Uncorking success: exploring the productivity of Italian wine farms

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Abstract

Over the past few decades, Italy's wine industry has shifted from producing low-value, local wines to a modern sector that meets both domestic and international demand. Despite these achievements, the sector faces challenges such as rising production costs, climate change, and a need for enhanced sustainability, particularly affecting small and medium-sized enterprises . This paper investigates the key determinants of productivity across different farm sizes within the Italian wine sector, emphasizing the role of farm size in shaping financial performance. Using data from the Agricultural Accounting Information Network database (2008-2021), the study employs a random-effects regression model to assess the impact of various structural, management, and control variables on wine farm revenues. Findings highlight that large farms benefit more from mechanization, diversification, and the production of processed products, whereas the productivity of smaller farms is driven by organic farming, direct sales, and agritourism. Furthermore, ownership of land has a negative impact on performance across all farm sizes. EU subsidies consistently enhance productivity for all farm sizes, with a stronger effect for smaller farms. The study concludes that tailored management strategies and access to financial support are crucial for enhancing the economic performance and resilience of wine businesses in Italy, particularly small farms.

Keywords: Italian wine farms, productivity drivers, economic size, random-effect regression model

1. Introduction

Over the last decades, the Italian wine industry has transformed from a focus on low-value, local wines to a modern industry meeting both domestic and international demands: moreover, a notable shift from lower to higher quality wine, evidenced by an increase in the proportion of Protected Designations of Origin (PDOs) and Protected Geographical Indications (PGIs) in total output [1], has occurred. Alongside this, Italy has made significant strides in the wine export market, reaching 8 billion euros in 2023, positioning itself second only to France, which boasts 14 billion euros in wine exports [2]. Furthermore, Italy accounts for 9% of the global vineyard area, ranking third worldwide after Spain and France [1]. This widespread presence of vineyards across Italy’s diverse regions, various altitudinal zones, mountainous areas, differentiates Italian viticulture from other traditional wine-producing countries and especially from newer wine-producing nations, where viticulture tends to be concentrated in more limited regions.

Despite these positive trends, the performance of the Italian wine industry is not uniform across the board. While most large companies report positive results, the performance of small farms is more inconsistent, influenced by geographical location, production specialization, and the fluctuating balances of intermediate markets that change annually with harvest sizes [1]. This is further confirmed by data showing that, while overall revenues for wine companies grew during the 2019-2021 period, small businesses saw a decline in their revenue [3]. This volatility is further compounded by inherent complexity of improving productivity within the wine sector, a challenge that is particular evident form small and medium-sized enterprises (SMEs), which dominate the Italian market [4]. For these SMEs, operational efficiencies—such as advanced vineyard management techniques—are crucial for mitigating the disadvantages they face compared to larger firms [5][6]. In this context, high labor costs and fragmented farm structures significantly contribute to the negative returns on investment experienced by many grape wine farms, particularly in quality wine districts [7]. The reliance on labor-intensive technologies and limited economies of scale further undermine profitability, underscoring the urgent need for structural reforms in specific areas. Although some smaller wineries have succeeded in reducing costs, their limited capacity for innovation and collaboration adversely affects their financial performance [8]. Compounding these challenges are external factors, such as rising production costs, potential grape shortages, climate change, and the increasing need for environmental sustainability [9].In light of these challenges, there is a pressing need for more accessible financial resources and supportive frameworks to bolster farm resilience. Strengthening government policies to improve market regulation, particularly through initiatives that enhance access to information, is essential [10]. This analysis of the Italian wine sector highlights the importance of understanding the determinants of economic performance to help the industry tackle both existing and emerging challenges, especially for small wine companies. While numerous studies have explored the relationship between farm size and economic performance, this paper aims to delve deeper into how various drivers influence the productivity of Italian wine companies, with a specific focus on the economic size of the farms. By examining productivity drivers across different economic sizes, this paper seeks to identify the factors that play a key role in determining productivity within varying operational scales. The objective is to identify potential heterogeneities in the factors influencing productivity based on the firm's operational scale. The findings could also offer valuable insights on how firms of different economic sizes can improve their resilience and competitive advantage in the broader market, inform policy interventions, improving the understanding of the interplay between economic farm size, efficiency, and competitiveness in the wine sector, ultimately guiding the future growth and sustainability of Italy’s wine industry.

2. Literature review

The relationship between profitability and farm size in the wine industry is a complex and multifaced issue, with various studies offering both supporting and contrasting perspectives. A general consensus suggests that larger farms tend to achieve higher profitability and productivity, largely due to economies of scale [11] This is supported by findings that show technical efficiency and net farm income improve with greater economic size, further indicating that larger operations are often more financially successful [12] [13]. Furthermore, larger and medium-sized farms often exhibit higher marginal productivity, highlighting a positive relationship between farm size and land productivity [14]. However, this relationship is not always straightforward, as external factors, such as market conditions, can also play a crucial role in determining success [15]. Interestingly, it has been observed that technical efficiency increases with the expansion of farm size up to a certain point. However, beyond a specific threshold, efficiency can actually decline due to the greater labor demands associated with larger operations. This underscores the importance of promoting balanced management and investing in technologies that reduce labor requirements to ensure more sustainable agricultural production [16] [17]. In some cases, research has shown that smaller farms may actually be more efficient than larger ones, due to their ability to operate with fewer resources [18]. Additionally, smaller firms can still achieve strong economic performance by leveraging strategic flexibility and innovative competitive behaviors, rather than relying solely on scale [19][7].This suggests that smaller wineries can thrive through unique marketing strategies and nimble operational models, rather than simply attempting to scale up. Similarly, the economic performance of grape-growing farms is often more influenced by wine selling prices than by farm size, with even larger farms sometimes experiencing low profitability due to unfavorable market conditions [20] Moreover, improving product quality, adopting advanced production technologies, and refining marketing efforts can often result in better performance than simply increasing farm size [5]. Further exploring the determinants of wine firms' performance, Neves et al. [21] present a paradox wherein larger firms exhibit a negative correlation with Return on Assets (ROA) but show positive sales growth. This indicates that while larger size may not guarantee better efficiency metrics, it does enhance market visibility and attractiveness to investors, suggesting that market recognition could be an essential driver of profitability, regardless of operational efficiency. Sellers and Alampi-Sottini [22] reinforce this view, finding a positive correlation between firm size and all performance indicators (profit, productivity, and efficiency), attributing it to larger firms' ability to leverage both real and financial economies of scale. They argue that these firms also benefit from enhanced bargaining power with customers, suppliers, and financial institutions, facilitating easier access to international markets. Such advantages may further entrench the competitive divide between larger and smaller wineries.

Furthermore, Urso et al. [23]found that larger companies, particularly those that process grapes, tend to perform better in terms of efficiency. Additionally, companies focused on quality production tend to exhibit higher efficiency compared to those that target mass-market wines. This suggests that efficiency is not solely determined by farm size but is also influenced by the degree of specialization and the nature of the production process.

In summary, the literature presents a nuanced view of the relationship between farm size and economic performance in the wine industry. While larger farms typically benefit from economies of scale and enhanced market recognition, smaller farms can achieve competitive profitability through strategic innovation and niche marketing. Nevertheless, external economic pressures, structural inefficiencies, and the need for effective policy support continue to be critical factors shaping profitability in the wine industry. Consequently, the comparative analysis of farm size remains significant for both research and agricultural policy [24]. The literature presents various methodologies for measuring economic performance, particularly in agriculture. Traditional indices for assessing profitability include return on assets (ROA), which is often viewed from a managerial perspective, along with return on equity (ROE), return on investment (ROI), and return on sales (ROS). Additionally, specific ratios, such as sales per employee, are utilized to evaluate labor productivity, while the ratio of total costs to total revenue provides further insights into economic efficiency [25] [26]. In the context of wine production, Figurek et al. [27] identify several key indicators of economic performance, including farm net value added (FNVA), FNVA per annually working unit (AWU), farm net income (FNI), and family farm income (FFI/FWU). Additionally, gross value-added indicators have been widely used to assess farm economic performance, providing a broader understanding of value creation within the sector [28].

In our examination of the economic performance of wineries, we have selected productivity, defined as total farm revenue per hours worked, as the dependent variable. This indicator provides a clear view of operational efficiency, as it relates the ability to generate economic value to the labor input. Furthermore, choosing to examine productivity through this indicator enables a more precise understanding of how effectively farms convert their resources into financial output. In an industry like wine production, where variability in resources, technologies, and production methods is significant, analyzing productivity per hours worked provides valuable insights into labor efficiency and optimization across different farm sizes. As discussed in the literature review, several studies have explored the relationship between farm size and economic performance in the wine industry, with varying conclusions. Our study provides a novel contribution by not only investigating whether a relationship exists between economic farm size and economic performance, but also, more importantly, identifying the key factors that significantly influence wine farm performance based on

its economic size. To the best of our knowledge, no existing research has specifically addressed this aspect, making our study both innovative and highly relevant.

3. Methodology

3.1 Conceptual framework

Building on existing literature that establishes a relationship between farm economic size and performance, this study seeks to evaluate the drivers of wine farm productivity in Italy, with farm economic size as a key explanatory factor. We sought to identify and differentiate the factors affecting the productivity of smaller wine farms compared to medium and large enterprises. To this end, we used data from the RICA (Rete di Informazione Contabile Agricola, or Agricultural Accounting Information Network) database, a sample survey conducted across all EU Member States and serves as the sole harmonized European source for farm management data. RICA database provides an unbalanced panel dataset covering the period from 2008 to 2021, encompassing nearly 18,000 observations, each corresponding to a wine farm in a given year. Our analysis employed a random-effects regression model, with Total Farm Revenues per Hours Worked as the dependent variable. Total Farm Revenues includes revenue from both core agricultural activities and supplementary activities, while Hours Worked represents the total labor hours (excluding subcontracted services). the dependent can ensure comparability across farms of different sizes. The explanatory variables include structural characteristics, management factors, and control variables (Table 1).

Table 1 - List of explanatory variables included in the econometric model

Variables	***Group***	***Definition***	***Unit of measure***
Manager gender	structural	Indicates the gender of the farmer	0-1 (0 = Male; 1 = Female)
Young manager	structural	Indicates if the farm is managed by a farmer under 40 years old	0-1 (0 = Farmer > 40; 1 = Farmer < 40)
UAA property index	structural	Indicates the proportion of owned on total UAA in the farm	Absolute value between 0 and 1 (0=farm UAA is totally rented)
EU subsidies	structural	Defines the amount of EU subsidies received by farm	€/YEAR
Mechanization	structural	Defines the KW used in farms/year	KW/YEAR
Diversified production	management	Indicates the presence of supplementary activities in addition to primary production activities in the farm	0-1 (0 = No supplementary activities; 1 = Supplementary activities present)
Organic farming	management	Defines if the farm produces organic products	0-1 (0 = Not organic, 1 = Organic farm)

Agritourism revenues	management	Indicates the amount of revenues derived from agritourism activity	€/YEAR
Subcontracting	management	Indicates the amount of revenues derived subcontracting activity	€/YEAR
Current liabilities	management	Indicates the amount of current liabilities by farm	€/YEAR
Consolidated liabilities	management	Indicates the amount of consolidated liabilities by farm	€/YEAR
Direct sale	management	Defines if the farm has direct sale	0-1 (0 = No direct sale; 1 = Direct sale)
Processed products	management	Defines if the farm processes its products	0-1 (0 = No processed products sold; 1 = Processed products sold)
Altitudinal zone	control	Indicates if the farm is located in mountain-hill-plain	0-1 (0 = the farm is located in the altitudinal zone considered)
Regions	control	Indicates in which Italian region is placed a farm	0-1 (1= the farm is located in the Region considered)
Farm size	control	Indicates the economic farm size (UDE classification): small (revenues ≤ €25,000); medium (revenues €25,000 - € 100,000); large (revenues > €100,000)	0-1(1= the farm belongs to the group considered)

Based on the existing literature (see par. 2), we decided to choose a set of explanatory factors, divided into three distinct groups: structural, management and control variables. Structural variables refer to the characteristics based on the farm structure that are related to its organization and resources. Key structural variables include:

- Age and gender of the farm manager: the demographic characteristics of the farm manager play a crucial role in shaping management styles, risk preferences, and decision-making processes. Research indicates that younger farmers are generally more open to adopting innovative practices and science-based research, essential for ensuring long-term viability and profitability. They require access to robust decision-making tools and high-quality information to effectively implement risk management strategies [29]. Additionally, the gender of the farm manager has been shown to impact farm performance[30].
- Utilized agricultural area (UAA) property index: this index reflects the balance between owned and rented land, indicating whether ownership contributes to technical efficiency or if rented land offers flexibility and access to resources [31].

- EU Subsidies: EU subsidies can constitute a substantial portion of farms' revenues. These subsidies may have both positive and negative effects on efficiency and productivity, particularly in light of policy changes [32].
- Level of mechanization: this variable reflects the extent of machinery and technology use on a farm. Higher mechanization enhances efficiency, lowers labor costs, and boosts productivity. In viticulture, increased mechanization can improve economic sustainability, significantly reducing costs in both flat and steep terrains. Ultimately, enhancing vineyard mechanization can lead to greater economic performance for wine producers [33]

Management variables relate to strategic choices made by each single entrepreneur; they are:

- Diversification: this involves incorporating complementary activities beyond traditional wine production. Diversification not only enhances revenue stability but also fosters resilience in a competitive landscape, ultimately influencing a winery's overall economic success [8].
- Organic farming: the inclusion of a dummy variable for organic farming - indicating either a fully organic winery or the presence of at least one organic product or process - serves as a relevant independent variable for analyzing economic performance. Given the recent challenges faced by wine growers, organic wine represents a promising alternative, often commanding higher market prices [34]; [35].
- Agritourism revenues: agritourism emerges as a significant factor influencing the economic performance of wine farms, offering opportunities for diversification into high-value activities. Moreover, agritourism plays a vital role in engaging the next generation of potential farmers, increasing the likelihood of attracting successors and employing family members, thereby supporting the economic health of the farm [36].
- Subcontracting: leading Italian agro-mechanical associations emphasize the critical importance of subcontracting in modern agriculture. It consistently accounts for a significant share among various support activities and is essential for the survival of small wineries in marginal areas, enabling them to operate more efficiently and sustainably [37].
- Current and consolidated liabilities: they are key factors in ensuring financial stability and facilitating future growth and investment opportunities. Current liabilities can impact cash flow, potentially restricting investments in marketing or product development, which directly affects revenue generation. Conversely, consolidated liabilities often represent long-term investments that can enhance production capacity and expand market reach, ultimately leading to increased revenues.
- Direct sales and processed products: we selected dummy variables for direct sales and processed products to differentiate wineries based on their managerial decisions.

- Finally, to increase the precision and enhance the validity of our analysis, we selected geographical variables as control factors. This choice is particularly relevant given that the Italian wine sector is highly regionalized and significantly influenced by altitude. These geographical variables help ensure that our analysis accounts for the unique characteristics of different wine-producing regions, leading to more reliable results. According to [38, 39, 40], including regional fixed effects allows us to neutralize unobserved heterogeneity arising from systematic differences across regions, such as climate, infrastructure, and market access [1, 41, 42].

3.2 *Case study and data*

Italy has a deep-rooted tradition in viticulture, showcasing a high and diverse production landscape. This includes a wide selection of native grape varieties, advancements in nursery practices, and competitive pricing that strengthens its position in the market. However, over the past 40 years (1982 to 2020), the number of wine-producing farms in Italy has significantly declined, decreasing from over 1.6 million to just 255,000. The decline in the number of wine-producing farms is more pronounced among smaller farms, with the rate of reduction diminishing as the size of the utilized agricultural area (SAU) increases. For instance, according to the most recent ISTAT (National Institute of Statistics) data [43], between 1982 and 2010, farms with less than one hectare decreased by 84%, whereas those with 30 to 50 hectares experienced a smaller decline of 44%. This reduction has been accompanied by a decrease in the total vineyard area, though at a slightly slower pace. Consequently, the average vineyard size has increased from 0.70 hectares in 1982 to 2.46 hectares in 2020, according to the Seventh general agricultural census [44]. Despite this growth, the average size remains relatively small, which continues to be a defining feature of the structure of Italian wine-producing farms. This average size varies regionally, decreasing from north to south: vineyards in the Northwest average 3.19 hectares, those in the Northeast average 3.42 hectares, while in the central regions the average size is 2.25 hectares. In the South, the average vineyard size drops to 1.74 hectares, with vineyards in the islands averaging 2.54 hectares [44]. Building on this observation about the relatively small size of vineyards, another relevant ISTAT statistic highlights that small-scale wine farms, with an economic size of 0-25,000 euros, account for 53% of all wine-producing farms. Medium-sized farms, with an economic range of 25,000-100,000 euros, account for 32%, while the remaining 14% consists of large-scale farms with an economic size exceeding 100,000 euros [44].

3.3 Econometric model

To determine the most appropriate model, we used a stepwise approach and ultimately selected the Random Effects (RE) model. This choice was driven by the unbalanced nature of our panel dataset and the assumption that unobserved differences between units are not correlated with the independent variables. The Random Effects model is particularly beneficial because it allows for the estimation of effects for time-invariant variables, such as control variables, which are excluded in Fixed Effects models. Additionally, we conducted statistical testing and error correction as follows: first, the Breusch-Pagan test confirmed the presence of significant random effects, validating the use of the Random Effects model for managing the panel data structure. The results demonstrated that the variance between units is significantly different from zero, thereby supporting the superiority of the Random Effects model over a pooled OLS (Ordinary Least Squares) model. To address potential heteroscedasticity, we applied robust standard errors. This correction accounts for possible heteroskedasticity and/or correlation within clusters defined by the same farm identifier. As a result, Stata, the software used for this calculation, adjusted the standard errors to account for the cluster structure, thereby enhancing the precision of our statistical estimates.

We analyzed four distinct models based on farm size classifications: small, medium, and large farms; the first model includes all the farms of our database. We estimate Equation (1) first for the entire dataset and then separately for three distinct groups of representative wine farms based on their economic size. The productivity function for the full model takes the following form:

(1) $\text{Log (Prod)} = \beta_0 + \beta_1(\text{Gen}) + \beta_2(\text{Young}) + \beta_3(\text{UAA Property Index}) + \beta_4(\text{EU Subsidies}) + \beta_5(\text{Mechanization}) + \beta_6(\text{Diversified}) + \beta_7(\text{Organic}) + \beta_8(\text{Agritourism Revenues}) + \beta_9(\text{Subcontracting}) + \beta_{10}(\text{Current Liabilities}) + \beta_{11}(\text{Consolidated Liabilities}) + \beta_{12}(\text{Direct Sale}) + \beta_{13}(\text{Processed Products}) + \beta_{14}(\text{Mountain}) + \beta_{15}(\text{Plain}) + \beta_{16}(\text{Medium}) + \beta_{17}(\text{Small}) + j\sum\beta_j(\text{Regions}) + u_i + \epsilon_{it}$

where: Log(Prod) is the dependent variable, representing the logarithm of total farm revenues per hour worked; β_0 is the intercept (or constant term); β_1 to β_{17} are the coefficients corresponding to the independent variables; u_i represents the random effect associated with the *i*-th wine farm; and ϵ_{it} is the idiosyncratic error term. The categories "Hill" and "Large" are omitted from the equation as they serve as the reference groups for the altitudinal zone and economic dimension, respectively. The use of the natural logarithm of the dependent variable (Log(Prod)) is applied to normalize the distribution of farm revenue per hour worked. This transformation helps to linearize the relationships between the dependent and independent variables and to mitigate any potential skewness in the data. Additionally, taking the logarithm allows for the interpretation of coefficients in terms of percentage changes, making the results easier to interpret in economic terms, especially when considering elasticities of production and scale.

4. Results

After outlining the general structure of the Italian wine sector and describing the conceptual framework and econometric model we will proceed by presenting the descriptive statistics of the specific variables chosen for analyzing the economic performance of Italian wine farms. This analysis will provide a more comprehensive view of the sector's structure based on the economic size of the businesses. Table 2 presents the complete descriptive statistics for the explanatory variables.

Table 2 - Descriptive statistics of explanatory variables used in the regression model

Variable	***All***		***Large***		***Medium***		***Small***	
	mean	**SD**	**mean**	**SD**	**mean**	**SD**	**mean**	**SD**
Manager gender	0.23	0.42	0.16	0.37	0.24	0.43	0.31	0.46
Young manager	0.12	0.33	0.13	0.34	0.13	0.33	0.09	0.29
UAA property index	0.66	0.41	0.63	0.40	0.66	0.41	0.72	0.41
EU subsidies	3212.33	9033.60	7012.12	14620.62	1733.60	3717.90	636.93	1423.03
Mechanization	142.13	216.51	230.39	196.55	109.40	73.43	77.30	410.15
Diversified production	0.10	0.30	0.16	0.36	0.09	0.28	0.05	0.21
Organic farming	0.12	0.33	0.17	0.37	0.11	0.31	0.07	0.26
Agritourism revenues	2878.64	28170.25	5960.67	47326.89	1705.98	12208.86	707.24	6241.70
Subcontracting	427.43	6090.31	1081.30	10554.64	148.30	1754.39	60.33	1136.75
Current liabilities	16720.25	124953.00	40952.00	214163.90	6665.66	41181.35	2222.69	10355.12
Consolidated liabilities	14971.69	176200.60	36943.43	306251.30	5968.99	46460.98	1474.25	31507.79
Direct sale	0.16	0.37	0.22	0.41	0.14	0.35	0.12	0.33
Processed products	0.51	0.50	0.59	0.49	0.49	0.50	0.45	0.50
Altitudinal zone								
Plain	0.28	0.45	0.31	0.46	0.26	0.44	0.28	0.45
Hill	0.59	0.49	0.64	0.48	0.59	0.49	0.51	0.50
Mountain	0.13	0.33	0.05	0.22	0.15	0.35	0.21	0.41

The table provides a comprehensive overview of variables related to farm size (All farms, Large, Medium, Small). Small farms have a higher proportion of female managers, with 32% of small farm managers being women, compared to 24% in medium-sized farms and 16% in large farms. The proportion of managers under 40 years old is relatively similar across large and medium-sized farms but is notably lower in small farms. The index of UAA property ownership in small firms is the

highest (mean = 0.72), suggesting they own a larger portion of utilized agricultural area. Large firms benefit from significantly higher EU subsidies compared to medium and small firms. The highest mechanization level is evident in large firms and the lowest is found in small firms. Diversification and organic farming are more prevalent in large firms, while small firms exhibit limited diversification and a lower adoption of organic practices. Large firms also generate higher agritourism revenues, engage more in subcontracting, and bear significantly higher current and consolidated liabilities, indicating greater financial exposure. The presence of direct sales and processed products on the farm is more common in larger firms. In mountainous areas, the prevalence of small firms is significant with respect to other altitudinal zones. Overall, large firms exhibit greater resources, diversification, and mechanization, while small firms remain more constrained in economic and diversification capacities. The descriptive statistics outlined above provide an initial understanding of the explanatory variables; however, to gain deeper insights, we now turn to the results of the econometric model, which will help explain and interpret these statistics more effectively.

The general model clearly shows that the control variables associated with the economic size of the companies yield significant results. This supports our decision to further investigate each specific category of farms in detail.

Table 3 - Regression of productivity (Total farm revenues/Hours worked) of Italian wine farms regarding economic size – random-effects modelling

Variable	***All***	***Large***	***Medium***	***Small***
Manger Gender	-0.098***	-0.047	-0.064**	-0.054
	(0.22)	(0.041)	(0.025)	(0.036)
Young manager	-0.027	-0.047	0.003	0.096
	(0.024)	(0.038)	(0.027)	(0.070)
UAA property index	-0.154***	-0.063	-0.103***	-0.146**
	(0.023)	(0.039)	(0.029)	(0.051)
EU subsidies	8.69E-06***	5.20E-06***	2e-05***	6.49E-05***
	(0.000)	(0.000)	(0.000)	(0.000)
Mechanization	8.06E-05	3.954E-04***	0.001***	-7.46E-05***
	(0.000)	(0.000)	(0.000)	(0.000)
Diversified production	0.189***	0.110**	0.095*	0.037
	(0.034)	(0.043)	(0.044)	(0.098)
Organic farming	0.117***	0.053	0.123***	0.154*
	(0.024)	(0.034)	(0.033)	(0.062)
Agritourism revenues	1.55E-06***	1.03E-06**	4.53E-06***	1.57E−05***
	(0.000)	(0.000)	(0.000)	(0.000)
Subcontracting	-9.96E-07	-1.46E-06	1.24E-05***	2.82E-05***
	(0.000)	(0.000)	(0.000)	(0.000)
Current liabilities	2.61E-07*	1.85E-07	3.00E-07*	2.22E-06.
	(0.000)	(0.000)	(0.000)	(0.000)
Consolidated liabilities	3.78E-09	-1.22E-09	6.48E-08	-1.32E-07
	(0.000)	(0.000)	(0.000)	(0.000)
Direct sale	0.027*	-0.014	0.041*	0.095**
	(0.013)	(0.019)	(0.018)	(0.037)

Processed products	0.169***	0.178***	0.135***	0.163***
	(0.018)	0.030	(0.025)	(0.036)
Altitudinal zone				
Hill	0	0	0	0
Mountain	0.062	-0.106	0.11	0.137
	(0.060)	(0.130)	(0.071)	(0.104)
Plain	0.047	0.038	0.047	0.111*
	(0.025)	(0.041)	(0.031)	(0.055)
Regions	X	X	X	X
Economic dimension				
Large	0	-	-	-
Medium	-0.313***	-	-	-
	(0.022)			
Small	-0.676***	-	-	-
	(0.030)			
Observation	17976	5666	92959	30156
Groups	4308	1519	2477	957
R-squared in between	0.4288	0.2140	0.2076	0.3460

Note: Standard errors in parentheses. The "Regions" variable was introduced as a control variable to verify the stability of the regression in the four different models. The goal is not to explain regional differences: Regions are included to ensure that the estimates of the other explanatory variables are more precise and robust by accounting for unobserved territorial heterogeneity.
*p<0.05; **p<0.01; ***p<0.001

Several key findings emerge from the results: concerning structural variables, the UAA property index shows a significant negative relationship with productivity, particularly for small and medium farms, with the strongest effect observed on small farms (-0.146) and medium farms (-0.103), while it is not significant for large farms. EU subsidies are positively associated with revenues per hour worked across all firm sizes, with the effect being more pronounced for small firms. Mechanization is positively associated with revenues for large and medium firms but shows a negative relationship with productivity on small firms, which may lack the resources or capacity to implement it efficiently. Regarding the second category, specifically the management variables, it can be observed that both diversification and organic farming are positively related to productivity. Larger and medium-sized firms see notable benefits from diversification strategies. In contrast, medium-sized and particularly small firms exhibit more substantial productivity improvements through the adoption of organic farming practices. Agritourism shows a positive relationship with total revenue per hours worked for farms of all sizes, with small ones experiencing the largest gains. Subcontracting is positively associated with the productivity of medium and small farms, with current liabilities also having a modest impact on the productivity of medium-sized farms. In contrast, consolidated liabilities do not exhibit any significant effect in our regression analysis. Additionally, both direct sales and processed products exhibit a positive relationship with productivity across farms, with varying impacts depending on farm size. Direct sales are significantly associated with higher productivity for medium

and small farms but have no significant effect on larger farms. In contrast, processed products have a strong, positive relationship on productivity across all farm sizes, regardless of economic scale.

As anticipated in Section 3.1, the variable Regions was included in the model to account for territorial heterogeneity. The coefficients associated with the regional dummies are mostly positive, with the exception of Calabria for large farms and Piedmont for small ones. However, these results should be interpreted with caution, as they are strongly influenced by the sample composition. The sampling design of the RICA survey relies on a stratified random procedure, which results in an unbalanced distribution of observations across regions. Consequently, directly interpreting the coefficients of the Regions variable may lead to biased conclusions, as these estimates may reflect sampling disparities rather than genuine territorial effects.

5. Discussion

The findings from the random effects regression model provide valuable insights into the productivity of Italian wine companies. The results reveal several nuanced factors that show a positive or negative relationship with productivity across different types of farms, highlighting the importance of tailored strategies for each business. First, the negative relation between property ownership and productivity growth highlights the potential inefficiencies in land management, encouraging wine farms to reevaluate their real estate strategies. In fact, as demonstrated by Bojnec and Latruffe [31], renting land can be more efficient, as it allows farms to focus on improving technical efficiency without being burdened by the costs and inflexibilities associated with property ownership. This reinforces the need for wineries to consider alternative land arrangements, especially as renting can often lead to better resource allocation and operational flexibility. The significant advantages of EU subsidies for smaller firms underscore the crucial role of external financial support in improving their competitiveness in the market. This trend is also noted by Kryszak et al. [25], who found that the proportion of subsidies relative to farm revenue is greater among small and medium-sized farms, gradually decreasing for larger operations. This finding emphasizes the critical role subsidies have in leveling the playing field, particularly for smaller businesses that may otherwise struggle to compete with larger, more capital-intensive enterprises. Mechanization shows a distinct impact based on farm size. The significant positive coefficient for mechanization in large farms, contrasted with the negative coefficient in small farms, highlights how these businesses utilize technology differently. Larger firms can capitalize on advanced machinery to improve operational efficiency and productivity, leading to increased profitability. In contrast, smaller farms frequently face a shortage of suitable equipment, which limits their capacity to mechanize effectively and ultimately reduces their productivity. Thus, mechanization poses a substantial challenge for small farms [45]. This difference with large farms highlights the

need for policy interventions or financial support to help small wine farms invest in the necessary technology to remain competitive. The positive effects of diversification and organic farming across all firm sizes underscore the importance of these strategies in adapting to market demands and enhancing financial resilience. Notably, organic viticulture proves to be especially advantageous for small-scale wine farms, highlighting the significant economic benefits that organic practices can offer in this context [46]. This finding suggests that organic farming is not only a sustainable choice but also an economically viable strategy for small-scale wine producers looking to differentiate themselves in a crowded market. Agritourism emerges as a particularly advantageous avenue for small firms, enabling them to diversify income streams and capitalize on their local appeal [47] [48]. The role of subcontracting in boosting productivity for smaller companies illustrates the significance of accessing specialized skills without incurring substantial overhead costs. Furthermore, the significant impact of direct sales on small (and, to a lesser extent, medium) farms, contrasted with the lack of significance for large farms, indicates that stronger consumer relationships can result in higher profit margins [49]. This presents an advantage that larger farms may struggle to replicate. . Overall, this study, which focused on analyzing productivity within the Italian wine sector, emphasizes the critical importance of strategic management and structural decisions. It underscores how these decisions must be tailored, considering the economic size of the farms. The findings suggest that a one-size-fits-all approach is insufficient. This study provides valuable insights for practitioners within the sector and offers a guide for stakeholders to better understand which strategic decisions may be most effective based on the economic characteristics of each farm. Additionally, it lays the foundation for future research, encouraging further exploration into how tailored management practices can enhance productivity in viticulture more broadly.

6. Conclusions

6.1 Theoretical implications of the results

This paper aimed to explore the factors that most significantly impact productivity within different farm size categories and to determine the sources of competitive advantage. The findings contribute to the theoretical understanding of productivity drivers in the Italian wine sector by highlighting the distinct roles of farm size and entrepreneurial characteristics. The contrasting impact of younger entrepreneurs on small versus large firms supports existing theories of innovation in viticulture, as they bring creativity and responsiveness to market demands. Additionally, the negative correlation between property ownership and revenues per hour worked suggests inefficiencies in land management, reinforcing the idea that leasing may enhance technical efficiency. Moreover, the significant role of EU subsidies for smaller firms underscores the importance of external financial support in achieving competitive advantage. Finally, the varying impacts of mechanization indicate

that while larger firms benefit from advanced technology and mechanization, smaller farms face barriers to effective mechanization. Ultimately, the findings suggest that focusing on improving productivity is not just about increasing output but about developing more sustainable, efficient, and profitable agricultural practices. This approach enables farms to remain competitive in an increasingly complex market, while also contributing to the broader goal of long-term economic sustainability in the Italian wine sector.

6.2 Practical implications of the results

The findings of this study present significant practical implications for both policymakers and wine makers within the Italian wine sector, providing insights into which factors should be prioritized in strategic planning to enhance firm performance. For policymakers, the crucial role of EU subsidies underscores the importance of ensuring that financial support is effectively directed toward smaller firms, where it can have the most substantial impact on productivity. The Common Agricultural Policy (CAP) 2023-2027 specifically addresses this need by redistributing income support. The EU mandates that at least 10% of direct payments from EU member states must be allocated to the redistributive income support tool, targeting small and medium-sized farms to meet their income needs more effectively. This strategy ensures that the most vulnerable sectors, including smaller wine producers, receive the support necessary for sustainable development and growth. By streamlining application processes and expanding funding opportunities, policymakers can strengthen the competitiveness of these businesses and promote sustainable viticultural practices. Additionally, policies that facilitate land leasing arrangements could enhance operational efficiency and productivity for wine producers, thereby challenging traditional notions of property ownership in agriculture. Moreover, the CAP 2023-2027 includes specific provisions to support the viticulture sector, which are crucial for helping producers meet evolving challenges. For wine makers, particularly those managing smaller farms, the results emphasize the critical importance of innovation and diversification in improving productivity. Adopting organic farming practices and exploring agritourism can provide valuable alternative income streams while aligning with evolving consumer preferences for sustainability. Furthermore, younger entrepreneurs should be encouraged to harness their creativity and responsiveness to market demands by integrating new technologies into their operations. Overall, it is essential for both policymakers and wine makers to recognize the multifaceted nature of productivity enhancement and adapt their strategies accordingly to thrive in an increasingly competitive market.

6.3 Limitations

While this study offers valuable insights, it is not without limitations. The reliance on quantitative data may overlook qualitative factors influencing farm performance. Additionally, the study utilizes an unbalanced panel database, resulting in a relatively limited number of distinct firms, with not all companies providing data for every year included in the panel. Consequently, future research would benefit from a larger and more diverse sample of companies. Furthermore, the analysis is primarily focused on Italian wine companies, which may restrict the generalizability of the findings to other countries or agricultural sectors. Finally, the analysis predominantly captures current conditions; therefore, potential future shifts in market dynamics or policy landscapes may not be fully accounted for.

6.4 Future steps

Addressing these limitations in future research will enhance the understanding of productivity within the wine sector and beyond. Future research should delve deeper into each factor contributing positively to the economic performance of wine farms to understand precisely how they influence productivity. This includes investigating the specific mechanisms by which diversification, organic farming, mechanization, and agritourism enhance efficiency and output. Additionally, examining the interplay between agritourism and productivity would be valuable for understanding how small firms can diversify their income streams. Longitudinal studies could also shed light on how these dynamics evolve over time, especially in light of climate change and its effects on vineyards.

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Variable	*All*	*Large*	*Medium*	*Small*
Manger Gender	-0.098***	-0.047	-0.064**	-0.054
	(0.22)	(0.041)	(0.025)	(0.036)
Young manager	-0.027	-0.047	0.003	0.096
	(0.024)	(0.038)	(0.027)	(0.070)
UAA property index	-0.154***	-0.063	-0.103***	-0.146**
	(0.023)	(0.039)	(0.029)	(0.051)
EU subsidies	8.69E-06***	5.20E-06***	2e-05***	6.49E-05***
	(0,000)	(0.000)	(0.000)	(0.000)
Mechanization	8.06E-05	3.954E-04***	0.001***	-7.46E-05***
	(0.000)	(0.000)	(0.000)	(0.000)
Diversified production	0.189***	0.110**	0.095*	0.037
	(0.034)	(0.043)	(0.044)	(0.098)
Organic farming	0.117***	0.053	0.123***	0.154*
	(0.024)	(0.034)	(0.033)	(0.062)
Agritourism revenues	1.55E-06***	1.03E-06**	4.53E-06***	1.57E–05***
	(0.000)	(0.000)	(0.000)	(0.000)
Subcontracting	-9.96E-07	-1.46E-06	1.24E-05***	2.82E-05***
	(0.000)	(0.000)	(0.000)	(0.000)
Current liabilities	2.61E-07*	1.85E-07	3.00E-07*	2.22E-06.
	(0.000)	(0.000)	(0.000)	(0.000)
Consolidated liabilities	3.78E-09	-1.22E-09	6.48E-08	-1.32E-07
	(0.000)	(0.000)	(0.000)	(0.000)
Direct sale	0.027*	-0.014	0.041*	0.095**
	(0.013)	(0.019)	(0.018)	(0.037)
Processed products	0.169***	0.178***	0.135***	0.163***
	(0.018)	0.030	(0.025)	(0.036)
Altitudinal zone				
Hill	0	0	0	0
Mountain	0.062	-0.106	0.11	0.137
	(0.060)	(0.130)	(0.071)	(0.104)
Plain	0.047	0.038	0.047	0.111*
	(0.025)	(0.041)	(0.031)	(0.055)
Regions				
Abruzzo	0	0	0	0
Alto Adige	0.628***	0.485**	0.615***	0.705***
	(0.088)	(0.182)	(0.107)	(0.157)
Basilicata	0.196*	0.340	0.223*	0.046
	(0.095)	(0.272)	(0.106)	(0.105)
Calabria	0.184	-0.683***	0.288**	0.705***
	(0.104)	(0.119)	(0.106)	(0.193)
Campania	0.241***	0.130	0.184**	0.508***
	(0.055)	(0.142)	(0.059)	(0.085)
Emilia Romagna	0.388***	0.381***	0.496***	0.147
	(0.047)	(0.078)	(0.058)	(0.090)
Friuli Venezia Giulia	0.417***	0.235***	0.438***	0.235*
	(0.041)	(0.072)	(0.049)	(0.101)
Lazio	0.172*	0.079	0.212*	-0.039
	(0.068)	(0.108)	(0.086)	(0.142)
Liguria	0.742***	0.460***	0.924***	0.844***
	(0.060)	(0.126)	(0.101)	(0.079)
Lombardia	0.292***	0.009	0.419***	0.273*
	(0.062)	(0.118)	(0.075)	(0.125)

Marche	0.028	-0.144	0.091	-0.079
	(0.053)	(0.085)	(0.072)	(0.090)
Molise	0.206***	-0.111	0.229***	0.263*
	(0.041)	(0.077)	(0.048)	(0.107)
Piemonte	0.166**	0.086	0.174*	-0.237*
	(0.055)	(0.079)	(0.071)	(0.102)
Puglia	0.459***	0.001	0.524***	0.690***
	(0.042)	(0.081)	(0.050)	(0.082)
Sardegna	0.190***	0.047	0.357***	0.007
	(0.054)	(0.099)	(0.062)	(0.096)
Sicilia	0.118**	-0.099	0.149**	0.193**
	(0.040)	(0.075)	(0.048)	(0.074)
Toscana	0.163***	-0.010	0.112*	-0.105
	(0.043)	(0.068)	(0.056)	(0.120)
Trentino	0.528***	0.194	0.592***	0.788***
	(0.071)	(0.151)	(0.084)	(0.135)
Umbria	0.158***	-0.013	0.103	-0.124
	(0.056)	(0.082)	(0.076)	(0.126)
Valle D'Aosta	0.375***	0.729*	0.538***	0.279*
	(0.088)	(0.315)	(0.113)	(0.128)
Veneto	0.419***	0.253***	0.384***	0.343***
	(0.044)	(0.078)	(0.052)	(0.086)
Economic dimension				
Large	0	-	-	-
Medium	-0.313***	-	-	-
	(0.022)			
Small	-0.676***	-	-	-
	(0.030)			
Observation	17976	5666	9295	3015
Groups	4308	1519	2477	957
R-squared in between	0.4288	0.2140	0.2076	0.3460

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