SUSTAINABILITY PRACTICES AT NEW JERSEY WINERIES
Exploring the Roles played by Agricultural Tourism and Firm Size

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ABSTRACT – *Using original survey data on 30 New Jersey winery-vineyards, this study tests whether there are more environmentally sustainable practices at operations that practice agritourism, and also at wineries that are relatively large. We take special care to deal statistically with this small sample. The number of sustainability practices in the sample is positively correlated with the quantity of output in bottles and with the amount of land planted in grapes. Agritourism has no discernible effect on conservation practices, in contrast to some prior studies on farms outside of this sector. It is argued that winery-vineyards are unique in ways that cause them to ignore agritourism and other forms of direct marketing as reasons to alter their production processes.*

KEYWORDS – Agritourism, Sustainability, Business Innovation, Wineries, Vineyards, Northeastern US, Environmental Conservation, Food, Beverage, Farming Practices.

1. INTRODUCTION

A significant literature on sustainability practices in the global wine industry has emerged over the last two decades (Santini, Cavicchi, and Casini 2013). It is difficult to use this literature to test hypotheses about the industry's relative

sustainability performance, which we will define in strictly environmental terms. With one exception (Pullman, *et al.*2010), data samples cover the wine industry only. A second challenge with the existing literature is that a significant number of studies test hypotheses drawn from psychosocial, management, and organizational behavior theory (Marshall, *et al.*2005; Marshall, *et al.* 2010). Focusing heavily on the preferences of managers and stakeholders, these studies often fail to uncover important structural relationships of which the respondents themselves may be unaware.

The present study uses regression analysis to investigate two such structural relationships in a sample of winery-vineyards: (1) the relationship between *agritourism* and sustainability practices, and (2) the relationship between *operation size* and sustainability practices. The first of these two causal factors relates to consumer preferences within a local agri-food system. The second relates to management capacity, a more traditional explanation of conservation practices on agricultural operations. The agritourism explanation is essentially "demand side" (marketing and communications-related), while the older explanation is "supply side" (management/resource-related). The present study therefore echoes, and contributes to, a much more general literature on firm innovation [1].

This study is based on a survey of winery practices in the state of New Jersey, in the northeastern U.S. Compared to California, which does engage in voluntary environmental standard-setting (Warner 2007; Desta 2008), winemaking in the Northeast is relatively young (Villaneuva and Moscovici 2016). As it strives to achieve critical mass, one would expect the northeastern U.S. wine industry to allocate more resources to growth and marketing than to environmental self-regulation. It will therefore be interesting to see how many sustainability practices our wineries engage in overall.

We begin with a literature review on the effects of the two causal variables in which we are interested.

[1] See Damanpour 1991 and Racela 2014 for old and new perspectives, respectively, on the causes of organizational innovation.

2. Literature and Hypotheses

2.1. Relationship between agritourism and sustainable winegrowing

It is difficult to imagine a behavioral model in which business managers who maintain a strictly arms-length relationship with their retail customers would implement more environmental practices than those who invite customers onto the production site. The opposite view – that there will be a positive correlation between agricultural visitors and sustainability practices – is commonplace. Sheherawat, Mehta, and Hu da 2011, for example, sought the opinions of 80 agritourism operators in India. Their respondents claimed that agritourism operations have additional funds to allocate to innovative activities. They also avoid monoculture and farm less intensively, thus improving soil quality, according to those surveyed.

When the subject turns to wineries and vineyards, Breitműn 2013 argues that the notions of terroir, history, and local food culture with which wine is associated will inevitably encourage sustainable practices. Also discussing wine, Mueller, Sumner, and Lapsley 2010 speculate that "being attractive to [wine] tourists" involves "a pleasant natural environment", "cultural events", and "environmental stewardship". Villanueva and Moscovici 2016 concur, and point to consumer surveys confirming that wine tourists value sustainability more than other wine buyers (Barber, Taylor, and Deale 2010; Taylor, Barber, and Deale 2010).

Although the logic that connects agritourism to environmental stewardship is clear, empirical evidence based on operational data is limited. In the first truly comprehensive study, Barbieri 2013 compared agritourism operations to other types of "entrepreneurial" farms selected on the basis of membership in a direct marketing association. She found that agritourism operations were more likely to implement integrated pest management, but were less likely to practice sustainable waste management or to propagate native plants. These results were compensated in part by agritourism's stronger performance on broader measures of sustainability, like succession planning and the preservation of landscapes and historic structures.

Of the 21 articles that cited Barbieri 2013 in the Social Science Citations Index, six are strictly about the economic benefits of agritourism. Only one of the citing articles, Mastronardi, *et al* 2015, asked the question, "Is agritourism eco-friendly?" This study included 11,200 Italian farms, approximately 3% of which were engaged in agritourism in 2011. Mastronardi and his co-authors

found that agritourism operations did better than the non-tourism farms on criteria of landscape preservation, biodiversity, renewable energy, less intensive use of chemical inputs, and the adoption of environmental certification. In other words, they behaved more sustainably across the board.

The present study is the first to use a sample of winery-vineyards to test Barbieri's and Mastronardi's hypothesis linking agritourism to greener behavior. It is similar to Barbieri 2013 in the sense that the entire sample consists of relatively entrepreneurial agricultural operations, only some of which engage in agritourism. It is similar to Mastronardi, *et al* 2015 by virtue of its large selection of variables on environmental practices. (Barbieri includes social dimensions of sustainability in her study, which reduces the number of environmental practices she is able to consider.)

2.2. Relationship between operation size and sustainable winemaking

A volume by the American Farmland Trust (Thompson 1986) argued forcefully that small farmers make especially good environmental stewards. D'Souza and Ikerd 1996 argued that small farms will be more sustainable simply because they are not engaged in industrialized monoculture. Small farmers are said to farm less intensively. They are also more likely to farm for lifestyle reasons, and to have personal objectives that go beyond profit maximization.

The alternative — and much older — view is that large agricultural operations have greater management capacity for making conservation investments. These investments will also be more profitable on operations that can leverage economies of scale (Lambert, *et al.*2007). To quote from a U.S. government report now thirty years old: "Most studies indicate the larger the farm size and the more income produced by the farm enterprise, the greater the use of conservation practices" (Clearfield and Osgood 1986).

In 2018, this conclusion remains unchanged. For example, two meta-studies conducted over the last ten years by a team of natural resource specialists in the U.S. found that farm size is consistently related to the adoption of environmental best management practices, including conservation tillage, precision agriculture, nutrient management, and integrated pest management, among others (Prokopy, *et al.*2008; Baumgart-Getz, Prokopy, and Floress 2012).

The relationship between farm size and environmental practices at win-

ery-vineyards is discussed in the literature only in passing. Pullman, *et. al.* 2010 puts the subject off for a future paper. Sinha and Akoorie 2010 found a significant relationship between the number of winery employees and recycling, but no relationship for energy conservation or pesticide use, and nothing at all using cases of wine produced as the measure of operation size. Also working in New Zealand, Gabzdylova, *et al.* 2009 found no obvious correlation between operation size and the intensity of sustainability practices. This conclusion is based on a frequency table with 24 observations distributed across three size classes.

Although the existing literature on farm size and sustainability practices offers contradictory hypotheses, we predict that the larger winery-vineyards in our sample will engage in more conservation activities, following the resource availability/management competency view. Our reasoning is that all of the operations in our sample are small by US standards (less than 70 acres) and pursue handicraft production, broadly defined. Industrial-scale farming is essentially missing from the dataset, reducing the source of variation in environmental stewardship hypothesized by authors like Thompson 1986 and D'Souza and Ikerd 1996.

3. Data Collection, Preparation, and Descriptive Statistics

A survey of wineries in the state of New Jersey was conducted in 2013. Using the New Jersey Department of Agriculture's winery websites and all state growers associations, we developed our sample frame. The state of New Jersey lists 45 wineries (New Jersey Department of Agriculture 2016). All of these wineries have at least some vineyard land, which is required by state law. The survey was conducted in person with management or owners of the establishment. The final response included 30 winery-vineyards in the State of New Jersey, for a 66.7% response rate.

Table 1 below reports descriptive statistics for our survey sample. The column labelled N shows the number of respondents who answered the question in that row; the number of nonresponses can be calculated as 30 – N. For purposes of regression analysis, most of these missing values were imputed using techniques described below. The correlation coefficients between pairs of variables did not suggest any collinearity concerns.

Table 1. Variables used: Survey questions and descriptive statistics

Original Survey Question	Variable name	N	Mean	Minimum	Maximum
Dependent variable					
Number of sustainability practices at the winery (out of 18 possible: see below)	Practices	30	5.73	2	9
Agritourism variables					
Do you serve food?	Food	30	0.77	0	1
What percentage of your bottles are sold at the winery?	Onsite_sales*	27	0.77	0	1
Operation size variables					
Approximately how many bottles do you produce annually?	Annual_bottles*	29	35686.55	2000	121110
How many acres planted?	Land_area_planted	30	16.90	3.25	70
Additional control variables					
Average price of a bottle (approx.)	Average_price	30	17.33	12	36
When was the vineyard established? (coded age = 2016 - answer)	Age_in_2016	30	16.53	7	39

Table 1 (continued).

Original Survey Question	Variable name	N	Mean	Minimum	Maximum
Individual sustainability activities (18)					
Do you compost any of your waste?	Composting*	28	0.79	0	1
Does your winery utilize any type of Integrated Pest Management (IPM)?	IPM*	28	0.46	0	1
Do you use pheremone traps?	Pheremone	27	0.19	0	1
Do you use bug traps?	Bugtraps*	27	0.30	0	1
Do you use cover crops?	Covercrops	29	0.72	0	1
Have you placed any owl boxes or raptor perches?	Owlboxes	30	0.20	0	1
Does your winery use any "healthy" practices that may help to rebuild healthy soil for each harvesting season?	Soil*	27	0.67	0	1
Do you use herbicides or fungicides?	Herbicide	25	0.80	0	1
Do you use pesticides?	Pesticide*	26	0.73	0	1
Do you rely on rainfall rather than irrigate your grapes?	Dry farm*	25	0.52	0	1
Do you collect rainwater?	Rainwater*	27	0.15	0	1
Do you burn your prunings?	Burn_pruinings	29	0.38	0	1
Do you use bottles that are environmentally friendly?	EFB	26	0.12	0	1
Has your winery conducted a carbon footprint analysis? (no variation in sample)	CO2	27	0.00	0	0
Do you use sulfites? (no variation in sample)	Sulfites	27	1.00	1	1
Are you wines aged underground?	Underground	29	0.24	0	1
Do you use daylighting?	Daylight*	29	0.59	0	1
Do you use energy efficient light bulbs?	Lightbulbs*	28	0.75	0	1

* Included in the imputation model

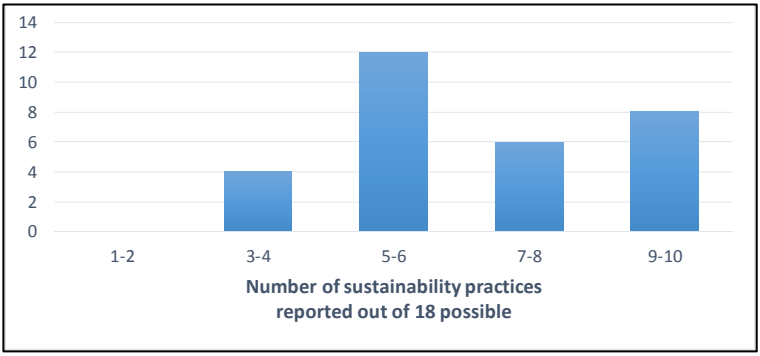

Figure 1 – Distribution of 30 wineries by count of sustainability practices

Figure 1 shows a histogram of our 30 wineries by total count of sustainability practices (this is the variable labelled "Practices" in *Table 1*). This figure helps to answer a basic question: Can our sample of 30 wineries be divided into two distinct groups – those that engage in sustainable practices almost all the time, and those that do the opposite? If that were the case, then the histogram in Figure 1 would be bimodal: one set of wineries would cluster at the far right, while another would cluster at the far left. Figure 1 suggests that this "all-or-nothing" hypothesis for winery sustainability practices is not correct. Instead, we have a large cluster of operations in the middle category and a smaller cluster in the top category (which still implies fewer than 10 of the 18 possible practices). There is a strong tendency to engage in multiple practices.

Two-thirds of the operations implement six or more. Overall, sustainability performance is respectable, but not stellar. It should be noted that many of the questions in our survey represent environmental practices that are specific to this industry; the rate of adoption is *not* low because a practice simply does not apply.

4. Statistical Methods

4.1. Multiple imputation to handle missing data

Having a small sample places a premium on figuring out how to handle missing data. When faced with a blank cell for a variable that is used for analysis, most statistical software packages will simply throw away the entire observation. This arbitrary approach to missing data could take a small dataset and quickly convert it into one that is unusable.

According to Graham 2012, the preferred techniques for dealing with missing data are (1) full information maximum likelihood (FIML), which uses the available data in each observation; (2) "expectation and maximization" algorithms designed to produce a covariance matrix and vector of means (EM), and (3) multiple imputation of several complete datasets (MI).

The third of these techniques has a number of advantages, both in general and for our particular situation. It has the advantage of simulating the expected noise in its estimates of the missing data (Graham 2012). In addition, Monte Carlo tests have found it to be acceptable in small-data situations, defined as low as 50 observations (Graham and Schafer 1999). Barnard and Rubin 1999 argue that MI is appropriate for small samples provided that a minor adjustment is made in the combination step, where the imputed datasets are aggregated and analyzed together.

In our dataset of 30 winery-vineyards, approximately 6.7% of the individual survey answers are missing. After inspecting the raw data, we believe it is appropriate to assume that these data are "missing at random" (MAR), a useful feature of the data for the proposed technique. *Table 2* below shows regression results for 25 imputed datasets, following the procedures recommended in Rubin 1987 and Barnard and Rubin 1999.

4.2. Choice of link function

The hypothesis tests in which we are primarily interested use a count of sustainability practices as the dependent variable. When using this dependent variable, we recognized that we had three choices of link function: Poisson, the standard transformation for count data; Tobit, because our count of sustainability practices has both a minimum and a maximum; and ordinary least squares, because our counts are distributed more or less normally and are not clustered near zero.

We ran several identical models using all three of these link functions. Our results were highly robust to the choice of link function. For this reason, and because it is the obvious approach to count data, we report here only poisson results for those models where the dependent variable represents a count of sustainability practices.

5. EMPIRICAL RESULTS

Table 2. Eight poisson regression models in which the count of sustainability practices is the dependent variable. Based on 25 imputed datasets.

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
SIZE OF OPERATION								
Annual_bottles								
parameter estimate	0.373**	0.366**			0.379**	0.376**		
standard error	0.155	0.151			0.156	0.152		
Pr > t	0.012	0.012			0.012	0.011		
Land_area_planted								
parameter estimate			0.006*	0.007**			0.006*	0.007**
standard error			0.004	0.004			0.004	0.004
Pr > t			0.057	0.042			0.055	0.043
AGRITOURISM								
Onsite_sales								
parameter estimate	0.040		-0.054		0.015		-0.080	
standard error	0.224		0.225		0.226		0.228	
Pr > t	0.430		0.406		0.474		0.364	
Food								
parameter estimate		0.051		0.131		0.019		0.109
standard error		0.167		0.174		0.173		0.182
Pr > t		0.381		0.231		0.457		0.278
ADDITIONAL CONTROLS								
Average_price								
parameter estimate					0.008	0.007	0.005	0.002
standard error					0.015	0.015	0.015	0.015
Pr > t					0.307	0.314	0.381	0.447
Age_in_2016								
parameter estimate					-0.004	-0.004	-0.005	-0.004
standard error					0.009	0.009	0.009	0.009
Pr > t					0.322	0.324	0.279	0.309

**Statistically significant at the 5% level, one-tailed test
*Statistically significant at the 10% level, one-tailed test

Table 2 shows results for eight poisson regression models in which the dependent variable is the total count of sustainability practices for each winery-vineyard. With a survey sample of only 30, we must economize on degrees of freedom. For this reason, we focus on six independent variables that are both prominent in the literature and necessary to test our hypotheses. These six independent variables are of three main types. Two measure operation size, two measure the degree of agritourism, and two are included as controls.

Consider now the two controls. Average price of a bottle captures the socio-economic status of a winery's typical customer, as well as economic rents that could be used for innovative programs. Age of the winery in years is included as an additional measure of stability and management capacity. We expect a positive regression coefficient on both of these control variables. Because all regression coefficients in the models are hypothesized to be positive, *Table 2* reports one-sided t tests of statistical significance.

To conserve degrees of freedom, no model in *Table 2* includes more than four independent variables. Two of our variables measure precisely the same concept, operation size. The same is true of our two measures of agritourism. Rather than combine these pairs of duplicative variables, we use only one variable to proxy each concept and run all possible 2x2 combinations of the variables of interest. This gives us models 1 through 4 in *Table 2.* We then repeat this process with the two control variables added, giving us models 5 through 8.

Table 2 supports the hypothesis that within our population of small to medium-sized operations, the larger ones engage in more sustainability practices. The positive coefficient on the number of bottles produced is a highly significant predictor of sustainability practices. It is also robust to alternative model specifications. The amount of land in cultivation is correlated with the number of sustainability practices, but with somewhat less statistical significance. In contrast, neither measure of agritourism is statistically significant, nor are the two control variables.

We conclude that within our special sample, the traditional capacity-driven explanation of environmental practices (Baumgart-Getz, Prokopy, and Floress 2012) is confirmed. There is no evidence of a correlation between the number of environmental practices and agritourism. This second finding conflicts with results on *all* agricultural operations, as reported in Mastronardi et al 2015 and to a lesser extent, in Barbieri 2013.

6. Discussion and Conclusion

What explains the difference between our agritourism results and the two empirical articles that came before? The most obvious answer is that our small sample generated Type II error: the relationship exists in the population, but our tests lack statistical power. This does not explain, however, why our results on operation size are so significant. Perhaps the "signal" for operation size is much stronger than the signal for agritourism, so it is able to cut through the statistical noise.

Another factor that might be relevant to our findings is the fact that winery visitors in New Jersey tend to be "daytrippers. " They visit the vineyard and sample its product, but they do not typically travel from a distance or stay overnight. This contrasts with wine tourism in northern California, and also to some degree with general agritourism in Europe. Mastronardi *et al* 2015 report a large number of agricultural operations that supply not only food and drink onsite, but also lodging.

We suspect, however, that the real reason for our divergent finding is that Breitműn's 2013 speculation about the uniqueness of wine and terroir is, in the end, correct. Sustainability outcomes at wineries represent a kind of tug-of-war among (1) idealistic aspirations related to terroir, (2) certain inescapably dirty production practices [2], (3) the specter of formal eco-certification with its pros and cons, and (4) an obsessive focus on product quality – even occasionally at the cost of profitability (Morton *et al.*2002). The literature suggests that winery owners and managers believe that sustainability practices contribute to the overriding goal of product quality (Delmas and Grant 2014; Gabzdylova, *et al.*2009; Pullman, *et al.*2010; Warner 2007). This gives them significant incentives that have nothing to do with the presence of onsite visitors.

Agritourism is widespread at North American winery-vineyards and is a major component of place-based marketing. Even operators who do not currently engage in this practice may need to plan for it as a contingency. At the same time, wine customers (and others) tend to have a cozy, positive feeling about the practice of growing wine grapes, even if it is not warranted.

[2] Note that 100% of the wineries in our sample use sulfites as a preservative. It is difficult to avoid this practice while still delivering a quality product with a stable shelf life. None of our wineries carry the organic label, because it is virtually impossible to grow wine grapes in New Jersey's wet climate without the use of fungicides.

This gives vineyard operators what you might call a "free pass" (Christ and Burritt 2013; Warner 2007).

For all of these reasons, it should be no surprise that there is no significant correlation between agritourism and sustainability practices at a sample of wineries. To drive home this point: If you run a large soybean farm in Iowa – let's say one that also has some hogs – and you want to invite visitors onto your farm, you would probably do an inventory of your existing environmental practices and upgrade them in a hurry. If you run a winery-vineyard and your operation is reasonably picturesque, you would have the luxury to skip this environmental audit.

Further research in this area should consider the synergies and trade-offs among product quality and sustainability practices, in the context of owner preferences that are known to sacrifice profit on occasion (Morton et al.2002). It would compare sustainability performance across winery-vineyards and other types of value-added agricultural enterprises. It would seek to link operational decisions to consumer willingness-to-pay for sustainable wine (Schmit *et al.*2013; Corsi and Strom 2013; Delmas and Grant 2014), possibly comparing upscale and downscale market segments. It would compare older, established wine regions like California to new vineyard lands like those along the U.S. Appalachian ridge (Villanueva and Moscovici 2016). Finally, it would use additional small-sample techniques on datasets like this one, as well as additional data, to confirm these results on operation size and agritourism.

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