The Impact of Changes in Regulatory and Market Environment on Sustainability of Winegrowers. A Path Analysis

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Abstract

The production of sustainable wine improves the competitiveness of winegrowers and allow them to take advantage of a growing international market. Despite its benefits, several factors may influence the adoption of sustainability practices for many winegrowers, including internal factors such as production cost, the scale of production, institutional arrangements, and external factors such as climate change, regulations, and incentives. Although the internal factors are important, we contend that it is the external evolution in the regulatory and market environment occurring along winery supply chains that could provide sufficient motivations for the adoption of sustainable practices in winery industry. This research is based on the need to subject the above assertion through research scrutiny which unfortunately has received a limited attention. While presenting the Percentage Sustainability Practice (PSP) as a novel way of measuring sustainability, we developed a Structural Equation Model (SEM) with 13 hypotheses to support our hypothesis. The variables included in the model were consistent and the hypothetical model was applicable showing a satisfactory fitting in the SEM. A total of 10 out of 13 hypotheses were supported by our model. Access to credit and consumer behaviours were found to have a significant causal association with sustainability adoption, while climate change, environmental regulation and Common Agriculture Policy (CAP) have an indirect relationship. Our research provides evidence for larger wine producers in Toscana, Italy, thereby emphasizing on the role of large scale winegrowers as carriers of innovation towards the achievement of sustainability in wine industries.

Keywords: Sustainability, Wine, Market, Climate Change, CAP, SEM

1 Introduction

The concept of sustainability can be framed in food systems to advocates for the adjustment of present practices for future gains. It represents the general objective of the United Nations in its sustainable development goals, and the Europe 2020 strategy to promote a smart, sustainable and inclusive growth. Despite being used in several contexts, there is still an open debate on how to conceptualize sustainability (Casas-Cazares, et al., 2009; Hayati, et al., 2010). One reason for this is because of its complexity and contextual distinctiveness. Conceptualizing sustainability attracts numerous parties with different objectives, hence, arriving at a compromise is plaque by disputes and controversies (Rigby & Cáceres, 2001). Within these controversies, researchers have recommended a system approach for measuring sustainability framework, paying attention to the context specificity, credibility and consistency of indicators (Latruffe et al., 2016). Generally, sustainability framework encompasses all institutional arrangement that helps to maintain productivity and usefulness to the society over the long run, by engaging in environmentally-sound, economically viable and socially supportive practices (Rigby & Cáceres, 2001). It could be influenced by internal factors such as farmers awareness, attitude towards the concept, and the scale of production (Baumgart-Getz, et al., 2012; Brain, et al., 2014; Hinojosa-Rodríguez, et al., 2014), and external factors such as such as climate changes, environmental regulations, the availability of credit, and market demand (Brain et al., 2014; Kertész & Madarász, 2014; Teklewold, et al., 2013; Gabzdylova, et al., 2009).

Recent literature highlights a growing interest of sustainability in winery industry (Flores, 2018; Merli, et al., 2018; Pullman, et al., 2010; Santini, et al., 2013). The rationale for sustainability in wine industry is *to develop a global strategy on the scale of the grape production and processing systems, incorporating at the same time the economic sustainability of structures and territories, in order to produce quality wines that consider the requirements of precision in sustainable viticulture, risks to the environment and products safety and valuing the historical, cultural, ecological and aesthetic aspects of terroir with the objective to ensure the health and safety of consumers* (OIV, 2004). Despite its benefits, several factors may influence the adoption of sustainability practices for many winegrowers, including the internal and external factors listed above. Although, wine growers may practice sustainability without external influence either to maintain an existing tradition or as a reflection of conducive internal factors (Ashton, 2014; Bianchi, 2015; Delmas & Gergaud, 2014), it is the external evolution in the regulatory and market environment occurring along winery supply chains that could provide sufficient motivations for the adoption of sustainable practices (Rocchi & Gabbai, 2013).

This paper is based on the need to subject the above assertion through research scrutiny. Based on our knowledge, only a few researchers have quantified the drivers of wine sustainability at the winery level, beyond the internal factors (Pomarici, E., et al., 2015). Unfortunately, most wine sustainability research is rather skewed towards the consumer demand of sustainable wine (Pomarici, et al., 2016; Pomarici & Vecchio, 2014; Schmit, et al., 2013; Sogari, et al., 2016). Although the results suggest that there is a market for sustainable wine, we contend that this singular benefit may not be sufficient motivator for winegrowers to adopt sustainable wine production. There are numerous regulatory and market changes occurring simultaneously in the winery industry. These factors result in a complex network of possible causal relationship leading to sustainability practices. Quantifying the magnitude of the impact of these external factors is a challenge. Yet, research in this direction will help improve the implementation of policy assistance towards the production of sustainable wine (Mariani & Vastola, 2015).

Following Ménard & Valceschini, (2005) and Rocchi & Gabbai, (2013), we considered the regulatory evolutions to include changes in climate, environmental regulations and agricultural

policies, and the market environments to include demand, prices and financial assistance. For instance, on the regulation side, the changes in climatic conditions could influence wine yields and quality, forcing winegrowers to engage in conservatory practices which in long run may lead to sustainability production (Fraga, et al., 2012; OIV, 2018). In response to global environmental needs, wine industry constantly undergoes heavy environmental regulations which might raise public awareness of the importance of sustainability (Cacic, et al., 2012; Flores, 2018; Meloni & Swinnen, 2012). At the policy level, several institutions are making new policy and commitments to encourage sustainability practices among farmers. An examples is the introduction of the greening component in the Common Agricultural Policy (CAP) of the European Union (EU) which offer financial and technical assistance, encouraging change in farm behaviour towards adoption of sustainability practices (Recanati, et al., 2019; Solazzo & Pierangeli, 2016; Zahrnt, 2011). On the market side, globalization, technology advances, and trade liberalization has boosted production, promoted industrial export orientation, labelling and standardization of wine, increased competition, resulting to more cheaper brands (Smith, 2008; Virtuani & Zucchella, 2008). With numerous brand choices now available and customers are now being interested in healthy food, consumption patterns may be more sensible to wines with sustainable attributes (Bianchi, 2015; Higgins, et al., 2014; Ashton, 2014). In this process, the demand for traditional wines is being affected by the growing desire for wines with novel characteristics,- new blends, quality linked to the origin, organic wines and wine that communicate sustainability through green brands. Hence, by adopting sustainability practices, wine growers would be better prepared for the looming competition in the winery industry (Merli et al., 2018; OIV, 2018; Rocchi & Gabbai, 2013).

The objective of our study is to quantify the impact of regulatory and market changes on the adoption of sustainability practices among wine growers. We hypothesize that while changes in the market would have a direct causal influence on sustainability adoption, changes in the regulatory environment would have indirect influence through its influence on the market. Our hypothesis is tested using path analysis (SEM). Our study contributes to the current literature on wine sustainability on two fronts. First, we developed a conceptual model that explains the drivers of the sustainability practices of wine producers. Our model includes 3 variables for market changes (consumer behaviours, market prices, credit access) and 3 variables for changes in the regulatory environment (environment regulation, climate changes, changes in CAP policy). Second, considering the complexities in conceptualizing and measuring sustainability framework, our study provides a unique solution for calculating sustainability using PSP. Here we paid attention to the three components of sustainability, selecting indicators that are peculiar to wine production, yet reproducible and reliable (Dariush Hayati et al., 2010; Latruffe et al., 2016). The findings of our study will contribute to a better understanding of the magnitude of external factors driving sustainability practices among winegrowers in the EU, by focusing on the region's largest wine producing country, Italy (OIV, 2018).

2 Conceptual Framework and Hypotheses

The conceptual framework *(Fig.1)*, shows the factors that explain winegrowers sustainable practices, accordingly divided into market forces and regulatory factors. The market features included the changing institutional arrangements that offer an advantage to winegrowers when they adopt sustainability practices. This may include the provision of credit facility (Goodhue, et al., 2004; Santiago & Sykuta, 2016)**;** the changing consumer behaviour and demand for sustainable wines (Bianchi, 2015; Higgins, et al., 2014; Ashton, 2014), and the changing market prices of wine (Smith, 2008; Virtuani & Zucchella, 2008). According to Santini, et al., (2013), these three factors directed influence farmers decision to engage in sustainability practices in wine production. Hence, we developed the first set of our hypothesis.

1. Hypothesis 1: Access to credit will positively influence sustainability practices among wineries.
2. Hypothesis 2: Increase in market price will positively influence sustainability practices among wineries.
3. Hypothesis 3: change in consumer behaviour towards sustainable wine will influence sustainability practices among wineries.

The regulatory factors take place external to the farming system, a space beyond the farmer's control. They are those factors that would influence sustainability practices through their effects on the wine market orientation and institutional arrangements. They include climate change, changes in environmental regulations and in EU farming system, changes in CAP policy. Kertész & Madarász, (2014) observed that environmental policies and programs of the Common Agricultural Policy (CAP), and climate change will likely be the major driving forces defining the direction and for the extension of sustainability practices in the EU farming system. Climate change may compel policymakers to make an adjustment in the CAP policy and environmental regulations. For instance, the need to meet climate goals was the antecedents for the introduction of Greening in the 2013 CAP reform (Merino, 2012)**.** Emerging studies have shown that the CAP greening has led to farmers adoption of climate-friendly behaviour by curtailing chemical use and increasing crop diversity (Cortignani & Dono, 2015).

Furthermore, aside from the influence in CAP policy, climate change may also cause changes in wine regulations. According to Gaeta & Corsinovi, (2013), the EU has made several changes in its wine legislation in response to climate change. Some of the regulations help to check farmers oenological practices and treatments to ensure quality wines. Climate changes also may influence farmers to access credits facilities. For instance, Fraga, et al., (2012) observed that the increasing evidence for erratic changes in the climate called for adaptation and mitigation measures which often require additional financial resources on the winegrowers. In recognition of this, the EU through the Greening policy has committed up to 30% of the 2014 – 2020 budget providing non-repayable financial incentives for actions that improve climate change mitigation and adaption measures at the farm level (Rossi, et al., 2017)**.** In the other hand, climate change may also influence market prices of wine. Relevant studies have shown that this could occur through its effect on the quantity and quality of the wine (Ashenfelter & Storchmann, 2016; Ashenfelter & Storchmann, 2010)**.**

Finally, there is a growing literature connecting changes in wine regulations with changes in consumers behaviour towards sustainable wine (Malorgio & Grazia, 2007; Sogari, et al., 2016)**.** These studies tend to suggest that regulations on sustainability labelling may offer quality signals to wine consumers, increasing their knowledge about sustainability and improving their willingness to pay for wine with sustainable labels. More so, the price of wine is an important

driver of consumers' willingness to pay for sustainable wine. (Pomarici, et al., 2016; Pomarici & Vecchio, 2014; Schmit, et al., 2013; Sogari, et al., 2016). It is therefore based on this literature that we propose the next set of hypothesis.

4. Hypothesis 4: Changes in CAP interact with changes in environmental regulation.
5. Hypothesis 5: Changes in CAP positively influence wine farmers to access credit.
6. Hypothesis 6: Changes in CAP regulates the market prices of wine.
7. Hypothesis 7: Climate changes influences changes in CAP policies.
8. Hypothesis 8: Climate changes influences changes in environmental regulation.
9. Hypothesis 9: Climate change influences access to credit.
10. Hypothesis 10: Climate change influences market prices of wine.
11. Hypothesis 11: Changes in environmental regulation influence farmers access to credit.
12. Hypothesis 12: Changes in environmental regulation influences consumer behaviours.
13. Hypothesis 13: Drop in market price will influence consumers behaviour.

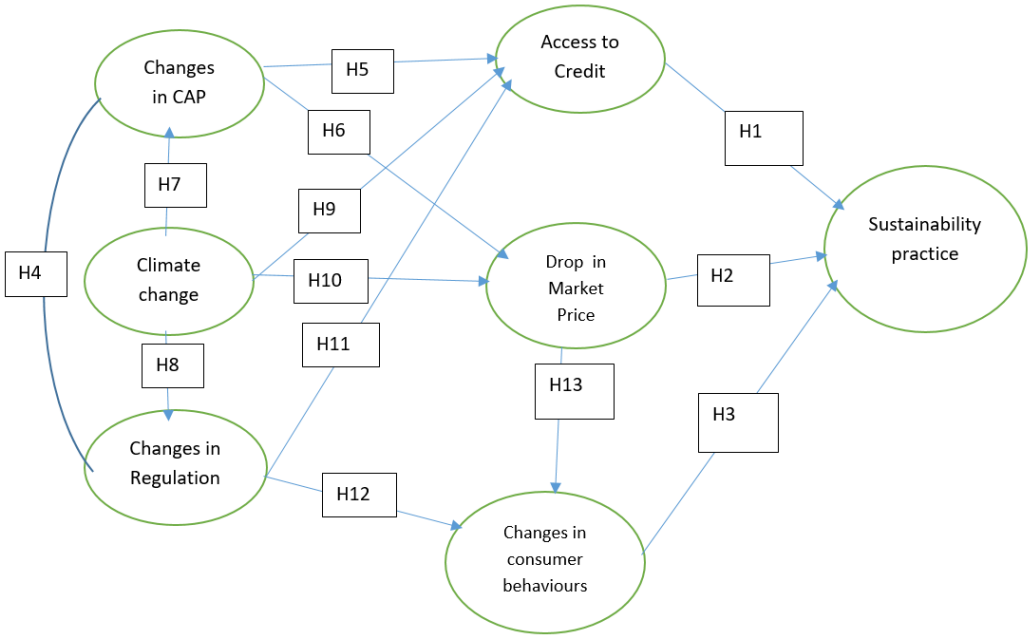

Fig. 1: Hypothesized Model

3 Methodology

3.1 Data

The hypothesized model was tested with a sample of Tuscan wine producers who completed the producer's survey of SUFISA project in Italy. The SUFISA producer survey collected representative quantitative data at the farm level from Toscana wine producers. Respondents were drawn from a producer list collected by the Tuscany Region during the 8th editions of their international Business-to-Business meeting event in Florence in 2017 (Buy Wine Meeting). Most of the participants are large wineries from the Chianti Area and in the Area of Siena and Montalcino. Data were collected through telephone calls. In order to improve data quality and respect of the time constraint, the questionnaire was initially tested through six pilot phone call interviews. Further adjustments were made after the pre-test to avoid the excessive use of technicalities and to make the telephone interviews as quick as possible, but also exhaustive, clear, understandable and effective. A representative sample of 110 respondents was called, 80 of them responded to questions in the sustainability section. After eliminating 1 case with excessive missing data, the final cases used in the model is 79 wine producers. The characteristics of the participants were analysed using descriptive statistics. The participants answered questions on regulatory and market conditions influencings wine supply chain, as well as questions on sustainable farming practices.

3.2 Regulatory and Market Issues Influencing farming strategies.

The key variables of regulatory and market issues were identified through three different pieces of research (media analysis, desk research and stakeholder interviews). The summary of the findings is available in the Deliverable 2.1 “Draft National Report” of SUFISA project (link). The 6 key issues identified for wine industries include adverse climatic condition and pest; a severe drop in market price; changes in consumer behaviour; access to credit for farms consumable inputs; changes of environmental regulations e.g pesticide regulation; and changes in the CAP policy. The producer's survey asked to what extent these issues have influenced the farming strategies adopted by the winegrowers. A 5 point Likert scale was used in the measurement. The Likert scale ranges from not at all (1) to strongly (5). The analysis was done by rescaling the 5 point scales to binary. The first 3 Likert scales: Not at all, Partly and Somewhat was recorded as No (0), and the last 2 considerable and strongly were recorded as Yes (1). Hence, a Likert score of 4 or 5 indicates that the underlying variable is indeed a determinant of the choice of farming practices of the winegrower.

3.3 Calculating Percentage Sustainability Practices of Winegrowers

The complexity associated with sustainability framework, with its three symbiotic components (environmental, social, and economic) present difficulties in its assessment. According to Hayati et al., (2010), there are two ways of assessing sustainability. The first is by evaluation at the component level that enables comparisons of different components of sustainability, and the second is a systematic approach which is expressed as a function or aggregate of the different sustainability components. The latter is usually favoured provided that the selected indicators are reliable and adapted to the local situation (Latruffe et al., 2016). Different methods can also be used to calculate the aggregate sustainability score (for details, see Hayati et al., 2010; Latruffe et al., 2016). Zahm et al., (2008) calculated the aggregate sustainability of individual farms by adding together the scores of the different indicators. Casas-Cazares et al., (2009) calculated the Sustainability Relative Index of their respondents using the integrated area of a triangle of which values below a given threshold implied sustainability or otherwise.

In our case, we analysed the aggregate sustainability of our respondent using the Percentage Sustainability Practice (PSP). The PSP represent the winegrowers' opinions and perception of the extent to which their choice of production practices helped them maintain sustainability. Unlike Zahm et al., (2008), with used count number index, our percentage approach is to increase the variability of the sustainability score. It also helped to satisfy the basic assumption of path analysis requiring that the endogenous variable must be continuous (Streiner, 2005). Furthermore, instead of providing a dichotomous score for the sustainable and non-sustainable farm as done by Casas-Cazares et al., (2009), we assume that sustainability is a systemic process that should be measured in extent.

The selected indicators are in line with the literature (Zahm et al., 2008). It includes 11 disentangled variables covering the three pillars of sustainability – i.e. environmental (n=3), social (n=4) and economic (n=4). The question asked in the producer survey is – the production choice you made help you to example maintain biodiversity?. A Likert scale approach was adopted retrieving responses ranging from 1 (strongly disagree) to 5 (strongly agree). Following Bianchi, (2015), a reliability test was conducted to check the internal consistency of the indicators on the three components, and confirmatory factor analysis (CFA) was conducted for measurement validity. Furthermore, the Percent Sustainability Practice (PSP) is given as:

$$PSP = \sum_{n=1}^{11}\left[\sum_{i=1}^{3}\frac{X_i}{n_x}, \sum_{j=1}^{4}\frac{Y_j}{n_y}, \sum_{k=1}^{4}\frac{Z_k}{n_z}\right]\frac{100}{T}$$

Where PSP = Percent Sustainability Practice

n = Number of indicators

X_i = Value of the ith indicator in the Likert scale of Environment component

Y_j = Value of the jth indicator in the Likert scale of Social component

Z_k = Value of the kth indicator in the Likert scale of Economic component

T = Maximum absolute value in the Likert scale

3.4 The Structural Equation Model: Assumption and Modelling

The variables of marketing and regulatory changes and the variable of PSP were combined for the final SEM modelling (also known as path analysis). The main advantage of the SEM is that it allows multiple and simultaneous testing of magnitude as well as the significance of the complex predictive relationships between a set of variables (Taimalu & Luik, 2019). The basic assumption of the SEM include that there should be no missing value, the variables are to follow a normal distribution, they must be well correlated, and have satisfactory goodness of fit (Streiner, 2005). Exploratory statistics were conducted to ensure that the first three assumptions were satisfied, while the goodness of fit was assessed through the SEM analysis. The SEM was conducted using STATA 13.1GUI. The Maximum Likelihood Estimation method was adopted. The goodness of fit of the model was evaluated using the significant level of the Chi-square (Chi^2), the value of the Root mean square error of approximation (RMSEA), Standardized Root mean square residual (SRMR), the Comparative fit index (CFI), and the Tucker-Lewis index (TLI) as suggested by Schreiber, et al, (2006) and Streiner, (2005). Hence, a model with good fit should have non-significant Chi^2 test, the RMSEA and SRMR should be very close to 0, while the CFI and TLI values should be very close to 1.

4 Results and Discussion

4.1 The characteristics of the Winegrowers

The descriptive statistics of the participant's characteristics are shown in *Table 1*. It shows that different farm enterprises were represented in the analysis. These include individual farms (34.2%), family farm (35.4%), and private company farms (29.1%). Majority of the farm owners are male (69%), above 40 years (63.9%), and attended at least higher secondary education (97.1%). About 34% of the participants produced organic wine. Considering that data was collected from winegrowers who participate in Business-to-Business meeting in Tuscany, interested in exporting wines to other countries, the survey reflects producers with a relatively higher scale of production. Two variables were used to examine the scale of production, total yield and total land use for grape production. The total yield varied extensively ranging from those with smaller scale, from 1 hectolitre to 100 hectolitres (14.1%), medium scale, 101 to 500 hectolitres (38.5), to those produced in the larger scale of above 500 hectolitres (47.4%). The grape land cultivated varied accordingly from the smaller land size that is below 9 hectares (42.3%), the medium between 10 to 25 hectares (30.8%), and larger scale which is above 25 hectares (26.9%). This findings, therefore, represent the large companies in the Chianti Area and in the Area of Siena and Montalcino, although, most Tuscan producers are small and medium-sized.

Table 1: Survey Participant Characteristics (n = 79)

Item	Definition	Percentage (%)
Farm Legal Status	Individual farm	34.2
	Family farm	35.4
	Private Company	29.1
	Public Company	1.30
Age of grower (Years)	Up to 40	36.1
	41 – 50	31.9
	51 – 65	26.4
	Above 65	5.60
Gender	Male	69.0
	Female	31.0
Education	Lower Secondary	2.90
	Higher Secondary	44.1
	University	52.9
Type of Wine	Conventional	65.8
	Organic	34.2
Total yield (hl)	Small (Up to 100)	14.1
	Medium (101 – 500)	38.5
	Large (Above 500)	47.4
Grape Land (ha)	Small (1 – 9)	42.3
	Medium (10 – 25)	30.8
	Large (Above 25)	26.9

4.2 The Marketing and Regulatory Drivers of Farming Strategies

The summary of the marketing and regulatory drivers influencing the farming strategy of winegrowers is presented in *Fig.2.* Here, we considered the underlying factor as an important driver of change in farming strategy if the respondent selected a score of 4 or 5 in the 5-point Likert scale. A summation result showed that the majority (62%) of the participants considered

adverse climate conditions as a major factor influencing their farming practice. This is followed by changes in consumers behaviours (57.7%). Others in ranking order include a severe drop in market price (30.1%), changes in environmental regulation (21.8%), and access to credit (20.5%). In the other hand, changes in CAP policy seems to play the least role in the choice of farming practices adopted by the participants (12.8%). As expected, all the 6 factors are important drivers of change in winegrowers behaviour. However, the level at which the factors influence the growers varied, with changes in climate being the most important driver of change in the winery industry in the study area. As seen early, changes in climate condition often trigger several series of changes both in the other regulatory and market environment that influence a decision towards the adoption of sustainability practices. Another important factor is changes in consumers behaviour which could motivate farmers to change in behaviour to maximize profit in a competitive winery industry.

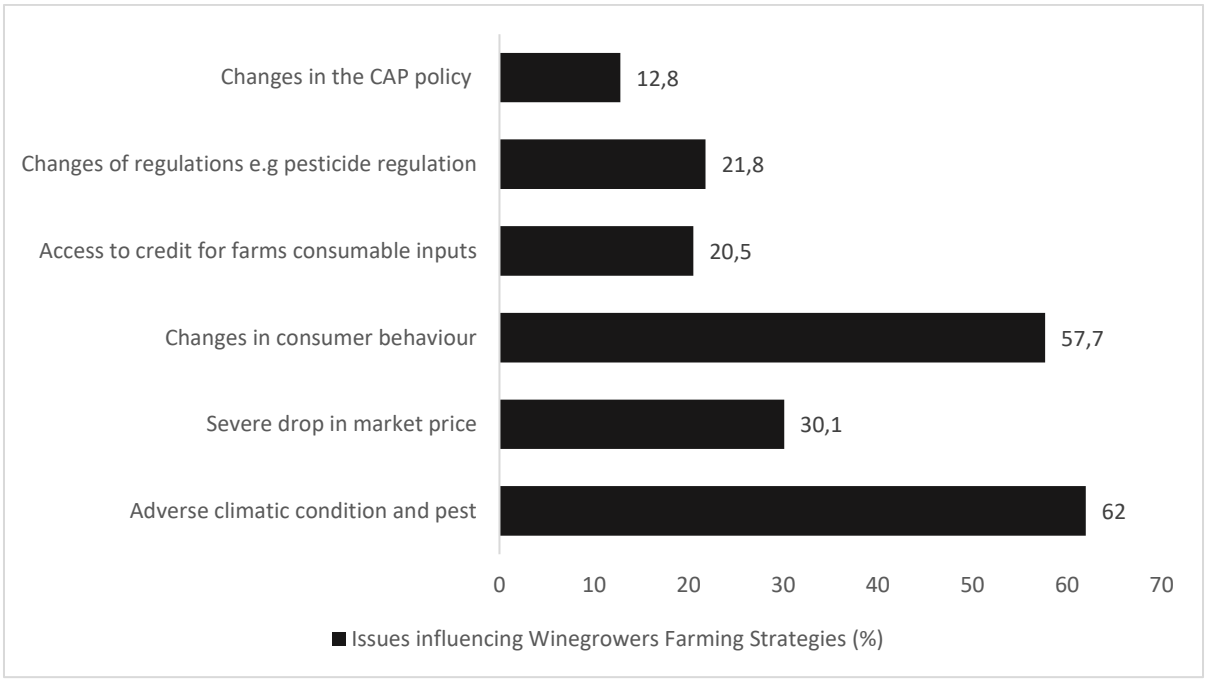

Fig. 2: Drivers of Winegrowers Farming Strategies

4.3 The Percentage of Sustainability Practiced by the Wine Growers

Using the PSP formula, sustainability was analysed as the function of the environmental, social and economic component. The description of the indicators of the components, their mean, reliability test, and coefficient of the CFA is found in *Table 2*. The standardized Cronbach's alpha ranged from 78% to 92% indicating relatively high internal consistency (reliability). The result from the CFA showed that all the standardized regression on the factor loading are significant (Chi^2= 283.07, $\rho > 0.000$). This confirms that the indicators selected for measuring sustainability are consistent with the measurement model, providing robust support for the validity of the indicators. Generally, the mean PSP is 70.62%, implying that on average, the production choice of the wine growers in the study area help them to adopt sustainability practices in the range of 70%. This shows that the wine growers considered in the study perceived that 7 in 10 of their farming strategies are sustainable practices. Although this is not a perfect score, it is encouraging to know that winegrowers are capable of understanding the meaning of sustainability. They can also perceive when their activities contribute to sustainability or not.

Table 2: Percentage Sustainability Practiced (PSP) by the Participants

	The production choice you made help you to:	Mean	β (CFA)	Reliability	Component Mean	**PSP (Total)**
Environment (X)	X.1. Maintain biodiversity	3.86	0.94***	0.92	3.72	70.62
	X.2. Maintain water quality	3.44	0.77***			
	X.3. Maintain soil organic matter	3.89	0.99***			
Social (Y)	Y.4. Create a good connection with buyers and input providers	3.94	0.82***	0.78	3.37	
	Y.5. Connect with other farmers	2.67	0.61***			
	Y.6. Achieve societal recognition of your farming activities	3.10	0.70***			
	Y.7. Secure a successor	3.77	0.55***			
Economic (Z)	Z.8. Maintain profitability	3.52	0.56***	0.81	3.58	
	Z.9. Invest in the farm business	4.03	0.75***			
	Z.10. Sell the products in periods of greater difficulty where prices were low	3.41	0.65***			
	Z.11. Cope with changing market conditions	3.38	0.91***			

Note: Mean is based on Likert Scale response: strongly disagree =1, agree = 2, neutral = 3, agree = 4, strongly agree = 5.
*** is significant at the 0.01 level; **significant at the 0.05 level, *significant at the 0.1 level.
Chi^2 value = 283.07, p >0.000

4.4 Path Analysis: Linking Drivers of Farming Strategy with Sustainability Practices.

In this section, we examined the causal relationship between the drivers of farming strategy and adoption of sustainability practices. We checked if our data satisfied the assumption of the SEM: correlation, normality, and goodness of fit. *Table 3* showed a significant correlation between changes in consumers behaviour and access to credit on PSP. While changes in consumer behaviour have a negative correlation, access to credit has a positive correlation. Although none of the regulatory factors has a significant correlation with PSP, our analysis showed a significant correlation between some of the market factors and regulatory factors. This provides the first base in support of our claim that while changes in the market environment could directly impact on the adoption of sustainability practices, while changes in the regulatory environment could influence sustainability through market forces. More so, almost all the constructs have skewness and kurtosis value between -2 and +2, being a sign of univariate normality of the variables.

Furthermore, the goodness of fit estimation of the SEM showed an overall good fitting. The result of the SEM standardized coefficient and their level of significance is presented in *Table 4* and *Fig. 3. Table 4* showed that the p-value of the chi2 is 0.627, the RMSEA is 0.00, SRMR 0.039, CFI 1.00, and TLI 1.062. The final column of the *Table* shows the hypotheses that were supported by the model, while this was represented with bold lines in the *Fig.* Out of the 13 hypotheses, the path coefficients of 10 were found to be statistically significant, implying that our model correctly supported these hypotheses.

Table 3: Correlation Statistics between Drivers of Changes and Sustainability

	PSP	I	II	III	IV	V	VI	Skewness	Kurtosis
PSP	1	-0.05	0.04	-0.22**	0.24**	0.11	0.12	0.10	-1.15
I	-0.05	1	0.38***	0.11	0.39***	0.28**	0.30***	-0.51	-1.79
II	0.04	0.38***	1	0.17	0.32***	0.22**	0.30***	0.74	-1.49
III	-0.22**	0.11	0.17	1	0.25**	0.33***	0.18	-0.29	-1.97
IV	0.24**	0.39***	0.32***	0.25**	1	0.43***	0.38***	1.51	0.28
V	0.11	0.28**	0.22**	0.31***	0.43***	1	0.45***	1.41	-0.004
VI	0.12	0.30***	0.30***	0.18	0.38***	0.45***	1	2.29	3.32

I = Adverse climatic conditions or pests, II = Severe drop in market prices, III = Changes in consumers behaviours, IV = Access to credit for farms consumable inputs, V = Change of the regulations e.g pesticides regulation, VI= Changes in the CAP. ***. Correlation is significant at the 0.01 level (2-tailed); **. at the 0.05 level; *at the 0.10 level.

4.4.1 Market Environment Drivers of Sustainability

Putting this finding in perspective, we consider the hypothesis of a direct relationship between the changes in the market environment and sustainability practices (Hypothesis 1-3). Supporting Hypothesis 1 and 3, the result showed that having access to credit have a causal positive significant association with sustainability practices ($\beta = 0.312$, $\rho = 0.003$), while changes in consumer behaviour have a causal significant negative relationship with farmers sustainability practice ($\beta = -0.295$, $\rho = 0.004$). The model did not support Hypothesis 2, as there was no significant relationship between changes in the market price and sustainability practices ($\beta = -0.011$, $\rho = 0.916$). To discuss why access to credit should have a significant positive impact on the adoption of sustainability practices, we considered the higher cost of shifting towards sustainability practice. Previous research has shown that sustainability practices mean higher production cost, hence it is the winegrowers who have adequate liquidation through credit access that are more likely to change in behaviour towards sustainability adoption (Goodhue, et al., 2004; Santiago & Sykuta, 2016)**.**

Our study shows that a negative change in consumer behaviour could instigate a positive change in sustainability adoption. We define a negative change to be a lower demand for traditional wines in the presence of increasing demand for wines with sustainable labels. It is therefore plausible that farmers would strive to have a sustainability label not only to tap on the growing market of sustainable wines but also to maintain competitiveness in the broader setting. Although market prices are an economic feature that determines farmers supply, it seems not to be a significant factor considered by farmers in the adoption of sustainable wine production. Apparently, the reason for this is that wine is an experience good mostly influenced by reputation, customer loyalty, and recommendation, receiving lesser influence by price (Ashton, 2014). Without a good reputation, premium wine even if it is sustainable may not record a marginal demand. Hence, satisfying the need of customers is paramount to producing premium wines.

4.4.2 Regulatory Environment Drivers of Sustainability

On the regulatory environment side (Hypothesis 4 – 12), our hypothesis specifies that the changes in climate, changes in environmental regulation, and changes in CAP policy would have an indirect impact on sustainability through a change in the market. The result of the SEM showed that changes in CAP policy have a significant co-dependent association with changes in environmental regulation ($\beta = 0.398$, $\rho = 0.000$), thereby supporting Hypothesis 4. Furthermore, while changes in CAP policy was found to positively influence the market price for wine ($\beta = 0.205$, $\rho = 0.05$), it did not have a significant relationship with farmers credit access ($\beta = 0.175$, $\rho = 0.103$). Therefore, Hypothesis 5 was supported but Hypothesis 6 was not. Changes in climatic conditions were found to significantly influence all the path it connects

within the model. It leads to significant direct relationship with changes in CAP policy (β = 0.298, ρ = 0.003), significant changes in environmental regulation (β = 0.283, ρ = 0.005), significant increase in farmers access to credit (β = 0.265, ρ = 0.006), and significant changes in market price for wine (β = 0.320, ρ = 0.001). Hence our model correctly predicted Hypothesis 7, 8, 9 and 10. In furtherance to this, changes in environmental regulation significantly influence farmers access to credit (β = 0.271, ρ = 0.010), and changes in consumers behaviours (β = 0.308, ρ = 0.003), hence supporting Hypothesis 11 and 12. Finally, changes in the market price of wine were not found to significantly influence consumers behaviours. Hypothesis 13 was not supported.

In line with the literature, our model correctly predicts that climate change could influence CAP policy and environment regulations. Studies have shown that the introduction of the greening component in the CAP policy and other environmental laws are a direct reflection of the need to manage climate change (Gaeta & Corsinovi, 2013). Climate change also has a positive significant association with access to credit. This may indirectly lead to farmers adoption of sustainability practices. For instance, during erratic climate change, maintaining adequate copping practices sometimes require that the winegrowers seek for financial assistance. In most cases, financial assistance may be conditioned to the adoption of several conservatories and sustainable practices (Cortignani & Dono, 2015)**.**

Our model showed that changes in environmental regulation have an indirect influence on sustainability by instigating a change in farmers to assess credit and consumers behaviour. While environmental regulation may encourage governments to provide credits to farmers, it could also enhance environmental awareness and concerns of consumers, which may apparently result to a shift in consumer behaviour favouring a higher demand of sustainable wine (Joshi & Rahman, 2015).

Finally, changes in CAP policy specifically may result in changes in market prices, but these changes are not sufficient to influence farmers adoption of sustainable practices. Surprising, our result also demonstrates that changes in CAP policy, in general, have no significant direct impact on farmers access to credit. It, therefore, seems, that the CAP policy does not improve sustainability practices, yet considering that there is a significant co-dependency between changes in CAP policy and changes in environmental condition, it becomes plausible to assert that CAP policy could only influence farmers adoption of sustainability if the policy is related to environmental issues, e.g greening policy. This explanation carefully means that non-greening policies may result in poor sustainability practices among wine growers.

Table 4: Path Analysis Result from the SEM for Testing the Hypothesis

Item	Statement	β	ρ	Hypothesis supported?
Hypothesis 1	Credit access → Sustainability	0.312	0.003***	Yes
Hypothesis 2	Market price → Sustainability	-0.011	0.916	No
Hypothesis 3	Consumer behaviour → Sustainability	-0.295	0.004***	Yes
Hypothesis 4	CAP ↔ Environment regulation	0.398	0.000***	Yes
Hypothesis 5	CAP → Credit access	0.175	0.103	No
Hypothesis 6	CAP → Market price	0.205	0.05*	Yes
Hypothesis 7	Climate → CAP	0.298	0.003***	Yes
Hypothesis 8	Climate → Environment regulation	0.283	0.005***	Yes
Hypothesis 9	Climate → Credit access	0.265	0.006***	Yes
Hypothesis 10	Climate → Market prices	0.320	0.001***	Yes
Hypothesis 11	Environmental regulation → Credit access	0.272	0.010**	Yes
Hypothesis 12	Environmental regulation → Consumer behaviour	0.308	0.003***	Yes
Hypothesis 13	Market price → Consumers behaviour	0.105	0.331	No

*** is significant at the 0.01 level; **significant at the 0.05 level, *significant at the 0.1 level.

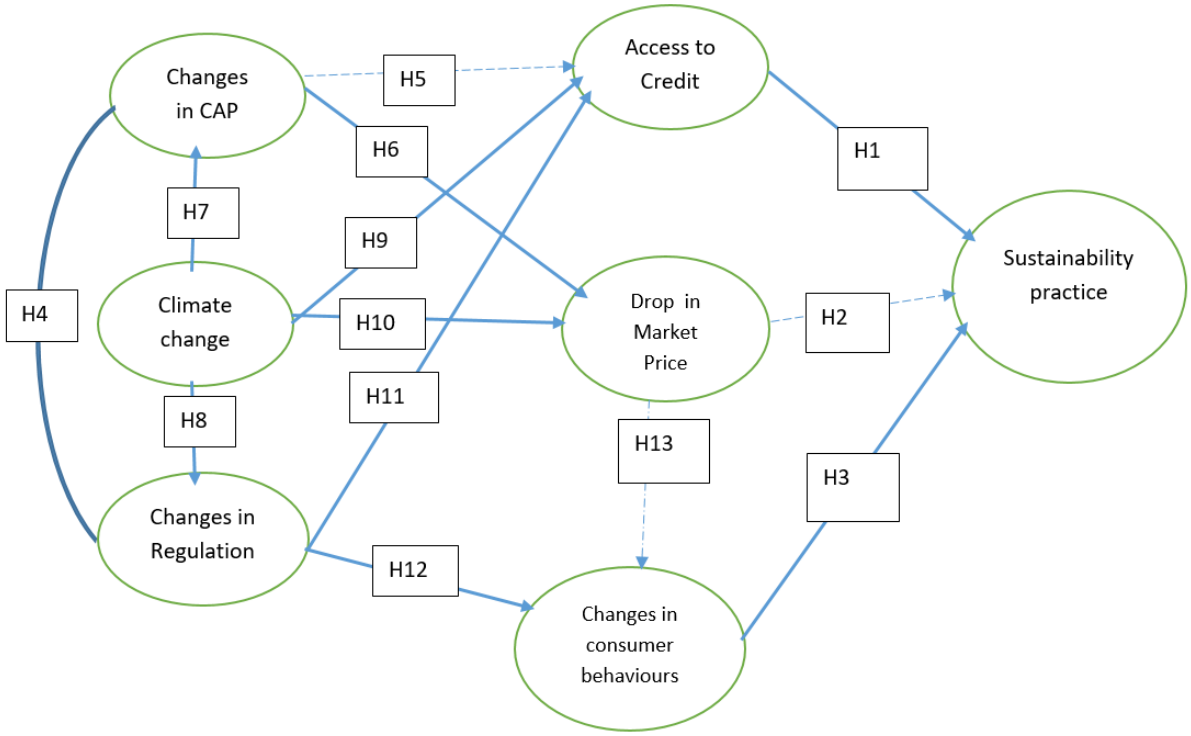

Fig. 3: Result of the Path Analysis of the Hypothesized Model

5 Conclusion

This research aimed to investigate the impact of evolutions in the regulatory and market environment on the adoption of sustainability practices of wine growers. While previous research on wine sustainability focuses on consumers acceptance, the research on the drivers of farmers adoption of sustainability often does not go beyond internal motives such as awareness and income. In particular, we considered adverse changes in climate condition, changes in environmental regulations, changes in agricultural policies such as CAP policy, changes in consumers demand, dropping in market prices of wine, and having access to financial assistance. Among these variables, climate change and change in consumers are the two most important driver of sustainability. Therefore, the variables included in the model were consistent and the hypothetical model was applicable showing a satisfactory fitting in the SEM. A total of 10 out of 13 hypotheses were supported by our model.

We want to understand how changes in the market environment impact on the adoption of sustainability. Here, we hypothesized that access to credit, market price, and consumer behaviour (demand) had an effect on the adoption of sustainability practices. Two hypotheses were confirmed, precisely, access to credit and consumer behaviours were found to have a significant causal association with sustainability. While having access to credit improves farmers liquidity encouraging winegrowers to take up more financial demanding sustainability practices, the negative shift of consumer demand from traditional wines to sustainable wines would likely pull more wine growers towards the adoption of sustainable wine. In other words, if fewer consumers demand sustainability wines, winegrowers may have lesser incentives to shift to sustainability production. Wine price is not a significant factor driving sustainability as growers would rather rely on consumers loyalty than on the market price of sustainable wines.

Further, we examine how regulatory factors including changes in climate, environmental regulation and CAP policy influence the adoption of sustainability practices for wine growers. We hypothesized that these factors would have an indirect impact. Eight out of the ten hypotheses were supported. We observe that changes in climate result in a network of changes that eventually lead to the adoption of sustainability practices. In line with the literature, climate change could influence CAP policy and environment regulations. We also showed that environmental regulations may raise public awareness of environmental issues, which may result in a higher demand for sustainable wine. But the CAP policy could only be sufficient to influence farmers adoption of sustainable practices conditional that policy has some environment management motives.

Although previous studies have shown that production cost is one of the hindering factors towards the adoption of sustainability practices, and invariable farmers would recoup by increasing product prices, our result provides evidence that sustainability practices are possible while keeping product price constant. Winegrowers were found to be capable of responding to the global call for sustainable agricultural practices even without influencing the price of wine. This perhaps may be a peculiar case as wine is an experience good, it, however, draws nuanced thought on wine sustainability research.

The production of sustainable wine improves the competitiveness of winegrowers and allow them to take advantage of the growing international market of sustainable lovers. While sustainability practices may be driven by individual needs due to awareness and maintenance of terroir practices, regulatory policies have a great role to play in pushing towards sustainability. Some policy implication can be drawn from the study. For instance, to influence winegrowers adoption of sustainability practices, it is important in addition to awareness creation to also enact policies that allow conditional incentives for adopters of sustainability practices. Incentive should go beyond credit provision but also creation of enabling platform where producers of sustainable wines and buyers meet. The Toscana BuyWine business-to-business meeting which through information technology and physical meetings provide opportunity for winegrowers to negotiate with international market is recommended. These platforms, remotely or physically can help differentiate wine products, opening more market for wine with green labels.

Environmental policies and indeed the CAP policies that specifically and clearly promote sustainability practices have a good chance of succeeding. This is because winegrowers at least in our study are already sustainability practitioners and have a good level of knowledge of the need and benefit of wine sustainability. Our research provides evidence for larger wine producers. These groups operate or aspire to operate at the international level. Being some sort of innovators in the industries, ensuring that this group adoption sustainability practices may have a diffusion effect on the smaller wine producers. Therefore, the role of large wine producers in trickling done of innovations may be one of the key factors towards the achievement of sustainable development in the wine industry.

Finally, while we follow a multidimensional causal perspective, our general hypothesis maintains external evolutions in a market environment is a direct driver for adoption of sustainability practices, while regulatory changes including climate change would have an indirect impact on the adoption of sustainability practices by triggering changes in the market. We go beyond this limit by presenting a novel approach for calculating sustainability. The percentage Sustainability Practice in its originality allows a systematic approach in assessing comparable sustainability level of farmers in percentage. We hope that the formula provides a direction in the conceptualization of sustainability.

6 Reference

Ashenfelter, O., & Storchmann, K. (2010). Measuring the Economic Effect of Global Warming on Viticulture Using Auction, Retail, and Wholesale Prices. *Review of Industrial Organization*, *37*(1), 51–64. https://doi.org/10.1007/s11151-010-9256-6

Ashenfelter, O., & Storchmann, K. (2016). The economics of wine, weather, and climate change. *Review of Environmental Economics and Policy*, *10*(1), 25–46. https://doi.org/10.1093/reep/rev018

Ashton, R. H. (2014). Wine as an Experience Good: Price Versus Enjoyment in Blind Tastings of Expensive and Inexpensive Wines. *Journal of Wine Economics*, *9*(02), 171–182. https://doi.org/10.1017/jwe.2014.7

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management*, *96*(1), 17–25. https://doi.org/10.1016/j.jenvman.2011.10.006

Bianchi, C. (2015). Consumer Brand Loyalty in the Chilean Wine Industry. *Journal of Food Products Marketing*, *21*(4), 442–460. https://doi.org/10.1080/10454446.2014.885859

Brain, R. G., Hostetler, M. E., & Irani, T. A. (2014). Why do cattle ranchers participate in conservation easement agreements? Key motivators in decision making. *Agroecology and Sustainable Food Systems*, *38*(3), 299–316. https://doi.org/10.1080/21683565.2013.819479

Cacic, J., Kljusuric, J. G., & Schmid, R. (2012). Reform of the Wine Sector in the EU and its Implications in Croatia. *Croatian Journal of Food Technology, Biotechnology and Nutrition 7 (Special Issue)*, *7*, 59–62.

Casas-Cazares, R., Gonzalez-Cossio, F. V., Martinez-Saldana, T., Garcia-Moya, E., & Pena-Olvera, B. V. (2009). Sustainability and the Strategy Used in Smallholding Farming Agroecosystems in Oaxaca Valles Centrales. *Agrociencia*, *43*(3), 319–331. https://doi.org/Article

Cortignani, R., & Dono, G. (2015). Simulation of the impact of greening measures in an agricultural area of the southern Italy. *Land Use Policy*, *48*, 525–533. https://doi.org/10.1016/j.landusepol.2015.06.028

Delmas, M. A., & Gergaud, O. (2014). Sustainable Certification for Future Generations. *Family Business Review*, *27*(3), 228–243. https://doi.org/10.1177/0894486514538651

Flores, S. S. (2018). What is sustainability in the wine world? A cross-country analysis of wine sustainability frameworks. *Journal of Cleaner Production*, *172*, 2301–2312. https://doi.org/10.1016/j.jclepro.2017.11.181

Fraga, H., Malheiro, A. C., Moutinho-Pereira, J., & Santos, J. A. (2012). An overview of climate change impacts on European viticulture. *Food and Energy Security*. https://doi.org/10.1002/fes3.14

Gabzdylova, B., Raffensperger, J. F., & Castka, P. (2009). Sustainability in the New Zealand wine industry: drivers, stakeholders and practices. *Journal of Cleaner Production*, *17*(11), 992–998. https://doi.org/10.1016/j.jclepro.2009.02.015

Gaeta, D., & Corsinovi, P. (2013). *Economics, governance, and politics in the wine market: European Union Developments*. *Economics, Governance, and Politics in the Wine Market: European Union Developments*. New York: Palgrave Macmillan US. https://doi.org/10.1057/9781137395320

Goodhue, R. E., Heien, D. M., Lee, H., & Sumner, D. A. (2004). Contracts and quality in the California winegrape industry. *Review of Industrial Organization*, *23*(3–4), 267–282. https://doi.org/10.1023/B:REIO.0000031371.03322.9e

Hayati, D., Ranjbar, Z., & Karami, E. (2010). Measuring Agricultural Sustainability. In E. Lichtfouse (Ed.), *Biodiversity, Biofuels, Agroforestry and Conservation Agriculture* (Sustainablility, Vol. 19, pp. 73–100). Springer Science+Business Media B.V. https://doi.org/10.1007/978-90-481-9513-8_2

Higgins, L. M., McGarry Wolf, M., & Wolf, M. J. (2014). Technological change in the wine market? the role of QR codes and wine apps in consumer wine purchases. *Wine Economics and Policy*, *3*(1), 19–27. https://doi.org/10.1016/j.wep.2014.01.002

Hinojosa-Rodríguez, A., Parra-López, C., Carmona-Torres, C., Sayadi, S., & Gallardo-Cobos, R. (2014). Certified quality systems and farming practices in olive growing: The case of integrated production in Andalusia. *Renewable Agriculture and Food Systems*, *29*(4), 291–309. https://doi.org/10.1017/S174217051300015X

Joshi, Y., & Rahman, Z. (2015). Factors Affecting Green Purchase Behaviour and Future Research Directions. *International Strategic Management Review*, *3*(1–2), 128–143. https://doi.org/10.1016/j.ism.2015.04.001

Kertész, & Madarász, B. (2014). Conservation Agriculture in Europe. *International Soil and Water Conservation Research*, *2*(1), 91–96. https://doi.org/10.1016/S2095-6339(15)30016-2

Latruffe, L., Diazabakana, A., Bockstaller, C., Desjeux, Y., Finn, J., Kelly, E., … Uthes, S. (2016). Measurement of sustainability in agriculture: a review of indicators. *Studies in Agricultural Economics*, *118*(3), 123–130. https://doi.org/10.7896/j.1624

Malorgio, G., & Grazia, C. (2007). Quantity and quality regulation in the wine sector: The Chianti Classico appellation of origin. *International Journal of Wine Business Research*, *19*(4), 298–310. https://doi.org/10.1108/17511060710837436

Mariani, A., & Vastola, A. (2015, May 8). Sustainable winegrowing: Current perspectives. *International Journal of Wine Research*. Dove Press. https://doi.org/10.2147/IJWR.S68003

Meloni, G., & Swinnen, J. (2012). *The Political Economy of European Wine Regulations*. *LICOS Discussion Paper, No. 320*. Retrieved from http://www.econ.kuleuven.be/licos

Ménard, C., & Valceschini, E. (2005). New institutions for governing the agri-food industry. In *European Review of Agricultural Economics* (Vol. 32, pp. 421–440). https://doi.org/10.1093/eurrag/jbi013

Merino, M. F. (2012). The EU Agricultural Policy – Delivering on Adaptation to Climate Change. In *Building resilience for adaptation to climate change in the agriculture sector: Proceedings of a Joint FAO/OECD Workshop 23–24 April 2012.* (pp. 333–336). Retrieved from http://www.fao.org/docrep/017/i3084e/i3084e23.pdf

Merli, R., Preziosi, S. experiences in the wine sector: toward the development of an international indicators system M., & Acampora, A. (2018). Sustainability experiences in the wine sector: toward the development of an international indicators system. *Journal of Cleaner Production*, *172*, 3791–3805. https://doi.org/10.1016/j.jclepro.2017.06.129

OIV. (2004). *RESOLUTION CST 1/2004 DEVELOPMENT*. *International organization of vine and wine*. Retrieved from http://www.oiv.int/public/medias/2074/cst-1-2004-en.pdf

OIV. (2018). *State of the Vitiviniculture World Market April 2018*. *International Organisation of Vine and Wine*. https://doi.org/10.1016/j.psyneuen.2012.01.003

Pomarici, E., Amato, M., & Vecchio, R. (2016). Environmental Friendly Wines: A Consumer Segmentation Study. *Agriculture and Agricultural Science Procedia*, *8*, 534–541. https://doi.org/10.1016/j.aaspro.2016.02.067

Pomarici, E., & Vecchio, R. (2014). Millennial generation attitudes to sustainable wine: An exploratory study on Italian consumers. *Journal of Cleaner Production*, *66*, 537–545. https://doi.org/10.1016/j.jclepro.2013.10.058

Pomarici, E., Vecchio, R., & Mariani, A. (2015). Wineries' perception of sustainability costs and benefits: An exploratory study in California. *Sustainability (Switzerland)*, *7*(12), 16164–16174. https://doi.org/10.3390/su71215806

Pullman, M. E., Maloni, M. J., & Dillard, J. (2010). Sustainability practices in food supply chains: How is wine different? *Journal of Wine Research*, *21*(1), 35–56. https://doi.org/10.1080/09571264.2010.495853

Recanati, F., Maughan, C., Pedrotti, M., Dembska, K., & Antonelli, M. (2019, February). Assessing the role of CAP for more sustainable and healthier food systems in Europe: A literature review. *Science of the Total Environment*. https://doi.org/10.1016/j.scitotenv.2018.10.377

Rigby, D., & Cáceres, D. (2001). Organic farming and the sustainability of agricultural systems. *Agricultural Systems*, *68*(1), 21–40. https://doi.org/10.1016/S0308-521X(00)00060-3

Rocchi, B., & Gabbai, M. (2013). Territorial identity as a competitive advantage in wine marketing: a case study. *Journal of Wine Research*, *24*(4), 291–310. https://doi.org/10.1080/09571264.2013.837382

Rossi, L., Gancheva, M., & O'Brien, S. (2017). *Financing climate action: opportunities and*

challenges for local and regional authorities. *European Committee of the Regions* (Vol. QG-01-17-9). https://doi.org/10.2863/329600

Santiago, M., & Sykuta, M. E. (2016). Regulation and Contract Choice in the Distribution of Wine. *Journal OfWine Economics*, *11*(2), 216–232. https://doi.org/10.1017/jwe.2015.34

Santini, C., Cavicchi, A., & Casini, L. (2013). Sustainability in the wine industry: key questions and research trends. *Agriculture and Food Economics*, *1*(9), 1–14.

Schmit, T. M., Rickard, B. J., & Taber, J. (2013). Consumer valuation of environmentally friendly production practices in wines, considering asymmetric information and sensory effects. *Journal of Agricultural Economics*, *64*(2), 483–504. https://doi.org/10.1111/1477-9552.12001

Schreiber, J. B., Stage, F. K., King, J., Nora, A., & Barlow, E. A. (2006). Reporting structural equation modelling and confirmatory factor analysis results: A review. *Journal of Educational Research*. https://doi.org/10.3200/JOER.99.6.323-338

Smith, A. (2008). Globalization Within the European Wine Industry : Commercial challenges but producer domination. In *UACES Annual Conference* (pp. 1–3). Retrieved from www.uaces.org

Sogari, G., Mora, C., & Menozzi, D. (2016). Factors driving sustainable choice: the case of wine. *British Food Journal*, *118*(3), 632–646. https://doi.org/10.1108/BFJ-04-2015-0131

Solazzo, R., & Pierangeli, F. (2016). How does greening affect farm behaviour? The trade-off between commitments and sanctions in Northern Italy. *Agricultural Systems*, *149*, 88–98. https://doi.org/10.1016/j.agsy.2016.07.013

Streiner, D. (2005). Research Methods in Psychiatry. Finding Our Way: An Introduction to Path Analysis. *The Canadian Journal Psychology*, *50*(2), 115–122. https://doi.org/10.1177/070674370505000207

Taimalu, M., & Luik, P. (2019). The impact of beliefs and knowledge on the integration of technology among teacher educators: A path analysis. *Teaching and Teacher Education*, *79*, 101–110. https://doi.org/10.1016/j.tate.2018.12.012

Teklewold, H., Kassie, M., & Shiferaw, B. (2013). Adoption of multiple sustainable agricultural practices in rural Ethiopia. *Journal of Agricultural Economics*, *64*(3), 597–623. https://doi.org/10.1111/1477-9552.12011

Zahm, F., Viaux, P., Vilain, L., Girardin, P., & Mouchet, C. (2008). Assessing farm sustainability with the IDEA method - From the concept of agricultural sustainability to case studies on farms. *Sustainable Development*, *16*(4), 271–281. https://doi.org/10.1002/sd.380

Zahrnt, V. (2011). *A Guide to CAP Reform Politics: Issues, Positions and Dynamics*. *ECIPE Working paper*. Retrieved from www.reformthecap.eu.