenous technological progress [56]. u_{it} is the error term.

Consistent with the climate literature (e.g., [57]), we compute the marginal impact of climate normals as follows:

$$\frac{\partial \hat{Y}}{\partial T} \cdot \frac{1}{\hat{Y}} = (\gamma_T + 2\gamma_{T^2}\overline{T})^*100 \text{ and } \frac{\partial \hat{Y}}{\partial P} \cdot \frac{1}{\hat{Y}} = (\gamma_P + 2\gamma_{P^2}\overline{P})^*100 \quad \text{(B.2)}$$

where γ_T, γ_{T^2}, γ_P, γ_{P^2} are coefficients estimated for long-run mean temperature and precipitation and their squares from equation (1), whereas $\overline{T}$ and $\overline{P}$ are the average value of temperature and precipitation normal of the sample.

The estimation results of the model in equation (B.1), reported in table B.1, show the relationship between wine productive and trade dynamics and long-run trends in climate in the main producing regions of wine in selected countries (i.e., Australia, France, Germany, Italy, Spain, the United States)[33]. While the effect of higher annual temperatures is observable both in production and trade patterns, greater annual precipitations tend to affect only the volume of wine production. The negative coefficient of precipitation and the positive coefficient of its squared term indicate that the volume of wine production would benefit only from rainfall levels larger than a certain threshold. After this threshold, a marginal increase in the precipitation normals would increase the production volumes.

As a sensitivity analysis, we extend the timeframe until 2021, the last year available for climate data, to better capture the changes in the global wine trade over the past decade. The cross-sectional climate model is run on different time periods (Table B.2). The results of the models estimated over the period 1996-2015 (column 1) and considering both the more recent time period (i.e., 2016-2021, column 2) and the whole period (i.e., 1996-2021, column 3) are comparable. The significant positive effect of temperatures found with outdated data (1996-2015) is confirmed when we incorporate more recent data (1996-2021) to capture the evolution of the global wine trade in the last decade.

In order to investigate the relationship between climate change and wine supply, we estimate different specifications of the equation (B.1) using as dependent variable, alternatively, the volume of countries' wine production, volume of countries' excess of production (obtained as the difference between production and domestic consumption), value of countries' wine exports (i.e., a proxy of the value of excess of production).

The results of the pooled Ordinary Least Square (OLS) estimates are reported in Table B.3. Higher temperatures in the main wine producing regions have a beneficial impact (up to a certain threshold) not only on countries' production levels of wine, but also on their excess of production volumes (net to the effect of domestic consumption) and values (i.e., countries' exports). The relationship between temperature normals and productive dynamics in the wine sector (both volumes of production and of excess of production) tends to be non-linear. The effect of precipitation on the excess of wine production and on wine exports is not detected.

The results are robust: higher temperatures in the main wine producing regions have a beneficial impact (up to a certain threshold) not only on countries' production levels of wine, but also on their excess of production volumes (net to the effect of domestic consumption) and values (i.e., countries' exports).

Also, the relationship between temperature normals and productive dynamics in the wine sector tends to be nonlinear (i.e., positive first-degree and negative second-degree terms for temperatures). The figure B.1 shows the concave response of the volume of production to temperature normal: it increases at a declining rate up to 38.5 °C, after which it decreases.

The average regional temperatures of the countries in the sample are lower than the turning point (Figure B.1): all else being equal, the production of wine both in Old World Producers (France, Germany, Italy, Spain) and New World Producers (Australia, the United States) would benefit from a marginal increase in temperature normal in the main producing regions. The benefits would be greater for countries characterised by lower average temperatures, such as Germany or the United States, than for warmer countries, such as Australia were the wine production is focused on regions of Victoria, New South Wales, and South Australia.

It is reasonable to assume that trends of temperature observed in the main producing regions of wine should be responsible of the impact of climate on the produc-

[32] Traditionally used in climate literature (e.g., [57]), the term climate normal, a synonymous of climatologies, refer to long time averages (usually 30-years) in climate variables (e.g., temperatures and precipitations) in a given location. Climate normals are built using the prevailing climate in the regions (r) that produce wine.

[33] The wine producing regions of Old World Producers are Piemonte, Veneto, Toscana, Puglia, Sicilia for Italy, Alsace, Champagne, Bordeaux, Burgundy, Languedoc-Roussillon, Provence for France, Andalucia, Castilla-La Mancha, Castilla y Leon, Catalonia, Galicia, Rioja for Spain, Baden, Mosel, Pfalz-Rheinhessen, Rheingau for Germany. The wine producing regions of New World Producers are California, Oregon, Washington, New York for the United States, Victoria, New South Wales, South Australia for Australia.

Table B.1. Effects of climate on countries' wine production and terms of trade.

Variables	Volume of wine production	Value of wine exports
Temperature	3.39645***	7.53360***
	(0.11702)	(1.27413)
Temperature-squared	-0.04421***	-0.13586
	(0.00865)	(0.08676)
Precipitation	-0.02142***	-0.07093
	(0.00803)	(0.08422)
Precipitation-squared	0.00002***	0.00005
	(0.00001)	(0.00005)
R-squared	0.923	0.189

Notes: Pooled OLS estimates of the model in equation (3). The dependent variables are in log. Regional annual temperature is in degrees Celsius and regional annual precipitation is in units of mm per year. The specification includes a constant term, time and macro-region fixed effects, countries' latitude and longitude. Robust standard errors are in parentheses. Observations are 1,473 in the first specification, 1,465 in the second specification (due to a few missing values in the exports from Australia). The sample of countries includes Australia, France, Germany, Italy, Spain, the United States.
*** Significant at the 1 percent level.

Table B.2. Effects of climate on countries' value of wine exports.

Variables	(1) 1996-2015	(2) 2016-2021	(3) 1996-2021
Temperature	7.347***	7.547	2.650***
	(1.206)	(7.538)	(0.713)
Temperature-squared	-0.125	-0.248	-0.083**
	(0.082)	(0.315)	(0.040)
Precipitation	-0.047	-0.096	-0.009
	(0.080)	(0.199)	(0.007)
Precipitation-squared	0.00004	0.0001	0.00001*
	(0.0001)	(0.0001)	(0.00001)
R-squared	0.196	0.219	0.166

Notes: Pooled OLS estimates of the Ricardian model. The dependent variable is the logarithm of export values of wine. Regional annual temperature is in degrees Celsius and regional annual precipitation is in units of mm per year. The specification includes a constant term, time and macro-region fixed effects, countries' latitude and longitude. Robust standard errors are in parentheses. Observations are 1,552 in column (1), 465 in column (2), 2,017 in column (3). The sample of countries includes Australia, France, Germany, Italy, Spain, the United States.
*** Significant at the 1 percent level.

tion of wine. To test the external validity of this hypothesis, we estimate the last specification of the model (using the value of countries' wine exports as dependent variable) controlling for temperature normals at the country level. The results are shown in Table B.4.

Table B.3. Effects of climate on countries' wine production and terms of trade.

Variables	Volume of wine production	Volume of wine excess of production	Value of wine exports
Temperature	3.39645***	1.69023***	7.53360***
	(0.11702)	(0.21296)	(1.27413)
Temperature-squared	-0.04421***	-0.10721***	-0.13586
	(0.00865)	(0.01515)	(0.08676)
Precipitation	-0.02142***	0.00336	-0.07093
	(0.00803)	(0.01068)	(0.08422)
Precipitation-squared	0.00002***	-0.00001	0.00005
	(0.00001)	(0.00001)	(0.00005)
R-squared	0.923	0.793	0.189

Notes: Pooled OLS estimates of the model in equation (1). The dependent variables are in log. Regional annual temperature is in degrees Celsius and regional annual precipitation is in units of mm per year. The specification includes a constant term, time and macro-region fixed effects, countries' latitude and longitude. Robust standard errors are in parentheses. Observations are 1,473 in the first and second specifications, 1,465 in the third specification (due to a few missing values in the exports from Australia). The sample of countries includes Australia, France, Germany, Italy, Spain, the United States.
*** Significant at the 1 percent level.

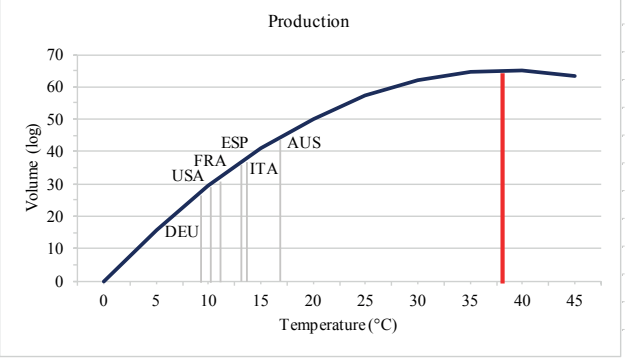

Figure B.4. Effects of temperature normals on the volume of wine production, turning point, and positioning of producing countries. Notes: The dependent variable is the volume of wine production (in log). Regional annual temperature is in degrees Celsius. The turning point is 38.5 °C. Acronyms are Australia (AUS), France (FRA), Germany (DEU), Italy (ITA), Spain (ESP), the United States (USA).

Consistent with results based on regional climate, we find a positive (although non-linear) effect of higher national annual temperatures in the expanded sample. As hypothesised, the impact of climate change on the value of wine exports is mainly due to trends of tem-

Table B.4. Effects of temperature normals on countries' wine exports: comparing the impact of national and regional climate.

Variables	Selected (Regional climate)	Selected (National climate)	All (National climate)
Temperature	7.534***	-4.061	0.091***
	(1.274)	(2.166)	(0.024)
Temperature squared	-0.136	0.019	-0.001
	(0.087)	(0.077)	(0.001)
Observations	1,465	1,465	2,851
R-squared	0.189	0.204	0.422

Notes: Pooled OLS estimates of the model in equation (1). The dependent variable is the log value of wine exports. Regional and national annual temperature is in degrees Celsius. The specification includes a constant term, time and macro-region fixed effects, precipitation and its quare. Robust standard errors are in parentheses. The sample of selected countries includes Australia, France, Germany, Italy, Spain, the United States; the sample of all countries additionally includes Argentina, Bazil, Canada, China, New Zealand, Russia, South Africa, the United Kingdom.
*** Significant at the 1 percent level.

Table C.1. Effects of TBT and excess of production for climate reasons on bilateral wine imports.

Variables	Specification i	Specification ii	Specification iii
TBT	0.254	0.013	0.238
	(0.205)	(0.179)	(0.203)
Excess of production (volume)		-0.743***	
		(0.237)	
Excess of production (value)			0.038
			(0.040)

Notes: Gamma Pseudo Maximum Likelihood (GPML) estimation of the structural gravity model. The dependent variable is the value of bilateral imports (in level). The TBT-related explanatory variable is modelled as dummy variables. All specifications include a constant, importer, time, exporter-time, and country-pair fixed effects, tariff levels. The excess of production (both in volume and value) predicted from the estimation of the model in equation (B.1) using regional climate variables. Robust standard errors are in parentheses. Observations are 494.
*** Significant at the 1 percent level.

peratures observed in the main wine producing regions rather than on average in the country. This is particularly true for large countries characterised by climate conditions heterogeneous across different regions. For instance, the average temperature in the main wine producing regions is 8 °C warmer than the average national temperature in the United States, about 3 °C in Spain, and less than 1 °C in Germany (see Table 1). Within the same country, long-run changes in climate may be beneficial for some wine regions and detrimental for others [29,58,59]: these differences may offset each other considering the average climate at the national level.

C. SENSITIVITY ANALYSES ON THE EFFECT OF CLIMATE CHANGE AND POLICY INTERVENTIONS ON WINE TRADE

Consistent with the gravity theory (e.g., [22]), the value of output in the exporter *i* should be equal to the total expenditure on *i*'s outputs in all trading partners *j* ($Y_i = \sum_J X_{ij} \; \forall \; j$)[34]. The output share of *i* may depend on its climate conditions. To test the robustness of the gravity model, we introduce in the gravity equation the prediction of countries' output shares (Y_{it}), both in volume and values, as a proxy of countries' excess of production due to long-run changes in climate. The prediction of countries' output shares derives from the estimation of the model in equation (B.1).

The Table C.1 reports the estimates of three different specifications: the baseline specification aims at capturing the effect of TBT on the value of wine imports (specification i), further specifications control for the effect of the excess of wine production, both in volume (specification ii) and in value (specification iii) predicted from the estimation of the model in equation (B.1) using regional climate variables. The larger the excess of production volumes due to long-run changes in climate, the lower the value of wine imports. The climate-induced changes in the productive dynamics in the main producing regions may alter comparative advantages of countries with consequences on the terms of trade [34].

To test the robustness of the relationship between environment-related trade policies and wine trade, we estimate the specifications (ii) and (iii) of the Table C.1 controlling for the impact of environment-related TBT. The results are reported in Tables C.2-C.5.

[34] It is worth noting that the value of output in exporter *i* should be equal to the sum of domestic internal consumption and the total expenditure on *i*'s outputs in all trading partners to account for both domestic and international demand and ensure a balanced supply-demand relationship.

Table C.2. Effects of environment-related TBT and excess of production for climate reasons on bilateral wine imports.

Variables	Specification i	Specification ii	Specification iii
TBT	-0.382***	-0.402***	-0.426***
	(0.079)	(0.073)	(0.062)
Environmental TBT	0.723***	0.522***	0.744***
	(0.215)	(0.176)	(0.212)
Excess of production (volume)		-0.606***	
		(0.190)	
Excess of production (value)			0.060
			(0.038)

Notes: Gamma Pseudo Maximum Likelihood (GPML) estimation of the structural gravity model. The dependent variable is the value of bilateral imports (in level). The TBT-related explanatory variables are modelled as dummy variables. All specifications include a constant, importer, time, exporter-time, and country-pair fixed effects, tariff levels. The excess of production (both in volume and value) predicted from the estimation of the model in equation (B.1) using regional climate variables. Robust standard errors are in parentheses. Observations are 494.
*** Significant at the 1 percent level.

Table C.3. Effects of registration requirement for TBT reasons on bilateral wine imports.

Variables	Specification i	Specification ii	Specification iii
TBT	0.257	-0.144	0.235
	(0.206)	(0.150)	(0.204)
TBT B15	-0.038	0.387***	-0.086
	(0.088)	(0.103)	(0.066)
Excess of production (volume)		-1.141***	
		(0.229)	
Excess of production (value)			0.058**
			(0.026)

Notes: Gamma Pseudo Maximum Likelihood (GPML) estimation of the structural gravity model. The dependent variable is the value of bilateral imports (in level). The TBT-related explanatory variables are modelled as dummy variables. B15 consists in registration requirement for importers for TBT reasons (including environmental protection). All specifications include a constant, importer, time, exporter-time, and country-pair fixed effects, tariff levels. The excess of production (both in volume and value) predicted from the estimation of the model in equation (B.1) using regional climate variables. Robust standard errors are in parentheses. Observations are 494.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.

Table C.4. Effects of authorisation requirement for TBT reasons on bilateral wine imports.

Variables	Specification i	Specification ii	Specification iii
TBT	0.100	-0.393***	0.100
	(0.159)	(0.098)	(0.158)
TBT B14	0.176***	0.358***	0.176***
	(0.056)	(0.097)	(0.065)
Excess of production (volume)		-0.982***	
		(0.239)	
Excess of production (value)			-0.001
			(0.045)

Notes: Gamma Pseudo Maximum Likelihood (GPML) estimation of the structural gravity. The dependent variable is the value of bilateral imports (in level). The TBT-related explanatory variables are modelled as dummy variables. B14 consists in authorisation requirement for importers for TBT reasons (including environmental protection). All specifications include a constant, importer, time, exporter-time, and country-pair fixed effects, tariff levels. The excess of production (both in volume and value) predicted from the estimation of the model in equation (B.1) using regional climate variables. Robust standard errors are in parentheses. Observations are 494.
*** Significant at the 1 percent level.

Table C.5. Effects of tolerance limits on bilateral wine imports.

Variables	Specification i	Specification ii	Specification iii
TBT	0.272	0.016	0.257
	(0.213)	(0.190)	(0.213)
TBT B21	-0.470*	-0.042	-0.451
	(0.267)	(0.187)	(0.278)
Excess of production (volume)		-0.739***	
		(0.225)	
Excess of production (value)			0.032
			(0.044)

Notes: Gamma Pseudo Maximum Likelihood (GPML) estimation of the structural gravity model. The dependent variable is the value of bilateral imports (in level). The TBT-related explanatory variables are modelled as dummy variables. B21 are tolerance limits for residues of or contamination by certain substances. All specifications include a constant, importer, time, exporter-time, and country-pair fixed effects, tariff levels. The excess of production (both in volume and value) predicted from the estimation of the model in equation (B.1). Robust standard errors are in parentheses. Observations are 494.
*** Significant at the 1 percent level.
* Significant at the 10 percent level.

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The agroecological challenges in the wine sector: perceptions from European stakeholders

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Abstract. This article explores the issues surrounding the agroecological transition in the European wine industry, focusing on reducing pesticide use, developing organic certification and using genetic research in relation to resistant grape varieties. The study distinguishes between stakeholders from the wine industry, institutions and the agricultural research sector. The findings consistently identify the agroecological transition as a priority, particularly in terms of pesticide reduction. However, variations exist in the views of the surveyed stakeholders. French and Portuguese stakeholders emphasise the role of market and societal pressures as drivers of the transition, while Italian producers do not. Professionals in France and Portugal express doubts about achieving pesticide reduction through changes in practices, while others stress the importance of regulatory constraints. The research also highlights industry challenges such as decreased consumption due to health awareness and the need for social responsibility. Resistant grape varieties are seen as a viable solution, especially for the development of organic production, but market acceptability remains a significant hurdle. The study sheds light on stakeholder perspectives and challenges, thus contributing to a better understanding of priorities in the European wine industry's pursuit of sustainable practices.

Keywords: wine economics, wine sustainable innovations, stakeholders' perceptions, agroecological transition, organic certification, resistant varieties.

1. INTRODUCTION

The agroecological transition has become a significant issue in European vineyards due to the extensive use of pesticides in the wine industry. However, the sector is also facing challenges concerning its carbon footprint, even though it contributes a relatively small percentage to agricultural greenhouse gas emissions. Viticulture frequently experiences the negative effects of climate change, such as irrigation difficulties, vine diseases and the inadequacy of traditional grape varieties, resulting in a loss of wine character [1,2]. In addition to environmental challenges, the wine industry is confronting various obstacles, including a decline in consumption in traditionally wine-drinking countries. This decrease can be attributed, at least in part, to increasing health consciousness among consumers, influenced by health lobbies. The sector's social responsibility and the economic organisation of fragmented industries also play a role, particularly when the absence of large trading companies hinders commercialisation efforts [3].

Given the multitude of challenges at hand, it is not surprising that stakeholders may not be fully convinced to prioritise the agroecological transition. While some progress has been made, a major revolution has yet to emerge to address these concerns. This article aims to shed light on the issues that stakeholders perceive as priorities, taking into account the perspectives of professionals in the wine industry, institutions and the agricultural research sector, who provide alternative viewpoints.

The policy environment in the EU pushes for a significant reduction of the environmental impact of production activities across the EU. In particular, the new common agricultural policy (CAP), which entered into force in January 2023, pledges to target more ambitious environmental and climate-related commitments than its predecessors. Considering the wine sector, it is explicitly recognised that 'while the successive 2008 and 2013 reforms of the wine policy have overall achieved their objectives, resulting in an economically vibrant wine sector, new economic, environmental and climatic challenges have appeared'[1] [4].

These more ambitious commitments were quantified in the farm-to-fork strategy, released by the Commission in 2020, while the reform process was slowly proceeding. The document announced that the Commission itself was to take additional action to reduce the overall use and risk of chemical pesticides by 50 % and the use of more hazardous pesticides by 50 % by 2030, without compromising farmers' incomes. Furthermore, it stated that EU Member States should consider such a target in the design of the Strategic Plan, the new CAP programming tool introduced by Regulation (EU) 2021/2115 (Strategic Plan Regulation)[2] [5].

The strategic plan regulation is not highly prescriptive concerning the financial resources allocated to addressing environmental issues in the wine sector. It only mandates the allocation of at least 5 % of the budget for actions that have a positive impact on the environment, climate change or sectoral sustainability [6]. Beyond these financial constraints, sectoral interventions provided for in the strategic plan regulation include a variety of intervention types that may support the agroecological transition of the vitivinicultural sector. This transition could also be supported by resources derived from the renewed mechanisms for calculating CAP direct payments, particularly from the new voluntary environmentally friendly practices (ecoschemes) and from the rural development policy [5,6].

The options provided by the CAP spending measures available to vine growers could contribute to improving the environmental performance of the EU wine sector. However, given the current state of vineyard protection techniques, such improvement would seem largely insufficient to achieve the target of halving pesticide use by 2023.

The CAP reform, through Regulation (EU) 2021/2117 (amendment regulation)[3], allows the inclusion of varieties derived from a cross between *Vitis vinifera* and other species of the genus *Vitis* in the production of wine with a protected designation of origin (PDO). These vine varieties are better adapted to changing climatic conditions and exhibit greater resistance or tolerance to diseases, enabling a significant reduction in the number of required treatments (usually to only three or four). Indeed, after lifting the ban on their use in PDO wine production, these varieties may

[1] Explanatory memorandum to reform proposals (p. 14).

[2] Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP strategic plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) No 1305/2013 and (EU) No 1307/2013 (OJ L 435, 6.12.2021, p. 1).

[3] Regulation (EU) 2021/2117 of the European Parliament and of the Council of 2 December 2021 amending Regulations (EU) No 1308/2013 establishing a common organisation of the markets in agricultural products, (EU) No 1151/2012 on quality schemes for agricultural products and foodstuffs, (EU) No 251/2014 on the definition, description, presentation, labelling and the protection of geographical indications of aromatised wine products and (EU) No 228/2013 laying down specific measures for agriculture in the outermost regions of the Union (OJ L 435, 6.12.2021, p. 262).

attract greater interest and could be a game changer for the future of sustainable winemaking, helping to align the industry with the aims of the Farm to Fork Strategy [7,8].

Previous research has highlighted that the cultivation of wine grapes and the production of wine are associated with a myriad of environmental issues. These concerns primarily revolve around the use of chemicals, particularly pesticides [5]. This concern regarding pesticides has been associated with consumers paying increasing attention to environmental protection and sustainable development, creating new awareness and opportunities [10]. However, differing views on how best to address this issue within the sector could potentially confuse consumers and delay the implementation of adaptation measures [11-16].

This study investigates this issue by analysing stakeholder perceptions of the ongoing agroecological transition, focusing particularly on the use of pesticides in the wine sector and potential strategies to address the problem. The research centres on two distinct strategies: organic production and the use of resistant grape varieties. To this end, a questionnaire was sent to the main stakeholders in the wine sectors of three major wine-producing countries, namely France, Italy and Portugal. Participants were asked about the significance of environmental issues for their businesses. This study aims to highlight stakeholder beliefs about sustainable innovation in the wine industry, addressing the following research questions. What influences stakeholder perceptions of an agroecological transition in the wine sector? Which strategy do wine sector stakeholders consider most viable in the long term? What is the role of resistant grape varieties?

The article is structured as follows. The subsequent section presents the survey and the methods for its analysis. This is followed by the results, which are divided into two parts: the components of perceptions and the multivariate analysis. A comparison of organic certification versus resistant varieties is then discussed, and the article finishes with the primary conclusions and policy implications.

2. METHODOLOGY AND DATA SOURCE

In 2018–2019, the questionnaires were sent to 1 525 randomly selected stakeholders in three countries, namely France, Italy and Portugal. Stakeholders were selected from lists of addresses from the European territorial cooperation programme Interreg VB southwest Europe. They included professionals, representatives of institutions and representatives from the research sector, while consumers and citizens were not targeted. Before the questionnaire was emailed to stakeholders, it was pretested in a short survey involving some representative stakeholders. After the pretest sessions, questions were improved based on the stakeholders' suggestions and comments. After screening for completeness, 877 questionnaires were retained for this analysis.

The survey questionnaire consisted of three parts, that is, questions related to (i) the importance stakeholders accorded to environmental issues, among other issues, in particular the challenges the wine sector will face, (ii) the levers identified by the stakeholders that could make the agroecological transition possible and (iii) the stakeholders' perceptions of innovations related to organic certification and resistant grape varieties. All were closed questions, and responses were collected on a Likert scale varying from 1 (strongly disagree) to 5 (strongly agree) [17]. In total, the questionnaire included 68 variables.

The 12 questions from part II of the questionnaire were used to create the dependent variables, representing the stakeholders' perceptions of the agroecological transition in the wine sector. Parts I and III were included in the models as explanatory characteristics, in order to capture the importance attributed to the environmental issues and the future challenges of the sector (part I) and how stakeholders' perceive the innovations regarding organic certification and resistance varieties (part III). Information about sociodemographic characteristics was also included in the questionnaires and divided into categories of responses, which are presented in Table 1. The information covers the country (three countries), gender (woman, man, n/a (preferred not to respond)) and age of participants (five categories of age); the sector of the institution that the respondent represents and the size of the institution (in number of employees, with four possible categories). The size of institution was not included in the analysis, since comparing the sizes of diverse groups of stakeholders was considered meaningless to this analysis. The stakeholders' sectors were grouped into six categories: public administration (excluding research); associations (e.g. syndicates, interprofession associations, farmers associations, commissions of viticulture); producers (e.g. cooperative members or managers, independent farmers, large private production/commercialisation companies); suppliers (e.g. companies supplying inputs, for example nurseries, oenological equipment, bottles, corks); research institutes; and others (e.g. those currently linked to professional wine activity, for example sommeliers and consultants).

Table 1. Frequency table of sociodemographic variables' categories.

Variable	Categorization	Frequency	%
Country	Italy	489	55.8
	Portugal	122	13.9
	France	266	30.3
Age (12 missing)	Less than 24 years old	36	4.1
	From 25 to 34 years old	184	21
	From 35 to 49 years old	279	31.8
	From 50 to 64 years old	289	33
	More than 65 years old	65	7.4
Sector (12 missing)	Public administration	67	7.6
	Associations	57	6.5
	Producers	389	44.4
	Suppliers	80	9.1
	Research institutes	124	14.1
	Others	148	17
Gender	Women	213	24.3
	Otherwise	664	75.7
Size (14 missing)	Less than 50 employees	451	51.4
	Between 50 and 250 employees	160	18.2
	More than 250 employees	172	19.6
	Currently without professional activity	80	9.1

The table shows that the largest share of complete responses was from Italy. Most of the respondents were between 35 and 64 years old, while 25.1 % were younger than 34 years old; 24.3 % of the total were women. Producers represent the main category among the sectors, followed by the 'others' group and the representatives of research institutes.

Before the regressions were carried out, the number of variables was reduced by principal component analyses (PCAs): for perceptions related to the agroecological transition, for perceptions related to organic certifications and for perceptions related to resistant grape varieties. The relationships among these perceptions were studied by means of multivariate regressions [18]. Standard parametric statistical procedures were used for the PCA of ordinal Likert scale variables [19].

The conduct of the multivariate analysis followed the steps described by Hair et al., Meuwissen et al. and Alvarez et al. [18,20,21]. The variables selected were submitted to the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity [18]. Only variables that presented an individual KMO of ≥ 0.5 were maintained for analysis [18]. The suitability of the analysis was confirmed by applying Bartlett's test, which presented $p = 0.000$ for all subsamples, confirming that the dataset was suitable for PCA. The number of factors retained in the PCA was based on the Kaiser criterion (i.e. eigenvalues of > 1) and a varimax orthogonal rotation was implemented in all subsets of components [18].

Subsequently, we used multiple regression to assess the relationships between the perceptions of agroecological transitions (components y1–y4), perceptions of environmental issues and challenges for the sector (components a1–a6), organic labels (components b1–b4), resistance varieties (components c1 and c2) and sociodemographic variables. In the regression analyses, multicollinearity between the independent variables was not present and no variables were omitted. A correlation test showed that, for all other socioeconomic variables, the correlations were low and variation inflation factors were all around 1 [18].

3. RESULTS OF THE COMPONENT OF PERCEPTION

3.1 Perceptions of agroecological transition

Twelve statements were used to gather insights into perceptions related to the levers that can make the agroecological transition possible, as shown in Table 2.

These were reduced to only four components with eigenvalues larger than 1 using PCA, accounting for 58 % of the total variance. According to the component loadings, components 1–4 can be best described as:

- **y1, technology and financial incentives.** This component is mainly characterised by having the highest values in variables 3, 5 and 9, which relate the agroecological transition to increased technological innovations and financial incentives that will grant farmers' access to these technologies. The incentives can also be in the form of agri-environmental aids.
- **y2, producers' information and awareness.** The second component is represented by variables 4, 8 and 10, which are related to producers having increased information and awareness, which could lead to changes in their production practices. In particular, production practices concerning reduced pesticide use at the individual level that drive the agroecological transition.
- **y3, societal and consumer pressure.** The third component is mainly formed by variables 1 and 2, meaning that the agroecological transition will be possible because of increased demands from consumers and society.
- **y4, regulations and standards.** The last component is primarily characterised by variables 11 and 12 and, to a lesser extent, variable 7. These refer to strengthening environmental legislation and public control over producers in a top-down approach, pushing producers in the direction of the agroeco-

Table 2. Statements on the stakeholders' perceptions about agroecological transition (Part "B" of the questionnaire) and rate of responses.

The agroecological transition will be possible …	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1. In view of the increasing demands of consumers	14.8 %	51.2 %	23.9 %	8.3 %	1.7 %
2. In view of the increasing demands of society	13.1 %	48.8 %	28.5 %	8.1 %	1.5 %
3. If technological innovations develop sufficiently	26.8 %	54.5 %	14.5 %	3.6 %	0.6 %
4. If we have an increase in winegrowers' awareness, leading to substantial changes in their agricultural practices	35.2 %	52.0 %	8.1 %	4.2 %	0.5 %
5. If we have better financial incentive systems to remunerate the individual efforts of producers (agri-environmental aid)	29.6 %	46.2 %	15.6 %	6.4 %	2.2 %
6. If we have a crop insurance development	13.3 %	39.7 %	31.9 %	11.6 %	3.4 %
7. If there is a development of private market downstream standards (specifications for private labels, standardisation requirements, importers' standards, requirements of intermediaries, etc.)	9.6 %	38.1 %	30.2 %	17.0 %	5.1 %
8. If we have better communication between the wine world and society (organisation of places of exchange)	23.1 %	53.5 %	18.1 %	4.6 %	0.7 %
9. If we have increased subsidies for the acquisition of more efficient equipment (promoting precision viticulture, new plant material, etc.)	29.6 %	45.0 %	16.4 %	6.8 %	2.1 %
10. If we have more information resources for winegrowers to better understand the possibilities of reducing pesticides at the individual level	37.9 %	48.1 %	9.8 %	3.6 %	0.6 %
11. If we have a strengthening of environmental regulations	16.1 %	47.7 %	22.8 %	10.5 %	3.0 %
12. If we have a strengthening of the effectiveness of controls by the public sector	14.9 %	34.2 %	28.7 %	17.6 %	4.6 %

logical transition. Beyond public regulations, private standards and labels with specific rules and requirements can also lead to the transition.

An overall KMO value of 0.76 was recorded. These four components can be understood as **how stakeholders perceive the agroecological transition**. They served as the dependent variables in the regression models.

3.2 Perceptions of environmental issues and challenges for the sector

Twenty two statements were used to gather insights into perceptions related to the importance stakeholders accorded to environmental issues, in particular the sustainability challenges the wine sector will face (Table 3).

These were reduced to only six components with eigenvalues greater than 1 using PCA, accounting for 53 % of the total variance. An overall KMO value of 0.82 was recorded. According to the component loadings, components 1–6 can be best described as follows.

- **a1, territory and culture.** Variables 8 and 19 characterise this component. According to these variables, the main sustainability challenges that the sector will face are related to strengthening the cultural character of the wines and the territorial heritage linked to the viticulture and preserving the landscapes attached to the wines.
- **a2, reducing chemicals.** This component is mainly formed by strong agreements in variables 4, 7 and 16. These are related to the reduction of pesticides and chemicals in the production and processing of wines in order to meet societal expectations in this regard, moving in the direction of producing more 'nature' wines. Furthermore, the specifications of PDOs and IGPs should be reoriented in the direction of sustainable production.
- **a3, consumers' and retailers' needs.** This component is formed of variables 9, 17 and 20. It groups the strong agreements on the main sustainability challenges linked to adapting the sector to the changing tastes and uses of consumers and consequently to the downstream requirements. There will also be challenges related to increasing the size of farms to promote the creation of new independent brands (commercialising more final products).
- **a4, European regulation.** This component represents variables 13–15, which refer to the stricter upcoming European regulations and the challenges the sector will face in adapting to them. Challenges are more severe production conditions at the vineyard level, and the consequent additional costs, and changes to labelling.
- **a5, decline of vineyards and yields.** This component is formed of only variable 3. This question

Table 3. Statements on the stakeholders' perceptions of the importance accorded to environmental issues, among other issues (part I of the questionnaire), and response rates

In your opinion, what are the sustainability challenges that the wine sector will face in your country regarding…	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1. Adapting to climate change	50 %	41 %	6 %	2 %	1 %
2. Showing that drinking wine in a moderate way is not incompatible with health	45 %	37 %	12 %	5 %	1 %
3. Adapting to the decline of the vineyard and the risk of reduced yields	18 %	37 %	18 %	17 %	9 %
4. Meeting societal expectations for reducing pesticides	47 %	41 %	8 %	4 %	1 %
5. Reducing the carbon footprint	33 %	44 %	19 %	3 %	1 %
6. Adapting alcohol content to public health policies	5 %	24 %	32 %	27 %	12 %
7. Reducing the use of oenological inputs (SO_2, ...) and go in the direction of more 'Natural' wines	16 %	34 %	26 %	16 %	7 %
8. Strengthening the cultural character of wine and the territorial heritage linked to viticulture	48 %	40 %	9 %	3 %	1 %
9. Adapting to changing tastes and uses of consumers (on the national and international market)	19 %	46 %	21 %	10 %	3 %
10. Facing international competition	26 %	41 %	17 %	12 %	4 %
11. Optimising the functioning of sector organisations	26 %	54 %	16 %	4 %	1 %
12. Improving business-to-business relationships from upstream to downstream in the sector	25 %	52 %	19 %	4 %	1 %
13. Adapting to changes in European regulations on production conditions at vineyard level	10 %	43 %	28 %	14 %	5 %
14. Adapting to the additional costs that will result from changes in European regulations	8 %	33 %	30 %	22 %	7 %
15. Adapting to changes in European wine labelling regulations	10 %	40 %	30 %	15 %	5 %
16. Reorienting the specifications of PDO-IGP in the direction of sustainable development	32 %	48 %	13 %	5 %	1 %
17. Adapting to changing requirements downstream of the sector (mass distribution, importers, trading)	8 %	28 %	29 %	26 %	9 %
18. Responding to corporate social responsibility (improvement of working conditions, remuneration, etc.)	34 %	48 %	16 %	3 %	0 %
19. Preserving the vine and wine landscapes	56 %	35 %	8 %	2 %	0 %
20. Increasing the surface areas of farms to promote the creation of corporate brands	4 %	10 %	27 %	37 %	22 %
21. Simplifying wine labelling and quality signs	24 %	39 %	21 %	11 %	4 %
22. Developing investments in insufficiently explored production areas (in your country or abroad)	11 %	31 %	29 %	22 %	8 %

refers to challenges that sustainability will bring in terms of adaptation to the decline of the vineyard and the risk of reduced yields.

– **a6, new production areas.** This component represents variable 20, but mostly variable 22. It is linked to the challenges and investments necessary for exploring new production areas and expanding the vineyards into other regions. It also concerns increasing farms' surface areas to promote the creation of own company brands.

3.3 Perceptions of organic certification

Eighteen statements were used to gather insights into stakeholders' perceptions of innovations related to organic certification (Table 4).

These were reduced to only four components with eigenvalues larger than 1 using PCA, accounting for 48 % of the total variance. According to the component loadings (Tables A1–A4 in the supplementary material), components 1–4 can be best described as follows.

– **b1, BIO not suitable for wine.** The first component groups variables 2 and 7 with a negative sign and variables 14–16. These can be translated into a component expressing the perception that wine is incompatible with organic production. There is a high level of agreement that organic production does not have the technical and economic capacities necessary for it to develop in many wine regions of the country and it is more relevant for other agricultural productions. There was agreement that organic certification cannot establish itself as the environmental benchmark and that

Table 4. Statements on the stakeholders' perceptions of focusing on organic certification (part III of the questionnaire) and response rates.

About organic farming …	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1. BIO is the most well-known certification logo among wine consumers for pesticide reduction	25 %	48 %	16 %	8 %	3 %
2. Organic production has the technical and economic capacities to develop significantly in many wine regions of our country	12 %	44 %	25 %	16 %	4 %
3. Adopting organic certification is too expensive	8 %	25 %	42 %	19 %	6 %
4. Organic certification risks being exceeded by certification types such as 'biodynamic' or 'natural' wine'	6 %	22 %	25 %	31 %	17 %
5. Organic certification concerns all types of wines in the quality and price scale	10 %	26 %	17 %	31 %	16 %
6. The repeated use of copper is a real problem for the societal credibility of organic certification	27 %	33 %	21 %	14 %	5 %
7. Organic certification will become the environmental standard	7 %	31 %	29 %	24 %	9 %
8. In the medium term there will be a deficit in the supply of organic wines	5 %	23 %	38 %	27 %	7 %
9. The organic production method is hardly compatible with climate change	8 %	18 %	23 %	37 %	14 %
10. The return risks linked to the organic production method are only bearable by companies that are already well established in the markets	10 %	33 %	24 %	25 %	7 %
11. Less demanding certification alternatives such as integrated production will eventually prevail on the market	9 %	30 %	30 %	22 %	9 %
12. More general certifications for the company (e.g. HVE, ISO standards) will become widely distributed	7 %	33 %	37 %	18 %	5 %
13. The organic production method can only develop on a large scale through significant public subsidies	9 %	22 %	27 %	29 %	13 %
14. The organic production method is less relevant for wine than for other agricultural productions	8 %	21 %	23 %	30 %	17 %
15. Organic wine is a fad that will eventually run out of steam	8 %	14 %	24 %	34 %	20 %
16. Organic wine can hardly be of good quality	3 %	7 %	20 %	34 %	36 %
17. The evolution of the regulations in organic production mode will make it impossible to produce these wines in certain regions	11 %	31 %	32 %	20 %	6 %
18. The BIO logo for wine is a detrimental addition to the proliferation of claims and certifications	9 %	23 %	28 %	30 %	10 %

NB: HVE, high environmental value (*haute valeur environnementale*); ISO, International Organization for Standardization.

organic wine is rarely good quality and will eventually run out of steam.

- **b2, BIO challenges to grow.** This covers variables 7, 10, 13 and 17 and represents the perception that, while organic certification has the potential to establish itself as the environmental standard, it can only develop on a large scale through significant public subsidies. According to this perception, the evolution of stricter regulations will make it impossible to produce wines in certain regions and the high risks linked to organic production will only be bearable for companies already well established in the market.
- **b3, BIO is a widespread label with competitors.** This component represents high levels of agreements on variables 1, 5, 6 and 12. These refer to the organic label not being limited to specific types of wine, but concerning all types of wine on the quality and price scales, and the BIO logo being the most well-known certification among wine consumers for pesticide reduction. However, other more general environmental/sustainability certifications, such as high environmental value (*haute valeur environnementale* (HVE)) (in France) and ISO, may become more widely distributed. In addition, the repeated use of copper can be a serious problem for organic certification's societal credibility.
- **b4, BIO alternatives.** This component groups high rates on variables 3, 4 and 18. Its most influential variable represents the perception that other certifications, such as 'biodynamic' or 'natural' wines, risk replacing organic certifications. This is especially the case because adopting organic certifications is too expensive and the BIO logo for wines is a detrimental addition to the proliferation of claims and certifications.

An overall KMO value of 0.88 was recorded. All components in this section include a certain degree of criticism of the organic certification, with none reaching unanimity that organic certification is the only viable solution for sustainable production of wine. Although component b2 groups the stakeholders' perceptions that best identify organic production as a viable strategy in the long run to reduce pesticides in wine production, despite challenges for expansion.

3.4 Perceptions of resistant grape varieties

Eleven statements were used to gather insights into the stakeholders' perceptions of innovations related to resistant grape varieties (RV) (Table 5).

These were reduced to only two components with eigenvalues greater than 1 using PCA, accounting for 50 % of the total variance. According to the component loadings, components 1 and 2 can be best described as follows.

- **c1, RV low reputation and acceptability.** This component covers variables 2, 3, 5 and 9, which are about criticism and low consumer acceptability of the use of resistant grape varieties in wine production. Concerns are related to the risks to the qualitative reputation of wines and that these will probably be assimilated to genetically modified organisms by consumers.
- **c2, RV driver of pesticide reduction.** This component groups variables 1, 8 and 10, which represent perceptions of good acceptability by consumers and a real solution regarding achieving significant reduction in the use of pesticides and the future of organic certification.

An overall KMO value of 0.88 was recorded. Component c2 groups the stakeholders' perceptions that identify resistant varieties of *Vitis* as a viable strategy to reduce pesticides in wine production in the long run and as the best solution for the future of organic certification.

4. RESULTS OF THE MULTIVARIATE REGRESSIONS

This section presents and discusses the results of the multivariate regressions on perceptions of the agroecological transition. For each dependent variable described in Section 3.1, Table 6 shows the partial regression coefficients. A full table of coefficients for the interactions of variables is shown in supplementary material Table A5. Overall, the factorial analysis detailed in the previous section detected four main perception types for the agroecological transition in the wine sector. These are

Table 5. Statements on the stakeholders' perceptions of focusing on resistant grape varieties (part III of the questionnaire) and response rates.

About varietal innovations …	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1. Resistant grape varieties are a credible solution to achieve a significant reduction in pesticide use	25 %	47 %	16 %	10 %	3 %
2. Resistant grape varieties run too great a risk to the qualitative reputation of mid-range wines	4 %	18 %	30 %	34 %	14 %
3. Resistant grape varieties run too great a risk to the qualitative reputation of wines with high added value	11 %	25 %	25 %	27 %	13 %
4. The bypassing of resistance, or the appearance of new diseases, will happen faster than the massive adoption of these grape varieties by winegrowers	7 %	28 %	43 %	17 %	5 %
5. In general, consumers will find it difficult to accept wines made from resistant grape varieties	4 %	20 %	30 %	34 %	12 %
6. Resistant grape varieties are an old illusory solution which has already proved its inability to satisfy professionals in the sector and /or the markets	3 %	12 %	34 %	35 %	17 %
7. Resistant grape varieties will only establish themselves in wine-growing areas with low awareness	4 %	19 %	29 %	35 %	13 %
8. The resistant varietal solution is the future of organic certification	8 %	33 %	34 %	19 %	6 %
9. Resistant grape varieties will be assimilated to GMOs by consumers	6 %	27 %	24 %	29 %	13 %
10. In general, producers will have no trouble accepting resistant grape varieties	6 %	38 %	25 %	25 %	6 %
11. We will probably have blockages on the part of producer groups, or institutions for the development of resistant grape varieties	9 %	37 %	30 %	20 %	4 %

NB: GMO, genetically modified organism.

Table 6. Results of multivariate regressions for perceptions of the agroecological transition.

Component code	Component name	y1, Innovation and financial incentives	y2, producers' information and awareness	y3, societal and consumer pressure	y4, regulations and standards
a1	Territory and culture	0.17***	0.21***	0.03	– 0.06*
a2	Reducing chemicals	0.06	0.26***	0.26***	0.30***
a3	Consumers' and retailers' needs	0.08*	– 0.03	0.14***	0.01
a4	European regulation	0.03	– 0.00	0.08*	0.12***
a5	Decline of vineyards and yields	0.04	0.04	– 0.02	– 0.03
a6	New production areas	0.17***	0.11***	– 0.02	0.10**
b1	BIO not suitable for wine	– 0.09***	– 0.07**	– 0.10***	– 0.13***
b2	BIO challenges to grow	0.27***	0.03	0.05	0.01
b3	BIO is a widespread label with competitors	– 0.07	0.02	0.05	0.06
b4	BIO alternatives	0.09*	0.11***	0.05	0.07
c1	RV low reputation and acceptability	0.01	0.03	– 0.03	0.06*
c2	RV driver of pesticide reduction	0.03	0.01	0.02	0.09**
	Country	– 0.10	– 0.05	0.18***	– 0.29***
	Age	– 0.06	0.03	0.06	– 0.09**
	Gender (1 = women)	0.05	0.16	– 0.05	0.06
	Sector	– 0.01	0.01	– 0.04*	0.04*
	Constant	0.45*	– 0.07	– 0.28	0.59***
	R^2	0.263	0.280	0.243	0.284
	DF	848	848	848	848

NB: DF, degrees of freedom. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

not entirely separate, as they may use similar composing variables in different orders, but, overall, they represent considerably different views of the transition which are supported by different socioeconomic groups.

These perceptions are best described in the four following subsections.

4.1 Innovation and financial incentives

Stakeholders who think that the agroecological transition will be possible with the development of further technological innovations and higher financial incentives (model 1), perceive the main challenges to be linked to the preservation of landscapes, cultural character and the territorial heritage of wines. Further challenges are associated with investments in new production areas and increases in the surface areas of farms. They also see difficulties in achieving large-scale organic production without support. Model 1 is the only model where variable **b2** is positive and significant, which shows that organic production is a viable strategy to reduce pesticides in wine production in the long run, but there are critical challenges to be overcome. According to model 1, those challenges can be confronted by providing farmers with better access to technology, innovations and financial incentives in order to enable the agroecological transition. No overall gender or age difference is present, but Italians most commonly share these perceptions. The interactions reveal that, in particular, those perceiving the agroecological transition in this way are mostly Italian women in mid-age ranges (25–49 years old) ([4]). The interactions between country and sector reveal that those in the 'others' group of stakeholders in France generally do not have these perceptions.

4.2 Producers' information and awareness

Stakeholders who believe that the agroecological transition will be possible with producers' improved access to information and awareness (model 2) on how to change their production practices believe that the main challenges are related to the preservation of landscapes, cultural character and the territorial heritage of wines. Another main challenge is related to improved information on how to reduce the use of chemicals in both the production and the processing of wines. The

[4] The estimation of all marginal effects for the four models can be provided upon request.

expansion of vineyards to new production areas will be a further issue to confront, and they perceive the BIO label/certification as expensive, which risks becoming outdated and surpassed by other labels, such as biodynamic and natural wines. In general, people aged 65+ and women have these perceptions. More specifically and according to the interactions, this applies to Italians aged 25–34 and 65+, Italian women, and respondents aged 65+ who are not women. These perceptions are not supported by French 25- to 34-year-olds. Interactions between country and sector show that French producers do not support these perceptions.

4.3 Societal and consumer pressures and market

Stakeholders who consider that the agroecological transition will be achieved through societal and consumer pressure (model 3) consequently also identify that the main challenges lie in the adaptation of the sector to meet consumer and retailer needs, especially in the reduction of chemicals (pesticides and oenological inputs). Once these challenges are overcome, the agroecological transition will be enabled. Adaptation to stricter European regulations on more severe production conditions at the vineyard level and the consequent additional costs are also considered challenging to the transition. Considering country differences, overall, Italians do not agree with these perceptions, while the French and Portuguese do agree. There are no particular age and gender differences or interactions. However interactions between country and age reveal that Italians under 34 years old do not agree, while Portuguese 35- to 49-year-olds and French respondents under 34 years old generally agree. Interactions between country and gender show that Italian respondents who are not women do not agree, while French and Portuguese respondents who are not women agree. Overall, representatives of public administration share these perceptions. In Italy, the public administration representatives agree, while the representatives of research institutes and the 'others' group of stakeholders do not. In Portugal the suppliers agree, and in France the representatives of research institutes 'others' group do not.

4.4 Regulations and standards

Finally, those who believe the agroecological transition will be achieved with more strict environmental regulations, controls and standards (model 4) perceive the main challenges to be reducing chemicals to meet societal needs in this regard and adapting to European regulations. Challenges that can drive the agroecological transition are also associated with the reorientation of specifications from private labels and standards (PDOs and IGPs) in the direction of sustainable production. The expansion of vineyards to new areas and the increase in farms' surface areas are also issues to be faced. This group believes that the development of more resistant varieties for the vineyards (variable **c2**) could be a driver of pesticide reduction that would lead to the agroecological transition. However, a certain degree of scepticism regarding the resistant varieties is also present, as variable c1 reveals that further adoption of resistant varieties in wine production might cause problems for the reputation of wines and their overall acceptability to consumers. Italians most commonly share these perceptions, while the French do not. Younger respondents (less than 34 years old) also share these perceptions, while those between 50 and 64 years old do not. There are no gender differences. Interactions reveal that young Italians (less than 34 years old) agree while French respondents between 35 and 64 years old do not. Italians of all genders share these perceptions, while not all genders of French respondents do. Respondents under 34 years old who are not women share these perceptions, while respondents between 50 and 64 years old who are not women do not. In Italy, representatives of public administration, producers, research institutes and the 'others' group of stakeholders share these perceptions. However, in France, representatives of suppliers, associations and producers do not.

5. ORGANIC CERTIFICATION VERSUS RESISTANT VARIETIES

This section uses ordinal logistic regressions to investigate the relationships between the stakeholders' perceptions of organic certification and resistant varieties in wine production. Accordingly, two models were estimated and in each model the dependent variable is the direct stakeholders' responses to question 7 'Organic certification will become the environmental standard' (Table 4) and to question 1 'Resistant grape varieties are a credible solution to achieve a significant reduction in pesticide use' (Table 5) from part III of the questionnaire. These were regressed in the components (as independent variables) defined in Section 4 and in the socioeconomic variables. The components to which variables 7 and 19 contributed the most in the PCA, b2 and c2 respectively, were not included in the respective models to avoid endogeneity issues. Results are shown in Table

Table 7. Results of ordinal logistic regressions for perceptions of organic certification and resistant varieties.

x	Variable name	Organic certification will become the environmental standard	Resistant grape varieties are a credible solution to achieve a significant reduction in pesticide use
a1	Territory and culture	0.04	0.10*
a2	Reducing chemicals	0.11*	0.02
a3	Consumers' and retailers' needs	0.07	0.06
a4	European regulation	0.08	0.02
a5	Decline of vineyards and yields	– 0.10	0.17*
a6	New production areas	0.05	– 0.09
b1	BIO not suitable for wine	– 1.06***	0.10*
b2	**BIO challenges to grow**		0.24***
b3	BIO is a widespread label with competitors	0.02	0.33***
b4	BIO alternatives	0.24***	0.01
c1	RV low reputation and acceptability	0.23***	– 0.77***
c2	**RV driver of pesticide reduction**	0.32***	
	Country	0.08	– 0.12
	Age	0.16*	– 0.17*
	Gender (1 = women)	0.16	– 0.47**
	Sector	0.03	0.02
	Cut1 constant	– 2.70***	– 5.32***
	Cut2 constant	– 0.26	– 3.37***
	Cut3 constant	1.67***	– 2.05***
	Cut4 constant	4.80***	0.81**
	Pseudo-R^2	0.242	0.183
	Prob > Chi^2	0.0000	0.0000

NB: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

7. For each independent variable, the table shows the partial regression coefficients.

The results show that stakeholders recognising that organic certification will become the environmental standard also agree that reducing chemicals in production and processing is one of the main challenges to enhancing sustainability in wine production. They believe that the sector should move in the direction of producing more 'nature' wines and the specifications of PDOs and IGPs should be reoriented in the direction of sustainable production. As expected, they also do not agree that organic production is unsuitable for wine production. They believe that resistant varieties can support pesticide reduction, but also have concerns that these varieties might have problems with low consumer acceptability and risk the qualitative reputation of wines, probably being assimilated to genetically modified organism by less informed consumers. Interestingly, they think that other certifications such as biodynamic or natural wines risk replacing organic certifications, especially because of the high prices of adopting these schemes. Overall, older respondents support these perceptions, and there are no country, gender or sector differences.

The stakeholders who believe that the resistant grape varieties are a credible solution to achieve a significant reduction in pesticide use see the decline of vineyards and yields as an important challenge. Strengthening the cultural character of the wines and the territorial heritage linked to the viticulture and preserving the landscapes attached to the wines are also concerns for this group. They do not believe that resistant varieties can cause problems of reputation and credibility for the wines. Furthermore, they agree that organic labels are not limited to specific types of wine, but concern all types of wine on the quality and price scale and the BIO logo is the most well-known certification among wine consumers for pesticide reduction. However other more general environmental/sustainability certifications, such as HVE (in France) and ISO, also tend to become widely distributed. In addition, the repeated use of copper can be a serious problem for societal credibility in organic certification. Contradictorily, these stakeholders believe that organic production is not suitable for wines, but still see organic certification as establishing itself as the environmental standard. However, it can only develop on a large scale through significant public subsidies

because it comes with several challenges. In this regard, they are sceptical that the evolution to more strict regulations will make it impossible to produce wines in certain regions and that the high risks linked to organic production can only be bearable for companies already well-established in the market. Younger respondents and those who are not women most commonly share these perceptions.

6. CONCLUSIONS AND POLICY IMPLICATIONS

This article has demonstrated how the agroecological transition is identified as a priority issue by stakeholders overall, especially regarding the reduction of pesticides. However, there are notable differences between the three European countries (France, Italy, Portugal) that were the focus of our survey. The stakeholders emphasise different drivers for the ecological transition. For example, French and Portuguese stakeholders (but not Italians) place significant importance on the market and societal pressures as catalysts for this transition. Another example is that professionals, unlike other stakeholders, in some countries do not consider themselves capable of changing practices to reduce pesticide use. In addition, in extreme cases, stakeholders clearly state that the agroecological transition cannot evolve under regulatory constraints.

The European survey tested two types of technical and organisational solutions that could incentivise companies and contribute to regulatory changes: (i) the development of organic certification and (ii) genetic research that would enable the development of varieties resistant to fungal diseases. In viticulture in 2022, organic certification accounted for more than 10 % of production in the three countries considered (especially in France and Italy, and to a lesser extent in Portugal). However, this certification has recently experienced a slight decline due to inflationary pressures, and it faces competition from other certifications on environmental and health issues. In all three countries, alternatives such as 'pesticide residue free', HVE and Terra Vitis in France, VIVA and Equalitas in Italy and Proteção Integrada in Portugal have emerged. Nonetheless, according to our survey, organic certification remains the most popular choice, particularly when it comes to meeting market expectations.

Concerns were also identified regarding the acceptability of resistant grape varieties, which are often presented as an acceptable solution as long as they are not considered genetically modified organisms. This distinction is not applicable to the new genomic techniques (NGTs) currently being discussed by the European Commission. In addition, there is a concern that nature might find a way to bypass these resistances. Market acceptability, particularly in relation to wine quality, is undoubtedly the most significant barrier to the development of resistant grape varieties [9]. This point is particularly emphasised by the stakeholders. In fact, regardless of stakeholder or nationality, this innovative solution of resistant varieties is perceived as very credible, and there are great hopes for it. It is worth noting that stakeholders who believe in the significant power of regulations do not consider organic certification to be the most well-known label and are in favour of deploying these innovative grape varieties. Resistant varieties are seen as a solution supporting the development of organic production.

Our results indicate that both organic production and resistant varieties are valuable options for reducing pesticide usage in viticulture, benefiting different groups of stakeholders. Therefore, sectoral policy should support the development of the knowledge, skills and tools required for the sustainable advancement of these diverse approaches to viticulture. Additional research efforts are needed to fill the gaps that currently hinder the full exploitation of their potential in terms of reducing the environmental impact of wine production.

In the EU, the organic area under vine surged remarkably (+55%) between 2013 (244 000 ha) and 2019 (379 000 ha) [22], establishing a trend consistent with the farm-to-fork strategy objectives. However, it should be noted that the adoption of organic production and resistant varieties alone may not result in a substantial reduction in pesticide volume. This raises concerns, as certain substances can harm soil fauna and, when leaked into groundwater, can endanger aquatic species [23]. In addressing this issue, the EU action plan for the development of organic production has already outlined the sectoral policy's need to deal with alternatives to contentious inputs and other plant protection products.

Section 3.3 of the action plan emphasises the importance of exploring pathways to phase out or replace contentious inputs in organic farming, such as copper, and developing alternatives to these products to enable organic farmers to protect their crops. Consequently, starting in 2023, the Commission intends to allocate funding under Horizon Europe for research and innovation projects on alternative approaches to contentious inputs, with a particular focus on substances such as copper, based on European Food Safety Authority evaluations.

In addition, since 2022, the Commission has promoted, where appropriate, the use of alternative plant protection products containing active biological sub-

stances through strengthened farm advisory services, notably agriculture knowledge and innovation systems. Furthermore, efforts will be made to provide risk management tools to address this issue effectively.

Concerning the new hybrid resistant varieties, new fungus-resistant grapevine varieties still represent an immature technology whose adoption requires investments with a long payback period [24]. The stability of the resistance to / tolerance of the pathogens targeted is unknown, and a strong research effort is even now devoted to obtaining new fungus-resistant grapevine varieties with multiple genes for resistance [25]. Moreover, the implications of using such new varieties regarding other pathogens are not yet clear. On the other hand, the choice of new varieties is now larger, despite still being rather small compared with the huge differences in wine styles, soil and climate conditions of viticulture. Therefore, the conditions exist for the use of these new varieties, perhaps in limited shares, in the production of test PDO wines, enabling the accumulation of experiences in order to discover the optimal viticulture and oenological practices to adopt and thereby opening the way for their sustainable introduction into the PDO product specification. This is already happening in Champagne, where the 'Voltis' variety is under observation.

Furthermore, NGTs are candidates for the agriculture of the future, with the aim of introducing resistant crops and ensuring food even in cases of prohibitive climatic events, all while protecting environmental sustainability. These could support organic production, especially in years with prohibitive climatic conditions in which organic farming treatments do not achieve the desired results. The Commission's 2021 study on NGTs showed that, as regards NGT-produced plants and related products, current legislation is no longer fit for purpose and needs to be adapted to scientific and technological progress [26].

The question of names and the possibility of allowing the use of hybrids in indications of geographical origin remain unsolved problems and are arousing considerable debate in EU Member States. Opinions often reflect the environmental conditions in which cultivation takes place. In regions with wetter climates, which accentuate the pressure of fungal diseases, it is understandable that using a name reminiscent of a well-known European variety is extremely advantageous in supporting the commercial spread of resistant hybrids. However, the introduction of hybrids into the PDO product specifications is not a straightforward process. The PDO product specifications should be discussed and approved locally and later approved by the Commission. Moreover, making decisions locally regarding the use of hybrids can be difficult, especially in Mediterranean regions, where the use of hybrids is frequently a source of concern. For example, in Italy, national legislation still prohibits the introduction of hybrids into the production of PDO wines, despite the change in EU general regulations.

Sectoral policy may play a crucial role in removing these drawbacks and facilitating a not-marginal diffusion of resistant varieties. Medium-/long-term genetic research programmes should be supported to obtain new fungus-resistant grapevine varieties with multiple genes for resistance (resistance gene pyramiding [27]). The replanting of vineyards with these varieties should be supported through interventions for the restructuring and conversion of vineyards. The operational groups established within the European Innovation Partnership for Agricultural Productivity and Sustainability, which has been relaunched by the CAP reform, should be encouraged to facilitate the exchange of experiences among producers and other stakeholders. This exchange can help improve knowledge of vineyard and winemaking management, and uncover site-specific solutions for various issues.

The survey sample was collected in 2018 and 2019, but this does not invalidate the results, as nothing substantial has changed since then in terms of the consequences of new regulations or shared experiences. While the area under vine planted with new resistant hybrids has grown at high rates in many regions over the past 5 years, it is still relatively small. Therefore, stakeholders' knowledge and awareness of this type of innovation is almost the same as when the data used in our analysis was collected.

Regarding the potential of NGTs as a new agroecological option for viticulture, the current scenario is quite similar to that of 2018–2019. It is true that the farm-to-fork strategy is open to these technologies, and the Commission is working on a proposal to regulate plants obtained through these techniques, amending Regulation (EU) 2017/625 ([5]). However, the legislative process is far from being finalised, and field tests are to

[5] Regulation (EU) 2017/625 of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products, amending Regulations (EC) No 999/2001, (EC) No 396/2005, (EC) No 1069/2009, (EC) No 1107/2009, (EU) No 1151/2012, (EU) No 652/2014, (EU) 2016/429 and (EU) 2016/2031 of the European Parliament and of the Council, Council Regulations (EC) No 1/2005 and (EC) No 1099/2009 and Council Directives 98/58/EC, 1999/74/EC, 2007/43/EC, 2008/119/EC and 2008/120/EC, and repealing Regulations (EC) No 854/2004 and (EC) No 882/2004 of the European Parliament and of the Council, Council Directives 89/608/EEC, 89/662/EEC, 90/425/EEC, 91/496/EEC, 96/23/EC, 96/93/EC and 97/78/EC and Council Decision 92/438/EEC (OJ L 95, 7.4.2017, p. 1).

begin in the coming months. Therefore, in the public debate, the new varieties that could emerge from these techniques are still seen as futuristic, despite the confidence of some researchers.

Nevertheless, the results presented here suggest the need for further research in several areas. Firstly, there is a need for studies on consumer acceptance and preferences for wines that are made at least partially from hybrid grapes. These studies should aim to analyse consumers' reactions and attitudes towards these wines in natural conditions. Secondly, there should be targeted efforts to develop a protocol that can accurately assess the sensory similarities and differences between selected new hybrids and traditional *Vitis vinifera* varieties. This would provide a rational basis for planning experiments involving the substitution of grape varieties in PDO product specifications. Such a tool would also be valuable when new varieties or clones derived from NGTs become available. Finally, once these new varieties or clones are truly accessible, potentially in the next 5 years, and the relevant EU legal framework is consolidated, it will be of paramount importance to study the opportunities and risks associated with the adoption of these innovations.

DISCLAIMER

The opinions expressed are those of the author(s) only and should not be considered as representative of the European Commission's official position.

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SUPPLEMENTARY MATERIAL

Table A1. Principal component loadings (orthogonal varimax rotation) of 'perceptions about agroecological transition'.

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
Q1	-0.0281	-0.0167	0.6942	0.0184	0.2106
Q2	0.0043	0.0082	0.6918	-0.0141	0.2092
Q3	0.3208	0.2541	0.0132	-0.2868	0.5828
Q4	-0.1515	0.5904	0.04	0.0696	0.3936
Q5	0.5893	-0.0727	-0.0316	0.0831	0.3504
Q6	0.2915	0.1289	0.1031	0.0159	0.6959
Q7	0.2125	-0.1373	0.0832	0.412	0.5981
Q8	0.1501	0.4453	0.0579	-0.2461	0.5418
Q9	0.6063	-0.0383	-0.022	-0.0127	0.3294
Q10	-0.0046	0.5711	-0.0895	0.1553	0.3464
Q11	-0.0468	0.1028	0.0537	0.5659	0.37
Q12	0.0589	0.0956	-0.0659	0.5748	0.3829

Table A2. Principal component loadings (orthogonal varimax rotation) of perceptions about "what importance is accorded to environmental issues among other issues".

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Unexplained
Q1	0.0912	0.2001	0.0173	-0.0538	0.3826	0.0121	0.5721
Q2	0.3571	-0.1911	-0.0063	-0.0333	0.0042	0.1869	0.566
Q3	-0.0872	0.0104	0.0126	-0.0177	0.6055	0.1256	0.3824
Q4	-0.0059	0.4827	0.0138	0.0113	0.1086	-0.1535	0.42
Q5	0.1185	0.3263	-0.123	-0.0101	0.2497	0.0441	0.4985
Q6	-0.1462	0.3033	0.265	0.0937	-0.2968	0.2611	0.4557
Q7	-0.1411	0.4608	-0.0319	0.0588	-0.1562	0.0068	0.563
Q8	0.4577	-0.0581	-0.0901	0.0881	-0.0195	-0.0404	0.4656
Q9	0.0322	0.0237	0.5828	-0.0602	-0.0208	-0.1648	0.4005
Q10	0.0407	-0.0624	0.3699	0.0277	0.3348	-0.1062	0.4562
Q11	0.3793	0.0695	0.1399	0.0938	-0.1818	-0.0491	0.4766
Q12	0.3765	0.0932	0.1451	-0.019	-0.1571	-0.0307	0.5035
Q13	0.0094	0.0091	0.0469	0.5623	0.011	0.0067	0.3431
Q14	-0.0476	-0.0546	0.0109	0.4511	0.2381	0.0818	0.3937
Q15	0.0466	0.0393	-0.0657	0.6196	-0.1136	0.0181	0.3432
Q16	0.096	0.4047	-0.0159	-0.016	0.073	-0.0533	0.5447
Q17	0.0126	-0.1194	0.4043	0.1461	0.1743	-0.1094	0.4577
Q18	0.2096	0.2719	-0.0195	-0.1075	0.0255	0.1799	0.5497
Q19	0.4471	-0.0117	-0.0582	-0.0055	0.082	-0.0325	0.4757
Q20	-0.0971	0.0059	0.4318	-0.0737	-0.0981	0.4004	0.4132
Q21	0.1905	-0.0092	0.1149	-0.1289	0.0101	0.3149	0.6713
Q22	-0.0005	-0.0369	-0.1179	0.056	0.085	0.7052	0.3482

Table A3. Principal component loadings (orthogonal varimax rotation) of perceptions about "Focus on organic certification".

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
Q1	-0.1519	0.2526	0.429	-0.28	0.4648
Q2	-0.3946	0.0363	0.1265	0.2047	0.489
Q3	-0.0278	0.2671	-0.0504	0.3808	0.5276
Q4	-0.0455	-0.0629	0.0779	0.673	0.4252
Q5	-0.102	-0.1385	0.5307	0.0552	0.5033
Q6	0.2315	0.0937	0.3226	-0.1435	0.6622
Q7	-0.4579	0.2749	0.0246	0.0476	0.4149
Q8	-0.0533	0.1922	0.2556	0.0763	0.7795
Q9	0.2752	0.2102	0.0259	0.0171	0.4732
Q10	0.0749	0.3881	0.0825	-0.034	0.5551
Q11	0.2615	0.0863	0.1106	0.1069	0.605
Q12	0.1657	-0.0906	0.5043	0.1801	0.543
Q13	-0.1554	0.4933	-0.037	0.0739	0.5158
Q14	0.3169	0.1314	0.0227	0.0068	0.5003
Q15	0.3794	0.0251	0.0358	0.1021	0.3984
Q16	0.2743	0.1496	0.0172	0.0663	0.5337
Q17	0.071	0.4593	-0.1618	-0.1787	0.4884
Q18	0.1262	0.1184	-0.1896	0.3905	0.4806

Table A4. Principal component loadings (orthogonal varimax rotation) of perceptions about "Focus on resistant grape varieties".

Variable	Comp1	Comp2	Unexplained
Q1	-0.1112	0.5281	0.3738
Q2	0.3809	-0.0838	0.368
Q3	0.3713	-0.0648	0.4165
Q4	0.3362	0.0719	0.6109
Q5	0.3702	0.0151	0.4884
Q6	0.3225	-0.1513	0.4633
Q7	0.3322	-0.007	0.5738
Q8	0.0565	0.6772	0.3186
Q9	0.3758	0.1464	0.5413
Q10	-0.1214	0.3388	0.6699
Q11	0.2847	0.2947	0.7247

Table A5. Results of multivariate regressions for perceptions of agroecological transition (full table with interactions).

x	Variable names	[y1] Technology and financial incentives	[y2] Producers' information and awareness	[y3] Society and consumers' pressure	[y4] Regulations and standards
a1	Territory and culture	0.17***	0.20***	0.03	-0.06*
a2	Reducing chemicals	0.05	0.26***	0.25***	0.31***
a3	Consumers and retailer's needs	0.08*	-0.02	0.13***	0.00
a4	European regulation	0.05	0.00	0.08*	0.11***
a5	Decline of vineyards and yields	0.03	0.05	-0.03	-0.03
a6	New production areas	0.19***	0.12**	-0.02	0.09*
b1	BIO not suitable for wine	-0.10***	-0.06*	-0.10***	-0.13***
b2	BIO challenges to grow	0.26***	0.03	0.06	0.01
b3	BIO widespread label with competitors	-0.07	0.00	0.07	0.06
b4	BIO alternatives	0.10*	0.12**	0.04	0.05
c1	RV low reputation and acceptability	0.00	0.03	-0.04	0.05*
c2	RV driver of pesticide reduction	0.03	0.01	0.02	0.09*
	Italy	(base)			
	Portugal	-0.81	-0.55	0.48	-0.69
	France	-0.23	-0.29	1.46*	-0.19
	Less than 24 years old	(base)			
	Between 25 and 34 years old	-0.12	0.30	0.26	-0.38
	Between 35 and 49 years old	-0.05	0.17	0.52	-0.82**
	Between 50 and 64 years old	-0.22	0.04	0.65*	-0.84**
	65 years old or more	-0.26	0.73*	0.86**	-0.54
	IT # Less than 24 years old	(base)			
	IT # Between 25 and 34 years old	(base)			

(Continued)

Table A5. (Continued).

x	Variable names	[y1] Technology and financial incentives	[y2] Producers' information and awareness	[y3] Society and consumers' pressure	[y4] Regulations and standards
	IT # Between 35 and 49 years od	(base)			
	IT # Between 50 and 64 years old	(base)			
	IT # 65 years old or more	(base)			
	PT # Less than 24 years old	(base)			
	PT # Between 25 and 34 years old	0.15	0.56	-0.29	0.45
	PT # Between 35 and 49 years od	0.65	0.34	-0.30	0.59
	PT # Between 50 and 64 years old	0.64	0.26	-0.63	0.45
	PT # 65 years old or more	0.22	-0.68	-1.41	0.19
	FR # Less than 24 years old	(base)			
	FR # Between 25 and 34 years old	-0.68	-0.83	-0.79	-0.40
	FR # Between 35 and 49 years od	-0.70	-0.44	-1.26**	-0.19
	FR # Between 50 and 64 years old	-0.47	-0.16	-1.28**	-0.31
	FR # 65 years old or more	-0.68	-0.95	-1.87***	-0.33
	Gender - Otherwise	(base)			
	Gender - Women	-0.50	-0.04	0.04	-0.39
	IT # Otherwise	(base)			
	IT # Women	(base)			
	PT # Otherwise	(base)			
	PT # Women	-0.25	-0.35	-0.37	0.34
	FR # Otherwise	(base)			
	FR # Women	-0.05	0.04	-0.56**	-0.20
	Otherwise # Less than 24 years old	(base)			
	Otherwise # Between 25 and 34 years old	(base)			
	Otherwise # Between 35 and 49 years od	(base)			
	Otherwise # Between 50 and 64 years old	(base)			
	Otherwise # 65 years old or more	(base)			
	Women # Less than 24 years old	(base)			
	Women # Between 25 and 34 years old	0.94*	0.31	0.28	0.28
	Women # Between 35 and 49 years od	0.66	0.21	0.26	0.50
	Women # Between 50 and 64 years old	0.37	0.20	-0.04	0.69
	Women # 65 years old or more	1.56	0.76	0.95	0.19
	Public Administration	(base)			
	Associations	-0.26	-0.09	-0.50	-0.42
	Producers	-0.28	-0.19	-0.42	-0.21
	Suppliers	-0.03	-0.27	-0.69*	-0.26
	Research institutes	-0.23	-0.17	-0.82**	0.08
	Others	-0.19	-0.35	-0.65**	-0.06
	IT # Public Administration	(base)			
	IT # Associations	(base)			
	IT # Producers	(base)			
	IT # Suppliers	(base)			
	IT # Research institutes	(base)			
	IT # Others	(base)			
	PT # Public Administration	(base)			
	PT # Associations	-0.05	0.13	0.49	0.28
	PT # Producers	0.40	0.10	0.28	-0.01

(Continued)

Table A5. (Continued).

x	Variable names	[y1] Technology and financial incentives	[y2] Producers' information and awareness	[y3] Society and consumers' pressure	[y4] Regulations and standards
	PT # Suppliers	-1.31	1.32	2.68*	-0.84
	PT # Research institutes	0.07	0.22	0.45	-0.48
	PT # Others	0.17	0.46	0.65	-0.17
	FR # Public Administration	(base)			
	FR # Associations	1.25*	0.82	0.13	0.10
	FR # Producers	0.57	0.41	-0.01	-0.14
	FR # Suppliers	0.52	0.82	0.24	-0.02
	FR # Research institutes	0.89	0.70	0.62	-0.09
	FR # Others	0.28	0.90*	0.36	0.18
	constant	0.43	0.03	-0.17	1.00**
	R-sqr	0.293	0.313	0.284	0.317

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