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Farm characteristics determine why a large share of organically produced wine is not labelled as organic

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Abstract

Organic agricultural production is increasing globally and is of high policy relevance, particularly in Europe. Various measures incentivize farmers to adopt organic practices, such as direct payments and labelling. We here address a rarely considered aspect of organic production, that not all organic producers in Europe opt for organic labelling for their products at the point of sale. We investigate the discrepancy between organic production and labelling in Swiss viticulture. Out of 115 grapevine growers who adhere to organic principles in production, 43.5% do not use organic labelling when marketing their wines. We find that especially farms using alternative labelling strategies (e.g. for fungus-resistant varieties), smaller farms and farms less specialized in viticulture to be more likely to forgo organic labelling. We draw conclusions for policy and science. For example, our findings show that there may be, for some crops, more organic products on shelves than indicated from sales statistics of organically labelled products. The use of statistics that indicate the share of sales of organic products for specific products and food sales at large may thus be misleading.

1. Introduction

Organic agricultural production is on the rise globally, and especially in Europe (Stolze and Lampkin 2009, Reganold and Wachter 2016, Willer *et al* 2023). The European Union aims to expand the share of organic land to 25% by 2030 within their Farm to Fork Strategy (Schebesta and Candel 2020, Moschitz *et al* 2021, Willer *et al* 2023). Policy makers in several countries use various measures to incentivise farmers' adoption of organic farming practices, e.g. using agri-environmental payments (Rees *et al* 2023). In addition, organic producers can benefit from private price-markups, i.e. third-party certification and labelling. However, not all farmers that produce organic are certified. The non-certification of organic farming practices is known to be prevalent in low income countries or for resource-poor farmers, e.g. due to the high costs or lack of incentives to do so (e.g. Cáceres 2005, Goldberger 2008, Wanjiku Kamau *et al* 2019, Zhu and Habisch 2019, Seufert *et al* 2023). Less is known about this phenomenon and its causes in European agriculture.

We here investigate the mismatch of organic production and labelling in Swiss grapevine production and the underlying determinants. More specifically, we examine whether grapevine growers who cultivate their grapes with organic production principles also use the organic label when marketing their wines. We survey 436 grapevine growers in Switzerland, out of which 115 comply with organic production standards and quantify how many do not use organic labelling. We investigate which farm- and farmer-specific factors correlate with the downgrading of organic production (i.e. organic production without organic labelling). Switzerland, ranking among the countries with the highest share of certified organic viticultural land, offers a prime case study to explore factors influencing organic production downgrading using comprehensive countrywide data (OIV 2021).

Previous literature especially focussed on the uptake of organic production systems and its determinants (e.g. Läpple and Rensburg 2011, Läpple and Kelley 2013, Veldstra *et al* 2014). However, there is limited literature that assesses whether organic farms also use the corresponding label when selling the agricultural product. The scarce previous research in this field has two perspectives. First, previous research used the market perspective, e.g. by using hedonic pricing models to estimate price premia of organic production without organic labelling (e.g. Delmas and Grant 2014,

Abraben *et al* 2017, Fanasch and Frick 2020). The phenomena of downgrading organic production was found to be especially relevant for high value crops such as grapevines, where organic labelling may not be price enhancing, e.g. because other attributes are more relevant for the buying decision (e.g. Delmas and Grant 2014). For instance, Delmas and Grant (2014) show that consumers exhibit no additional willingness to pay for wines with eco-labels, but certified yet unlabelled wines command a notable price premium. Similarly, Abraben *et al* (2017) confirm this finding that wines produced with organic practices but not organic labelled fetch higher prices than conventional counterparts. However, they show that this only holds true for wines with low quality ratings. As quality ratings increase, this price advantage diminishes so that for high-quality rated wines, both organic practices and labelling are associated with lower prices than comparable conventional wines. Second, there are two previous papers that identified farmer- and farm characteristics and their effect on whether farms align the production system choice with their labelling strategy (Flaten *et al* 2010; Veldstra *et al* 2014).[3] Using data from Norwegian livestock and arable crop farms who ceased certified organic production, Flaten *et al* (2010) find that especially direct marketers continue to manage their livestock and cultivate the arable crops organically without using the organic label. Similarly, Veldstra *et al* (2014) find that US fruit and vegetable producers employing organic practices and engaging in direct marketing are less inclined to seek certification. We here address two gaps in the literature. First, we add to the literature on non-labelling of organic production in European agriculture and grapevine production. The production of grapevines is of high economic relevance in European agriculture, representing the third most important crop (FAO 2022, Finger *et al* 2023, Zachmann *et al* 2024). Second, we identify characteristics of grapevine growers who chose to not label their organic production.

We find that 43.5% of the grapevine growers in our sample of organic growers (N = 115) downgrade the production, that is they use organic production principles without using organic labelling. We find that farm characteristics determine this choice. Specifically, smaller farms with less employed standardized labour as well as farms which draw most of their income from non-farming activities (e.g. work outside the farm) are more likely to produce according to organic principles but do not use the organic label when marketing the wines. Similarly, farms which draw the majority of farming income from non-viticultural sources (e.g. cultivate also arable crops) are more likely to downgrade their organic production. Moreover, we find that farms that abstain from using organic labelling are more likely to use alternative but still production system related labels (e.g. label or terms for fungus-resistant varieties).

The remainder of the paper is structured as follows. We first provide background on organic viticulture and organic labelling as well as the conceptual framework motivating reasons why organic production and labelling may be mismatched in section 2. Then, we present the econometric methods in section 3 and the data used in section 4. Section 5 presents results and section 6 discusses them. We conclude in section 7 with implications for policy and science.

2. Background and conceptual framework

2.1. Background on organic viticulture

Organic or biodynamic viticulture refers to the practice of growing grapes for wine production using organic or biodynamic farming principles and techniques.[4] We refer to organic viticulture, including both organic and biodynamic principles, as they share similar foundations (e.g. Steinemann *et al* 2022). Switzerland ranks globally among the countries with the highest shares of viticultural land under organic production (OIV 2021). Organic viticulture favours the use of management practices over external inputs from off-farm sources (e.g. pesticides), both in the vineyard and winery (Provost and Pedneault 2016). This approach relies primarily on agronomic, biological, and mechanical methods rather than synthetic materials (FAO 1999).

Pest and disease management is a key challenge in organic viticulture (Merot *et al* 2020). Without adequate pest management, yield losses in organic viticulture can be substantial (e.g. Guesmi *et al* 2012, Fermaud *et al* 2016). Fungal pathogens pose the greatest threat to grapevine yields. Around 80% of all pesticides used in viticulture are fungicides sprayed against mainly downy and powdery mildew and grey rot (Merot *et al* 2020, Zachmann *et al* 2024).

To counter fungal infestations, organic grapevine growers rely predominately on copper- and sulphur-based fungicidal mixtures. To do so successfully, organic grape production requires more spray treatments compared to integrated pest management which comes at substantially higher costs for pest management from machine, labor and product requirements (Linder *et al* 2006).[5] Instead of relying on treatment-oriented methods like copper-based

[3] Literature documents that consumers are willing to pay price premia on ecologically labelled wines, however at heterogenous levels with some consumers disliking eco-labelled wines (Lim and Reed 2020).

[4] Organic viticulture encompasses 4.5% of the global grape-growing area, with Europe hosting the majority of organic viticultural land (Döring *et al* 2019).

[5] Especially copper-based substances have been criticized for their adverse effects on the environment (Komárek *et al* 2010, Mackie *et al* 2012). Despite the yearly limit of 6 kg per hectare in European organic agriculture, the overall use of copper-based fungicides remains significant in organic viticulture (Mackie *et al* 2013). As a result, copper concentrations in many wine regions around the globe exceed legislative thresholds (Komárek *et al* 2010).

Table 1. The focus of this paper.

		Labelling organic production (step 2)	
		Yes	No
Complying with organic production standards (step 1)	Yes	The 'standard' case	The focus of this paper
	No	Not possible	Non-organic production

pesticides, organic growers often opt for cultivating grapevines that are more resistant to fungal infestations (Pedneault and Provost 2016, Finger *et al* 2023).

Growers can be compensated for their higher production costs in organic viticulture via two means. First, direct payments are paid for organic producers that meet the federal ordinance on organic agriculture (SR 910.18) which closely aligns with the European rules on organic farming (EU 2018/848).[6] Farms adhering to federal organic standards are prohibited from using organic labelling. Second, growers can certify as organic producers via homogenized private standards that set stricter rules than the federal ordinance (Döring *et al* 2019, Steinemann *et al* 2022).[7] However, the organic label on wine has been linked to lower quality perceptions (Delmas and Lessem 2017, Maesano *et al* 2021). Moreover, other labels that relate to the production system can be used by farms, such as Delinat[8] (a private production method requiring organic production principles), Fair & Green[9] (a private production process that requires integrated pest management), and PIWI (a label and term used to identify fungus-resistant varieties which require considerably fewer fungicides).

2.2. Conceptual framework

Credence goods, like organic food, suffer from high information asymmetry, making it hard for consumers to verify promised characteristics (Janssen and Hamm 2012). Labelling aims to bridge the information asymmetry between producers and consumers by offering credible information about the production system and a product's environmental and human health attributes (Crespi and Marette 2005). However, producers employing a specific production system might use different strategies for communicating the systems' attributes to consumers.

The decision whether to use the corresponding label of the production system is conditional on the uptake of the underlaying production system. For example, a farm can only use the organic label when it is certified organic, i.e. cultivates the crop according to organic principles (step 1 in table 1). There are many factors that are relevant for the choice of a specific production system, including direct payments paid for organic production. However, even when a specific production system is employed, farms might decide not to label the agricultural product or label it with a different label. This decision, to label or not to label (step 2 in table 1), is based on farmers' perception of the costs and benefits of using the label (Veldstra *et al* 2014).[10]

Labelling costs and benefits are many-fold. For instance, labelling comes with certification costs (e.g. administration) by the certifying body which may be unattractive for some (e.g. small or unspecialized) producers (Dabbert *et al* 2014, Veldstra *et al* 2014).[11] Labelling might also come with reputative costs such that wineries may think that there is a negative image associated with e.g. organic wine (Delmas and Grant 2014). Thus, using an alternative labelling strategy may be more attractive than using the organic label. Moreover, producers may not see the need to use a label. This might be the case because wine marketing may use different strategies (e.g. conveying emotions, geographical denominations, etc) than communicating the production system's attributes. The need to use a label may also depend on the marketing channel used (Flaten *et al* 2010). Short supply chains such as direct marketing have been shown to be a substitute of organic labelling due to direct communication between production and consumption (Park and Lohr 2006, Dabbert *et al* 2014, Veldstra *et al* 2014, González-Azcárate *et al* 2022), while labelling might be essential in anonymous and asymmetric market environments such as marketing via retailers.[12]

[6] The farm must have a standard labor requirement of at least 0.20 standard workers to be eligible for direct payments (Art. 5 DZV).

[7] Such private standards are BioSuisse, a private third-party certification organization or Demeter, the international association for biodynamic agriculture.

[8] Delinat guidelines go beyond general requirements for organic farming and are stricter in many aspects compared to other private organic guidelines, such as BioSuisse or Demeter. See https://www.delinat.com/richtlinien.html for more.

[9] See more here: https://www.fairandgreen.com/wein-landwirtschaft/.

[10] In Switzerland, there is no federal organic label. Wines produced in accordance with the organic regulation may bear the designation 'organic', 'ecological' or 'bio' for short in the product name without any illustration of a label. 'Labelling' (as described above) is thus not possible.

[11] Costs for the Bio Suisse label are dependent on farm sales but are at least 300 CHF per year. The costs for inspection and certification are billed by the control and certification bodies according to their tariff regulations.

[12] Research has also shown that 'local' grants larger price premium than organic (Onozaka and McFadden 2011).

We thus formulate the following three hypotheses. First, farmers who cultivate their grapes according to organic principles but do not choose to label their wines as organic use different labelling strategies (i.e. use other labels related to the production system, or geographical denominations to convey information about the terroir). Second, farms who downgrade the organic production are closer to the final consumer of wine (via direct marketing compared to marketing via gastronomy or retail). Third, smaller farms and unspecialized farms are less likely to use the organic label despite organic grape production due to administrative burdens.

3. Empirical framework

3.1. Main specification

In order to circumvent selection issues stemming from specific farm- and farmer characteristics that are linked with the choice of organic production, which is required to use the corresponding organic label, we use a sample consisting only of organic grapevine growers to test our hypotheses.[13] Our sample also includes farms that are transitioning to organic viticulture, as they are required to follow organic practices for two calendar years. The main specification follows a linear model which we estimate using Ordinary Least Squares including only grapevine growers cultivating their grapevines according to organic guidelines (N = 115):

$$\text{Organic production without organic labelling}_i = \alpha + \beta X_i + \gamma C_i + \delta_r + \varepsilon_i \quad (1)$$

Organic production without organic labelling$_i$ refers to a dichotomous variable that is 1 if farm i cultivates their grapes according to organic principles but does not use the organic labelling when marketing (i.e. downgrades the production system), 0 else.

X_i refers to a vector of farm-level variables describing our hypotheses to be tested which we include separately into Model 1 for reasons of multicollinearity. X_i includes whether the farm uses another production system related label (Yes: 1, No: 0), whether the farm uses geographical denomination labelling (Yes: 1, No: 0), whether the farm markets most of their wines directly (direct sales >50%: 1; else: 0), to gastronomy (sales to gastronomy >50%: 1, else: 0), or to retail (sales to retail >50%: 1, else: 0). Furthermore, it contains the degree of agricultural specialisation (>50% from income is from farming: 1, else: 0), as well as viticultural specialization (>50% from farm income is from viticulture: 1, else: 0), together with the standardized labour units employed and the farm's size (in ha) as proxies for farm size.

Moreover, C_i are control variables that we include in the regression because they could influence the choice of downgrading organic production. For instance, organic grapevine production may yield benefits for the producers independent of the signal provided by the label (e.g. ecological tools to produce quality grapes) (Delmas and Grant 2014). We thus include a binary variable that is 1 if the respondent indicated that environmental stewardship is their primary goal, 0 else. Similarly, we include a binary variable that is 1 if the primary goal of the respondent is high grape quality for winemaking, 0 else. Similarly, farmers' preferences and perceptions may affect perceived labelling costs and benefits. For example, farmers' time preferences may matter, as the switch to organic production may only fully materialize later and organic labelling requires a two-year transition in vineyard management (Steinemann *et al* 2022). During this period, producers cannot secure certified organic price premiums. We thus include a binary variable that identifies farms which are currently in transition to organic production. Moreover, the decision whether to use a label may also be influenced by the farmers willingness to take risks in the marketing domain (e.g. Hasibuan *et al* 2021). For example, farms who are more willing to take risks in the marketing domain may be using the organic label less frequently which can be seen as a risk-reducing marketing instrument. Last, we include the age and gender of the respondent as control variables.

ε_i refers to the error term of farm i. We add wine regional ($r = 6$) fixed effects (δ_r) to the regression and cluster the standard errors at the wine region level which are important decision making units in viticulture (Wooldridge 2003, Finger *et al* 2023, Zachmann *et al* 2024).

3.2. Robustness checks

To assess the sensitivity and mechanisms of our results we conduct a series of further analyses. First, we assess the included control variables for multi-collinearity which ensures the reliability and accuracy of the estimated coefficients. Second, we use a logistic choice model to examine whether the choice of a linear probability model for the dichotomous dependent variable influences our main results (Breen *et al* 2018). Third, we exclude biodynamic growers, and run Model 1 only for organic growers. This allows to assess the influence of biodynamic grapevine growers who are subject to stricter production and labelling requirements compared to organic grapevine growers (Steinemann *et al* 2022). Forth, since farms can only receive federal direct payments if

[13] For instance organic farmers are more likely to market via short supply chains (Aubert and Enjolras 2016).

Table 2. Statistics on organic production and organic labelling.

		Organic labelling		
		Yes	No	Total
Organic production	Yes	65 (56.5%)	50 (43.5%)	115 (26.6%)
	No	0 (0%)	318 (73.4%)	318 (73.4%)
	Total	65 (15.0%)	368 (85.0%)	

Organic comprises both organic and biodynamic production principles. Two observations are dropped because of impossible data entries, and one observation was excluded due to a impossibly large labor entry (N = 433). See appendix A for details.

they employ more than 0.2 standardized labour units, we run the analysis only for farms exceeding this threshold (Huber *et al* 2023). We hypothesis that this sample makes use of federal organic payments. Last, we perform sensitivity checks to assess the influence of unobserved confounders on our main research findings and as such biases stemming from omitted variables (Cinelli and Hazlett 2020, Cinelli *et al* 2020).

4. Data

We use survey data consisting of answers from 436 grapevine growers across Switzerland, including all wine (N = 6) and main language (N = 3) regions (Zachmann *et al* 2023).[14] In the survey, participants were asked to indicate what production system they use to grow their grapevines, with pre-specified answer options (e.g. proof of ecological performance, integrated production, organic and biodynamic production) and an open-text field to manually specify the production system.[15] We use additional control questions to identify non-organic producers, e.g. whether they use chemical synthetic pesticides (appendices A and B). Moreover, we conducted post-survey interviews with farmers to validate the understanding of the question.[16]

Participants were also asked to indicate which labels or terms they use to market their wines. Pre-specified answer options for organic labels, i.e. BioSuisse (organic), Demeter (biodynamic) and Delinat, as well as other (non-organic) labels, such as Vinatura (proof of ecological records) and for terms PIWI (fungus-resistant variety). Moreover, there was an open-text field to manually specify terms and labels used. We coded farms who use the Delinat, PIWI, Fair & Green label as using another productions system related label, 0 else.

Our sample consists of 115 organic grapevine producers that produce following organic or biodynamic production principles (including farms in transition to organic viticulture). It accounts for 31.3% of the total official viticultural land under organic cultivation (FiBL Statistics 2024).[17]

Table 2 shows that 43.5% (50 out of 115) of the sampled grapevine growers cultivate the grapes according to organic principles and market the wines without using the organic label. In contrast, 56.5% (65 out of 115) of growers cultivate the grapes under organic principles while using the organic label to market the wines.

Moreover, table 3 reports summary statistics of the total sample of organic grapevine growers, as well as those who do not use the organic label (but cultivate the grapes according to organic principles) and those who use the organic label. The summary statistics show a clear pattern. Farms that downgrade from organic production frequently use alternative production system related labels. However, about half of organic farms that do not use the organic label do not use any label at all. Additionally, organic farms selling primarily directly or through gastronomy are more likely to not use the organic label compared to those targeting retail. Furthermore, organic farms downgrading from organic production tend to earn less household income from farming, as well as less farming income form viticulture. They are also notably smaller in size and employ less standardized labour.[18]

[14] This broad research idea has been pre-registered at https://aspredicted.org/TL3_C7G before data was collected.

[15] Multiple answer options were possible. See appendix I for details on pest management requirements of the specific production systems.

[16] More specifically, we conducted post-survey interviews with three growers from the Swiss-German, French and Italian speaking parts of Switzerland to verify that the question regarding the applied production system was understood correctly, with overall positive feedback. However, note that the production system indicated by survey participants in the here used dataset is based on an impersonal survey response and cannot be fully validated, i.e. we did not collect proofs that all answers are correct.

[17] Refer to appendix J for a sample visualization.

[18] Standardized labor (SAK) refers to a unit used by the Federal Office for Agriculture in Switzerland to standardize and measure labor inputs in agriculture. It represents the amount of labor required to perform a standardized amount of work in agricultural activities to render it comparable and evaluating labor productivity across different agricultural operations and sectors. Standardized labor can thus be used as a proxy for farm size.

Table 3. Summary statistics.

			Farm produces under organic principles without using the organic label	
		Total (N = 115)	No (N = 65)	Yes (N = 50)
Labelling	Farm markets wine with another productions system related label[£] (Yes: 1, No: 0)			
	Mean (SD)	0.078 (±0.27)	0.046 (±0.21)	0.12 (±0.33)
	Farm uses geographical denomination labelling (Yes: 1, No: 0)			
	Mean (SD)	0.88 (±0.33)	0.94 (±0.24)	0.80 (±0.40)
	Farm uses no label (Yes: 1; No: 0)			
	Mean (SD)	0.24 (±0.43)	0 (±0)	0.56 (±0.50)
Marketing channel	Farm markets most of their wines directly (direct sales >50%: 1, else: 0)			
	Mean (SD)	0.50 (±0.50)	0.45 (±0.50)	0.58 (±0.50)
	Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1, else: 0)			
	Mean (SD)	0.043 (±0.20)	0.031 (±0.17)	0.060 (±0.24)
	Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)			
	Mean (SD)	0.087 (±0.28)	0.11 (±0.31)	0.060 (±0.24)
Farm typology	Farm specialization (>50% from income is from farming: 1; else: 0)			
	Mean (SD)	0.64 (±0.48)	0.72 (±0.45)	0.54 (±0.50)
	Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)			
	Mean (SD)	0.67 (±0.47)	0.82 (±0.39)	0.48 (±0.50)
	Farm size			
	Mean (SD)	1200 (±2300)	1500 (±2700)	860 (±1700)
	Standardized labour			
	Mean (SD)	3.5 (±3.4)	4.2 (±4.0)	2.6 (±2.2)
	Missing	5 (4.3%)	2 (3.1%)	3 (6.0%)

[£]Another label refers to other production system specific labels or terms used such as PIWI, Fair & Green and Delinat.

5. Results

5.1. Regression results

Table 4 presents regression results from Model 1. Thus, the dependent variable is whether a grower who cultivates grapes under organic production principles does not use the corresponding organic label when marketing the wines. We include the variables to be tested separately, but together with control variables and wine region fixed effects.

Table 4 shows that farms which are using different, but production system related labels are more likely to downgrade their production, i.e. cultivate the grapes according to organic principles but do not use the organic label. Moreover, farms which earn less than 50% from their household income from agriculture as well as especially farms which draw less than 50% from their agricultural income from viticulture are more likely to downgrade their production. We furthermore find that smaller farms in terms of employed standardized labour are more likely to cultivate their grapes according to organic principles without using the organic label. We do not find statistically significant effects for the main marketing channels chosen, nor the use of geographical denominations.

5.2. Robustness checks

Our main results remain robust to further checks and analyses. First, our results remain unchanged when including or excluding the most correlated control variables in Model 1. Moreover, variance inflation factors indicate that multicollinearity is not a major concern at common critical threshold levels (Sheather 2009) (appendix D). Second, using a logistic regression model does not influence the direction of the estimated main effects nor the precision with which they are calculated (appendix E). Third, excluding biodynamic growers (N = 27) does not influence our main results that mainly non-viticulture focused farms downgrade their organic production for their grape cultivation as well as those farms which employ different labelling strategies

Table 4. Regression results modelling organic downgrading, i.e. organic production without organic labelling (Model 1).

	Organic downgrading (i.e. organic production without organic labelling, Yes: 1, No: 0)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Farm uses other production system related label (Yes: 1, No: 0)	0.360***								
	(0.118)								
Farm uses geographical denomination label (Yes: 1, No: 0)		−0.416**							
		(0.189)							
Farm markets most of their wines directly (direct sales >50%: 1, else: 0)			0.102						
			(0.071)						
Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1, else: 0)				0.251					
				(0.209)					
Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)					−0.176				
					(0.102)				
Farming specialization (>50% from income is from farming: 1, else: 0)						−0.306***			
						(0.110)			
Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)							−0.466***		
							(0.065)		
Standardized labour								−0.033***	
								(0.012)	
Farm size (in ha)									−0.003
									(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wine region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115	115	115	115	115	115	115	110	115
R^2	0.109	0.134	0.089	0.089	0.089	0.137	0.225	0.132	0.090

We highlight coefficients that are statistically significant at $p<0.01$ with ***. Refer to appendix C for regression output for the full table (including control variables). Refer to appendix I for detailed analysis of environmental stewardship and high grape quality as main objectives of grape production.

(appendix F). Fourth, excluding farms (N = 10) that are not eligible for organic direct payments does not alter our main results. However, using this reduced sample, we find that farms which mainly market directly to consumers are more likely to produce organic without using the organic label (appendix G). Last, sensitivity analyses suggest that unobserved confounders would need to explain more than 16.7%–34.4% of the residual variance of both the treatments (X_i) and the outcome (organic production without organic labelling) to bring the respective point estimates to 0 (appendix H).

6. Discussion

Our results document that around 43.5% of grapevine growers that cultivate their grapes under organic production do not label their wines as organic. In terms of acreage, this means that roughly 31% of organic land under grapes remains unlabelled at the point of sales.

We hypothesized that farms using different labelling strategies are more likely to downgrade their production. While we find that farms using production system related labels (e.g. related to fungus resistant varieties) are more likely to downgrade their production, we find a negative effect for geographical denominations. The latter may be because small vineries in Switzerland do not make use of geographical denominations. Moreover, we hypothesized that organic farms which are closer to the final consumer of wine (via direct marketing compared to marketing via gastronomy or retail) are more likely to not using the organic labelling. Given our results, we do not find evidence in our sample for this hypothesis. Thus, whether farms use direct marketing or not does not explain the non-use of organic labels in our analysis. Finally, we hypothesized that smaller farms and unspecialized farms are less likely to use the organic label despite organic grape production.[19] We find robust evidence for this hypothesis in our sample of 115 organic grapevine growers.

In the past, organic labelling was found to result in a price penalty for wines (e.g. Delmas and Grant 2014). Along these lines, vineyards that cultivate their grapes according to organic principles but omit the according labels on bottles of higher-quality wines received price premiums and better ratings from experts for these wines (e.g. Delmas and Grant 2014, Abraben *et al* 2017, Delmas and Lessem 2017). Our results however show that especially smaller and unspecialized wineries downgrade their production. Thus, especially the relatively high costs and administrative burdens of these small wineries to seek organic labelling may hinder them to use labels. More specifically, if revenues from wine are small and only a small share of the household income depends on wine, seeking price premia from organic labelling does not outweigh the labelling costs.

The phenomenon of cultivating agricultural products with organic principles but abstaining from labelling is not unique to Switzerland nor the cultivation of grapes. It has been documented in other countries, e.g. United States, Norway, Greece and for other crops, e.g. hay, arable crops, livestock, fruits and vegetables (Flaten *et al* 2010, Argyropoulos *et al* 2013, Veldstra *et al* 2014).

7. Policy implications and conclusion

We here investigate to what extent organic grapevine producers also use organic labels. More specifically, we investigate the mismatch between organic production and labelling in Swiss grapevine production and its determinants. Using 115 organic grapevine growers in Switzerland, we find that 43.5% of organic growers do not label their wine as organic. Factors such as farm size, farm specialization, and the use of alternative labels influence this choice. More specifically, we find that especially farms using alternative labelling strategies (e.g. for fungus-resistant varieties) and smaller farms and farms less specialized on viticulture to be more likely to forgo organic labelling.

Our results carry implications for policy. Our findings show that there may be more organic products on shelves than indicated from sales statistics of organically labelled products. The use of statistics that indicate the share of sales of organic products for specific products and food sales at large may thus be misleading. Our results also show that incentives of selling via labels alone may not be enough to incentivise growers to switch to organic production, as costs associated with the certification does not outweigh expected benefits for all farms. Thus, policymakers may incentivize organic farming through measures like agri-environmental payments and other elements used in action plans (e.g. Rees *et al* 2023).[20] Yet, label premia for certified organic producers may also attract growers to switch to organic production. However, this is attractive only for larger, specialized farms whose income depends more on agriculture and the specific crop. Our results also show that other

[19] Smaller farms here refer to those measured in standardized labor, but not in terms of total agricultural land.

[20] Labelling here means that the wine lacks an organic label on the bottle. Farmers using organic methods can still receive agri-environmental payments but miss out on the price premium associated with organic labelling. Therefore, promoting labelling incentives alone may not effectively encourage organic viticulture, whereas agri-environmental payments could be more beneficial.

environmental characteristics of the production process such as the focus on low pesticide production systems may become viable strategies to label final products, so that organic certification is not necessarily needed. For example, cultivating fungus-resistant grapevine varieties that require significantly fewer fungicide applications and labelling the wines accordingly to highlight these production attributes may become an alternative strategy. However, it is important that these labels are regulated and monitored to ensure the practices are carried out accordingly.

Our findings also have important implications for science. Our analysis shall also be carried out for other crops and food products. While we acknowledge that wine is a special product with particularly high incentives to not label the products, we also expect that this phenomenon exists for other crops. Yet, its magnitude remains undocumented in European agriculture. Future research shall provide systematic assessments of this behaviour of farmers and the underlying reasons. Our results show that the production system label may not correspond to the underlying production system. This highlights the need to accurately identify organic farms, which is more complex than just looking for organic labels. Studies that use certification or labelling to indicate organic production might give biased results, as they may overlook farms that cultivate according to organic principles but do not label their products. Overall, our findings indicate that more nuanced analyses of organic downgrading are needed for other crops, countries and contexts. Moreover, investigations regarding the downgrading phenomenon in other production systems (e.g. integrated pest management, proof of ecological performance) may shed light on similarities and differences of this process along the production system hierarchy. Future research could also use personal interviews to address potential non-sampling bias from participant misreporting during impersonal online survey data collections and could reveal more insights in the reasons for not using organic labelling.

Acknowledgments

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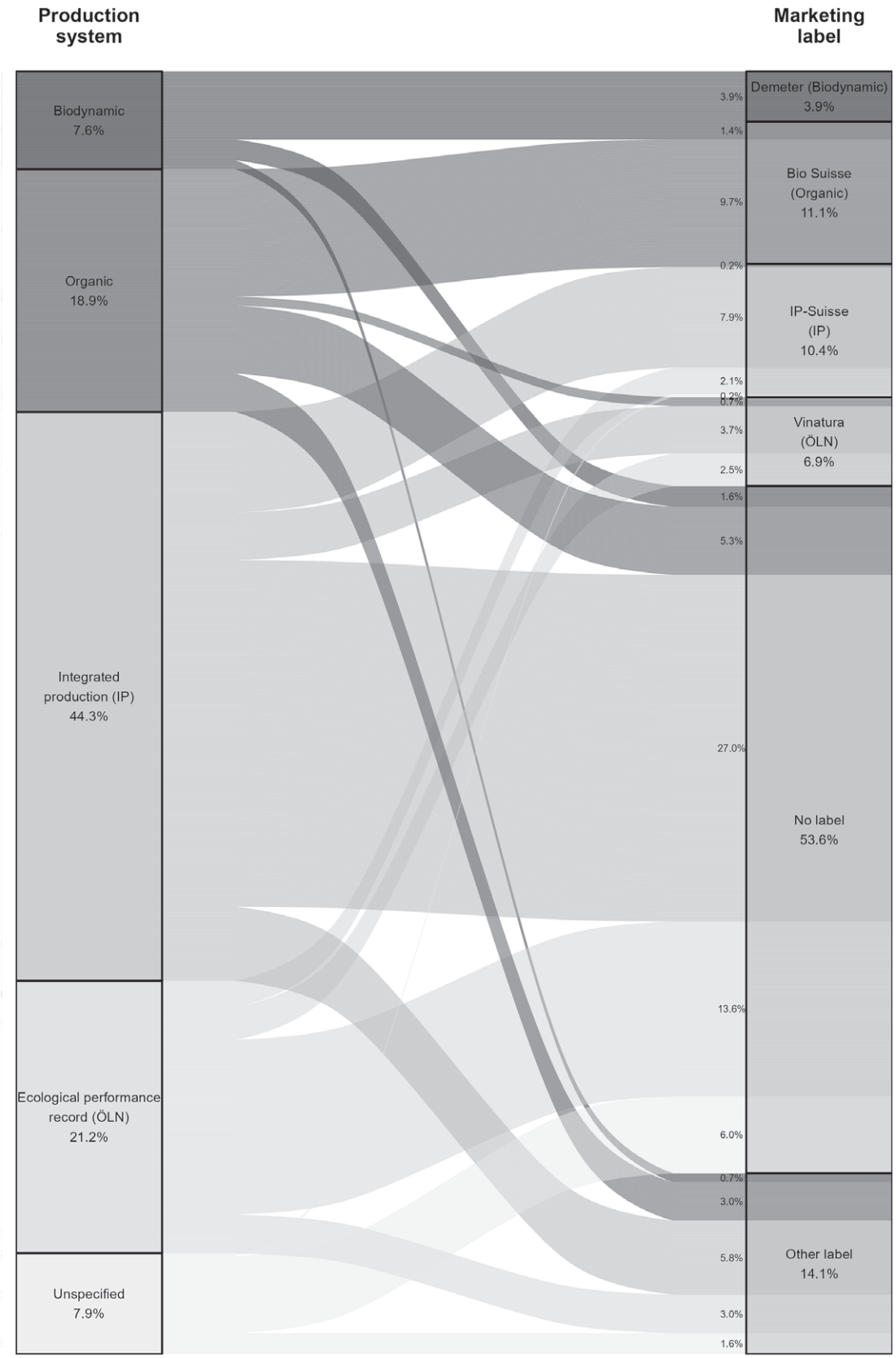
Data availability statement

The data that support the findings of this study are openly available at the following URL/DOI: https://doi.org/10.1016/j.dib.2023.109652.

Appendix A. Data processing

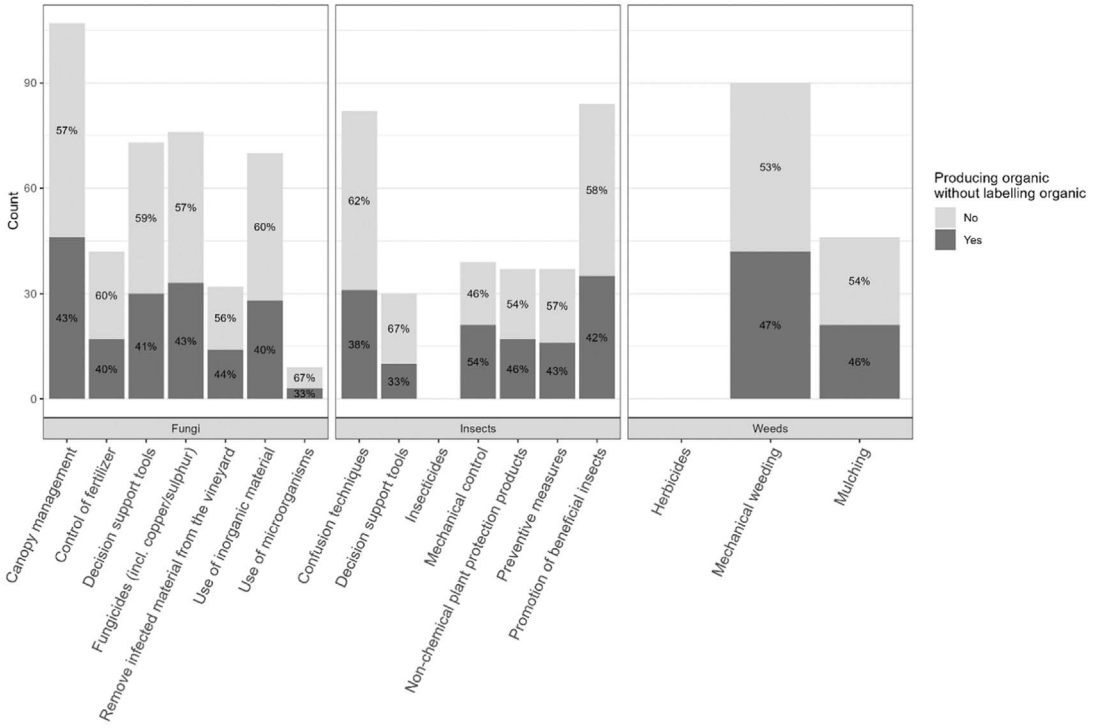
Data is publicly available via Zachmann *et al* (2023). The public data was processed following the here-mentioned protocol. First, from the whole sample of 436 grapevine growers, we only use grapevine growers who produce their grapes according to organic or biodynamic production principles (Delmas and Grant 2014). This results in 123 observations. Thereafter, we drop 6 self-reported organic growers who still use herbicides or insecticides, one farm which indicated an unfeasible production and labelling combination (IP production, organic labelling), and one farm which reports standardized labour that is an outlier, resulting in a final sample of 115.

The figure below shows the alignment of the production system and labelling choices for the full sample of 436 grapevine growers in Switzerland, including non-organic production systems and labels.


Production system
Marketing label
Biodynamic 7.6%
Organic 18.9%
Integrated production (IP) 44.3%
Ecological performance record (ÖLN) 21.2%
Unspecified 7.9%
Demeter (Biodynamic) 3.9%
Bio Suisse (Organic) 11.1%
IP-Suisse (IP) 10.4%
Vinatura (ÖLN) 6.9%
No label 53.6%
Other label 14.1%
3.9%
1.4%
9.7%
0.2%
7.9%
2.1%
0.2%
0.7%
3.7%
2.5%
1.6%
5.3%
27.0%
13.6%
6.0%
0.7%
3.0%
5.8%
3.0%
1.6%

Appendix B. Pest management

The graph below shows differences between pest management decision for all organic grapevine growers, differentiating between those that downgrade production (i.e. do not use the organic label) versus those using the organic label.



Note: The use of fungicides against fungi refers to both chemically synthetic as well as substances allowed for use in organic viticulture (e.g. copper and sulphur-based substances).

The figure indicates that growers who downgrade their production do not systematically differ in their plant protection strategies compared to their peers who use the label.

The table below further confirms this, showing that farms downgrading organic grape production do not show statistically systematic differences in their strategies employed against fungal pathogens and weeds. However, the table shows that these farms are more inclined to utilize mechanical insect control methods (e.g., nets and traps) compared to those using the organic label.

	Weed control strategies:		
	Mechanical weeding (Yes: 1, No: 0) (1)	Mulching (Yes: 1, No: 0) (2)	Herbicides (Yes: 1, No: 0) (3)
Downgrading organic production (Yes: 1, No: 0)	0.071 (0.118)	0.045 (0.087)	Not possible
Constant	Yes	Yes	—
Controls	Yes	Yes	—
Wine region FE	Yes	Yes	—
Observations	115	115	—
Adjusted R^2	0.220	0.004	—

	Insect control strategies:						
	Confusion techniques (Yes: 1, No: 0) (1)	Promotion of beneficial insects (Yes: 1, No: 0) (2)	Preventive measures (Yes: 1, No: 0) (3)	Decision support tools (Yes: 1; No: 0) (4)	Insecticides (Yes: 1, No: 0) (5)	Mechanical control (Yes: 1, No: 0) (6)	Non-chemical plant protection products (Yes: 1, No: 0) (7)
Downgrading organic production (Yes: 1; No: 0)	−0.178 (0.099)	−0.037 (0.059)	−0.030 (0.033)	−0.144 (0.121)	Not possible	0.160** (0.063)	0.064 (0.054)
Constant	Yes	Yes	Yes	Yes	—	Yes	Yes
Controls	Yes	Yes	Yes	Yes	—	Yes	Yes
Observations	115	115	115	115	—	115	115
Adjusted R^2	0.274	0.045	−0.041	0.109	—	0.041	0.022

(Continued.)

	Fungi control strategies:						
	Remove infected material from the vineyard (Yes: 1, No: 0)	Decision support tools (Yes: 1, No: 0)	Canopy management (Yes: 1, No: 0)	Use of microorganisms (Yes: 1, No: 0)	Use of inorganic material (Yes: 1, No: 0)	Fungicides (Yes: 1; No: 0)	Control of fertilizer (Yes: 1, No: 0)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Downgrading organic production (Yes: 1, No: 0)	0.007	−0.096	−0.025	−0.008	−0.062	−0.026	−0.034
	(0.041)	(0.067)	(0.015)	(0.032)	(0.051)	(0.075)	(0.046)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115	115	115	115	115	115	115
Adjusted R^2	0.035	0.012	0.113	−0.030	0.123	0.084	−0.028

$^{**}p<0.05$, $^{***}p<0.01$. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Here we conduct a robustness check by excluding 17 organic growers from the sample who indicated using more than one production system for growing their grapes (i.e., those who ticked both the integrated production or proof of ecological performance, and organic or biodynamic production systems).

	Organic downgrading (i.e. organic production without organic labelling; Yes: 1, No: 0)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Farm uses other production system related label (Yes: 1, No: 0)	0.445**								
	(0.195)								
Farm uses geographical denomination label (Yes: 1, No: 0)		−0.486***							
		(0.123)							
Farm markets most of their wines directly (direct sales >50%: 1, else: 0)			0.048						
			(0.065)						
Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1, else: 0)				0.102					
				(0.263)					
Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)					−0.196***				
					(0.043)				
Farming specialization (>50% from income is from farming: 1, else: 0)						−0.315***			
						(0.113)			
Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)							−0.469***		
							(0.083)		
Standardized labour								−0.052***	
								(0.017)	
Farm size (in ha)									−0.001
									(0.001)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wine region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	98	98	98	98	98	98	98	95	98
Adjusted R^2	0.015	0.061	−0.037	−0.038	−0.028	0.032	0.121	0.031	−0.038

$^{**}p<0.05$, $^{***}p<0.01$. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Appendix C. Full table regression output

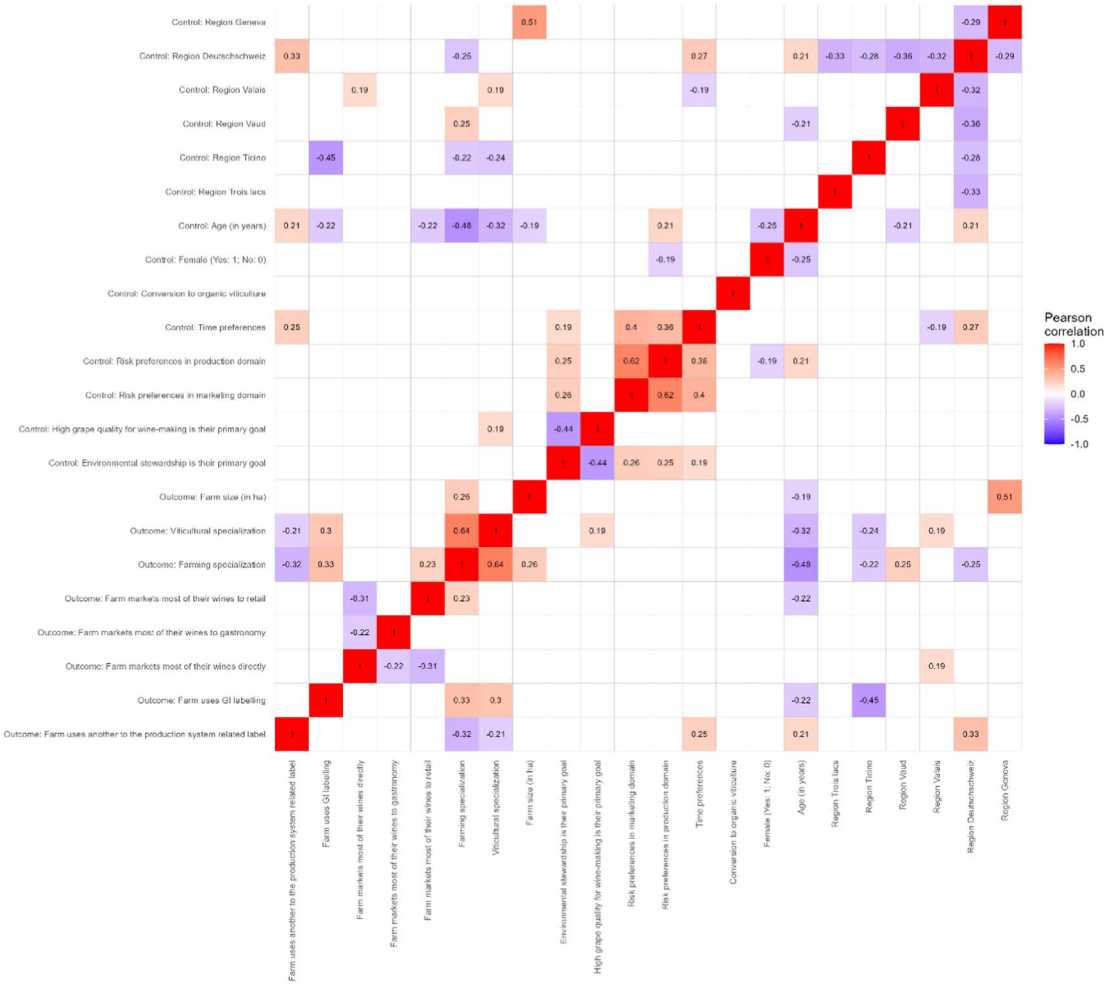
Here we provide full regression output from Model 1 including all control variables.

	Organic downgrading (i.e. organic production without organic labelling, Yes: 1, No: 0)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Farm uses other production system related label (Yes: 1, No: 0)	0.360***								
	(0.118)								
Farm uses geographical denomination label (Yes: 1, No: 0)		−0.416**							
		(0.189)							
Farm markets most of their wines directly (direct sales >50%: 1, else: 0)			0.102						
			(0.071)						
Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1, else: 0)				0.251					
				(0.209)					
Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)					−0.176				
					(0.102)				
Farming specialization (>50% from income is from farming: 1, else: 0)						−0.306***			
						(0.110)			
Viticultural specialization (>50% from farm income is from viticulture: 1; else: 0)							−0.466***		
							(0.066)		
Standardized labour								−0.033***	
								(0.012)	
Farm size (in ha)									−0.003
									(0.002)
Environmental stewardship is their primary goal (Yes: 1, No: 0)	−0.078	−0.101	−0.085	−0.087	−0.086	−0.072	−0.056	−0.132	−0.118
	(0.081)	(0.139)	(0.093)	(0.101)	(0.096)	(0.156)	(0.128)	(0.101)	(0.106)
High grape quality for wine-making is their primary goal (Yes: 1, No: 0)	−0.109	−0.093	−0.103	−0.086	−0.107	−0.054	−0.010	−0.065	−0.101
	(0.064)	(0.067)	(0.075)	(0.060)	(0.073)	(0.067)	(0.052)	(0.086)	(0.071)
Willingness to take risks in the marketing domain	0.047**	0.040***	0.042**	0.046***	0.042***	0.042***	0.048***	0.048***	0.043***
	(0.019)	(0.013)	(0.018)	(0.016)	(0.015)	(0.014)	(0.008)	(0.014)	(0.016)
Willingness to take risks in the production domain	−0.029***	−0.036***	−0.032***	−0.037***	−0.035***	−0.036***	−0.028***	−0.029***	−0.034***
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)	(0.009)	(0.005)
Time preferences	−0.021	−0.012	−0.012	−0.011	−0.011	−0.016	−0.017	−0.009	−0.009
	(0.019)	(0.017)	(0.014)	(0.014)	(0.016)	(0.014)	(0.013)	(0.012)	(0.015)
Conversion to organic viticulture (Yes: 1, No: 0)	0.123	0.142	0.098	0.046	0.085	0.151	0.063	0.026	0.092
	(0.141)	(0.163)	(0.135)	(0.197)	(0.165)	(0.107)	(0.091)	(0.105)	(0.167)
Female (Yes: 1, No: 0)	0.143	0.153	0.132	0.171	0.156	0.126	0.031	0.122	0.144
	(0.154)	(0.157)	(0.144)	(0.181)	(0.147)	(0.125)	(0.114)	(0.130)	(0.162)
Age (in years)	−0.002	−0.002	0.0002	0.0004	−0.001	−0.004***	−0.006***	0.0005	−0.0002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wine region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115	115	115	115	115	115	115	110	115
Adjusted R^2	−0.015	0.013	−0.038	−0.038	−0.039	0.017	0.117	0.004	−0.037

** $p < 0.05$, *** $p < 0.01$. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Appendix D. Testing for multicollinearity

The figure below reports significant (confidence level = 0.95) correlations of all control and treatment variables.



We define correlated variables empirically, that is we take the top 5% of the correlation distribution. This results in the correlated variables shown below:

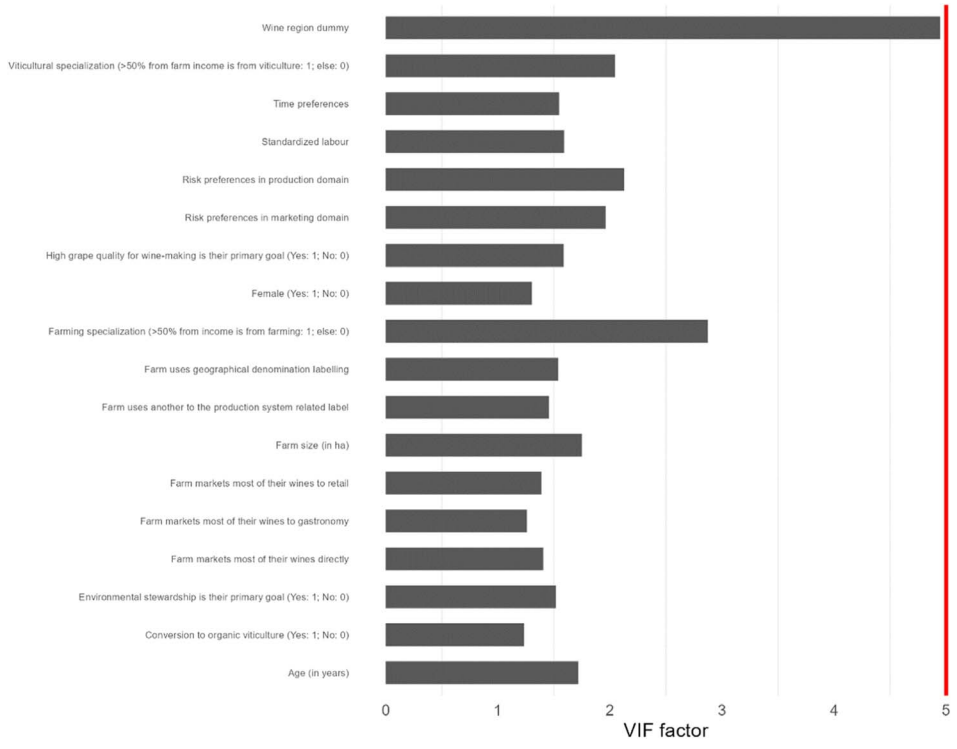
Variable 1	Variable 2	Pearson correlation coefficient	Potentially problematic
Farming specialization (>50% from income is from farming: 1, else: 0)	Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)	0.64	No, since we include them separately in the regression
Willingness to take risks in the production domain	Willingness to take risks in the marketing domain	0.62	Yes
Farm size (in ha)	Wine Region Geneva dummy	0.51	Yes

Thereafter we drop potentially problematic variables from the Model 1 to assess whether our main hypotheses remain unchanged. The table below shows regression output from Model 1 when dropping risk preferences in the marketing domain as well as regional dummies. The table shows that the main findings remain stable even with the inclusion of the most correlated variables.

	Organic downgrading (i.e. organic production without organic labelling, Yes: 1, No: 0)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Farm uses other production system related label (Yes: 1, No: 0)	0.380***								
	(0.114)								
Farm uses geographical denomination label (Yes: 1, No: 0)		−0.352							
		(0.165)							
Farm markets most of their wines directly (direct sales >50%: 1; else: 0)			0.112						
			(0.079)						
Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1, else: 0)				0.178					
				(0.222)					
Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)					−0.155				
					(0.117)				
Farming specialization (>50% from income is from farming: 1, else: 0)						−0.293			
						(0.116)			
Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)							−0.443***		
							(0.067)		
Standardized labour								−0.033***	
								(0.012)	
Farm size (in ha)									−0.003
									(0.001)
Controls	Yes, but possibly correlated controls are dropped								
Wine region FE	No	No	No	No	No	No	No	No	No
Observations	115	115	115	115	115	115	115	110	115
R^2	0.066	0.106	0.068	0.035	0.037	0.088	0.176	0.079	0.044

**p < 0.05, ***p < 0.01. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Moreover, variance inflation factors show little reasons for concern at a critical level of 5 (Sheather 2009). The only critical variables included are the wine regional dummies, that we have shown in the table above do not alter our main results whether they included or excluded from the modelling.



Appendix E. Logit regression

Here we provide log-odds from a logistic regression estimation of Model 1.

	Organic downgrading (i.e. organic production without organic labelling, Yes: 1, No: 0)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Farm uses other production system related label (Yes: 1, No: 0)	1.567***								
	(0.280)								
Farm uses geographical denomination label (Yes: 1, No: 0)		−1.862***							
		(0.467)							
Farm markets most of their wines directly (direct sales >50%: 1; else: 0)			0.452***						
			(0.167)						
Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1, else: 0)				1.071					
				(0.489)					
Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)					−0.814***				
					(0.257)				
Farming specialization (>50% from income is from farming: 1, else: 0)						−1.387***			
						(0.256)			
Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)							−2.234***		
							(0.186)		
Standardized labour								−0.268***	
								(0.028)	
Farm size (in ha)									−0.014***
									(0.003)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wine region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115	115	115	115	115	115	115	110	115
Akaike Inf. Crit.	174.255	171.272	176.708	176.737	176.759	170.604	159.185	162.478	176.459

**p < 0.05, ***p < 0.01. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Appendix F. Using only organic growers

This table shows regression results of Model 1 using only organic growers (dropping biodynamic producers).

	Organic downgrading (i.e. organic production without organic labelling, Yes: 1, No: 0)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Farm uses other production system related label (Yes: 1; No: 0)	0.626***								
	(0.128)								
Farm uses geographical denomination label (Yes: 1, No: 0)		−0.326							
		(0.184)							
Farm markets most of their wines directly (direct sales >50%: 1, else: 0)			0.075						
			(0.076)						
Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1; else: 0)				0.142					
				(0.191)					
Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)					−0.007				
					(0.135)				
Farming specialization (>50% from income is from farming: 1, else: 0)						−0.255			
						(0.187)			
Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)							−0.428***		
							(0.102)		
Standardized labour								−0.026	
								(0.014)	
Farm size (in ha)									−0.001
									(0.001)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wine region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	84	84	84	84	84	84	84	83	84
Adjusted R^2	0.068	0.005	−0.022	−0.030	−0.030	0.007	0.107	0.004	−0.028

**p < 0.05, ***p < 0.01. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Appendix G. Using only farms which are eligible for direct payments

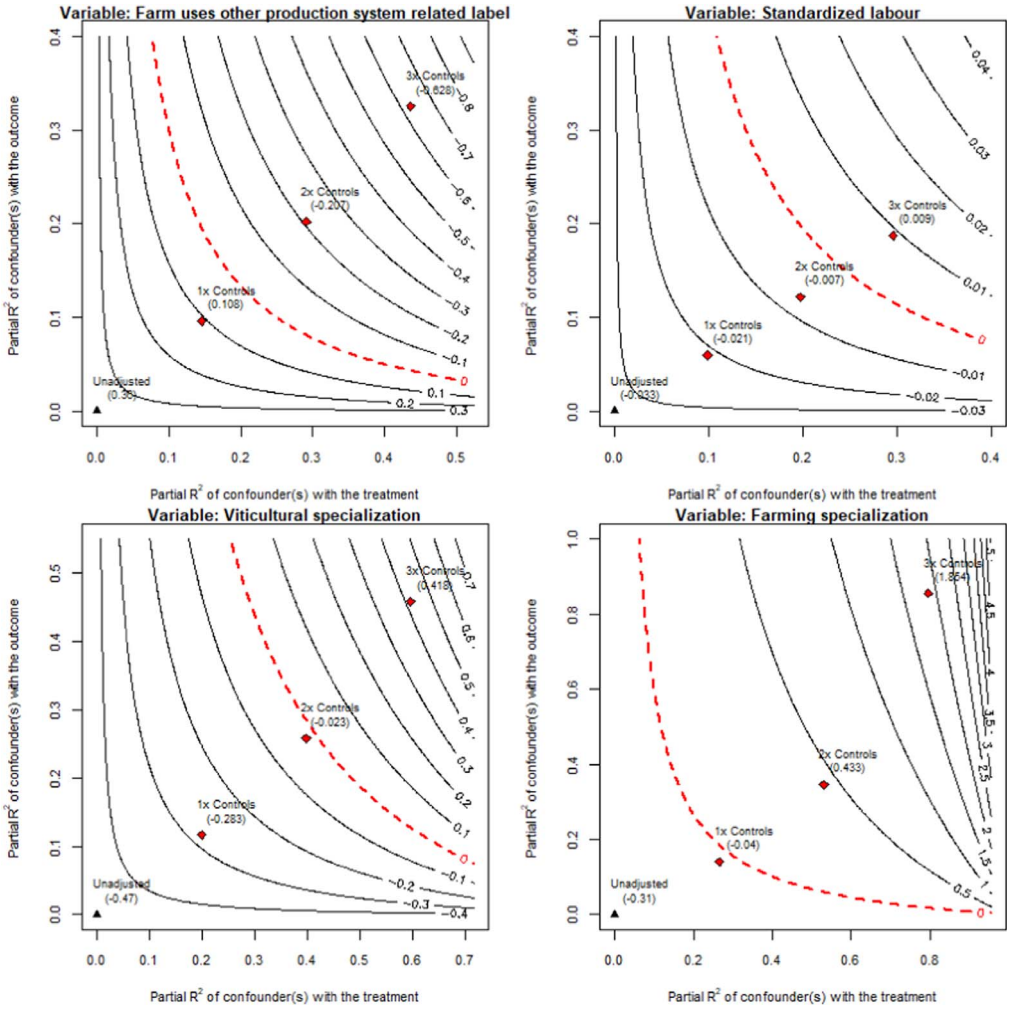
The table below shows regression output from Model 1 excluding farms which are too small to receive direct payments (i.e. SAK < 0.2, N = 5) or do not indicate information on their standardized labor utilized at the farm (N = 5).

	Organic downgrading (i.e. organic production without organic labelling, Yes: 1, No: 0)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Farm uses other production system related label (Yes: 1, No: 0)	0.436***								
	(0.169)								
Farm uses geographical denomination label (Yes: 1, No: 0)		−0.298							
		(0.269)							
Farm markets most of their wines directly (direct sales >50%: 1, else: 0)			0.140***						
			(0.047)						
Farm markets most of their wines to gastronomy (sales to gastronomy >50%: 1, else: 0)				0.139					
				(0.235)					
Farm markets most of their wines to retail (sales to retail >50%: 1, else: 0)					−0.138				
					(0.088)				
Farming specialization (>50% from income is from farming: 1; else: 0)						−0.219			
						(0.104)			
Viticultural specialization (>50% from farm income is from viticulture: 1, else: 0)							−0.432***		
							(0.046)		
Standardized labour								−0.030***	
								(0.011)	
Farm size (in ha)									−0.002
									(0.001)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wine region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	105	105	105	105	105	105	105	105	105
R^2	0.128	0.105	0.100	0.084	0.087	0.110	0.214	0.117	0.086

**p < 0.05, ***p < 0.01. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Appendix H. Sensitivity analyses

Below we show contour plots of our main point estimates to assess their sensitivity to unobserved confounders (Cinelli and Hazlett 2020, Cinelli *et al* 2020). The horizontal axes show the residual share of variation of the treatment that is hypothetically explained by unobserved confounding. The vertical axes show the hypothetical partial R^2 of unobserved confounding with the outcome. The contours show what estimate for our treatments (i.e. other label, standardized labour, viticultural specialization and agricultural specialization) would have been obtained in the full regression model including unobserved confounders with such hypothetical strengths. The bounds on the strength of confounding, are also shown in the plots. The plots reveal that the direction of the effect is robust to confounding once or twice times as strong as *all* the observed controls jointly that we included in our Model 1.



Appendix I. Production system descriptions

The table below describes the main production systems in Switzerland, corresponding labels and pest management requirements.

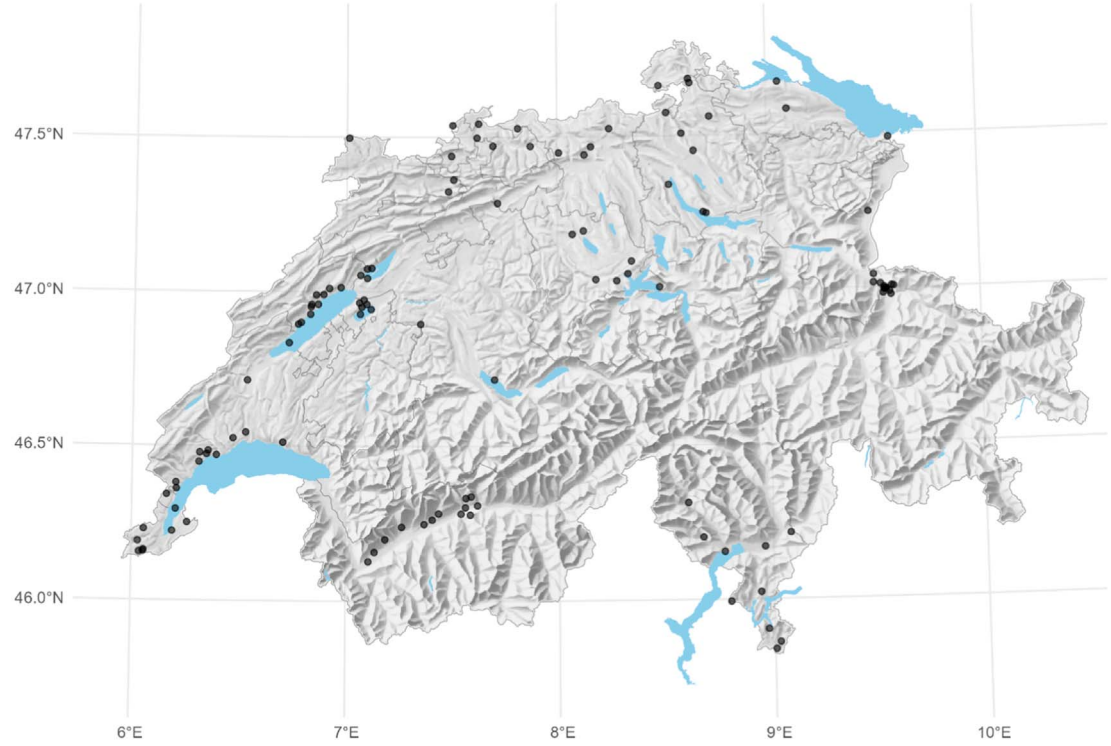
Production system	Policy domain	Pest management requirements	Sources
None	Public (legal)	Legal minimum requirements	
Proof of ecological performance	Public (legal)	Details are not shown here, refer to the source for more information.	(Fédération suisse pour le développement d'une vitiviniculture durable 2022)
Integrated production	Private	Details are not shown here, refer to the source for more information.	(IP-SUISSE 2022)
Organic ordinance	Public (legal)	Partial organic farm management is possible, e.g. organic viticulture, other branches under Proof of ecological performance. Requirements for plant protection: - No plant growth hormones - No herbicides - Approved plant protection products according to Annex 1 of the Ordinance of the Federal Department of Economic Affairs, Education and Research (WBF) on organic farming. Maximum amounts of pure copper: - max. 4kg per ha and year	(Steinemann *et al* 2022)
Organic production (Bio Suisse)	Private	Full organic farm management. Requirements for plant protection: - No plant growth hormones - No herbicides - Approved plant protection products according to the input list of FiBL Maximum amounts of pure copper: - max. 4kg per ha and year	(Steinemann *et al* 2022)

(Continued.)

Production system	Policy domain	Pest management requirements	Sources
Biodynamic production	Private	Similar as organic production (Bio Suisse), but approved measures and substances according to the Demeter guidelines. Use of biodynamic preparations, more restricted copper use (e.g. max. 3 kg per ha) compared to Bio Suisse.	(Steinemann *et al* 2022)

Appendix J. Sample visualisation and reach

The graph below illustrates the distribution and reach of our sample of 115 organic growers across Switzerland.



Note: Each dot represents a farm that indicates to grow grapevines according to organic principles. The dots are randomly placed within the municipalities and do not indicate the actual locations of the farms. This ensures the anonymity of the survey participants.

Appendix L. Environmental stewardship and high grape quality

Here we elaborate on the variable 'Environmental stewardship' which is 1 if the growers sees environmental stewardship as their primary goal, 0 else (N = 17) as well as 'High grape quality for wine-making' (N = 61). We include them as a single predicter (column 1) and together with control variables (2). In all regressions, we find no relationship between environmental stewardship and high grape quality and organic downgrading.

	Organic downgrading (i.e. organic production without organic labelling, Yes: 1, No: 0)			
	(1)	(2)	(3)	(4)
Environmental stewardship is their primary goal (Yes: 1, No: 0)	−0.027	−0.032		
	(0.104)	(0.097)		
High grape quality for wine-making is their primary goal (Yes: 1, No: 0)			−0.053	−0.067
			(0.068)	(0.066)
Controls	No	Yes	No	Yes
Wine region FE	No	Yes	No	Yes
Observations	115	115	115	115
R^2	0.0004	0.073	0.003	0.077
Adjusted R^2	−0.008	−0.036	−0.006	−0.032

$^{**}p < 0.05$, $^{***}p < 0.01$. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

Next, we regress the same regression as above, but replace the dependant variable with an organic dummy (organic production, Yes: 1, No: 0, N = 115) and compare organic growers with non-organic growers in relation to environmental stewardship as their primary goal (N = 433).

	Organic production (i.e. organic production, Yes: 1, No: 0)			
	(1)	(2)	(3)	(4)
Environmental stewardship is their primary goal (Yes: 1, No: 0)	0.176***	0.148***		
	(0.064)	(0.053)		
High grape quality for wine-making is their primary goal (Yes: 1, No: 0)			−0.043	−0.049
			(0.028)	(0.023)
Controls	No	Yes	No	Yes
Wine region FE	No	Yes	No	Yes
Observations	433	433	433	433
R^2	0.013	0.122	0.002	0.115
Adjusted R^2	0.011	0.096	0.00005	0.090

$^{**}p < 0.05$, $^{***}p < 0.01$. Clustered and wild bootstrapped standard errors at the wine region are shown in parentheses.

The table above shows that environmental stewardship is much more important for organic growers than for non-organic growers. However, among organic growers, there is no significant difference between those who use the organic label and those who do not.

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