

THREE ESSAYS ON MARKETING AND CONSUMER BEHEVIOR OF  
AMBIGROUS PRODUCTS: THE CASE OF WINE

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Jie Li  
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# THREE ESSAYS ON MARKETING AND CONSUMER BEHAVIOR OF AMBIGUOUS PRODUCTS: THE CASE OF WINE

Jie Li, Ph.D.  
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This dissertation consists of three independent research papers focusing on wine marketing and consumer wine preferences in the U.S. The first paper, entitled “*Taste physiology and consumer behavior---A Lab Experiment*”, examines how consumer heterogeneous taste physiology influences purchasing decisions in the presence of external cues (product tasting information). This paper collects data from 201 adult participants in a lab experiment and uses ANOVA and post-hoc pairwise comparisons to examine the impact of taste physiology. The results indicate that taste physiology influences how consumers perceive wine tasting information as well as their purchasing behavior. The results also indicate that consumers pay little attention to wine tasting information for lower price wines; however, both supertasters and non-supertasters are influenced by the tasting information for higher price wines. Supertasters and non-supertasters appear to have different attitudes toward the sensory descriptors. The potential marketing implications as well as the future research are also discussed at the end of this paper.

The second paper, “*Nature or Nurture? The influence of taste physiology and consumer product expertise on consumers’ purchasing behavior---A Field Experiment*”, extends the research of the first essay and examines to what extent consumers’ preferences and behavior are learned and to what extent they are innate. This paper relies on a field experiment in two wineries in the Finger Lake region with 385 winery visitor

participants. This paper examines how consumer heterogeneous taste physiology and product expertise influence purchasing behavior, particularly when wine description cues are presented. The results show that the interaction between consumer taste physiology and wine expertise contributes to the differences in purchasing decisions across consumers. Seemingly small differences in wine tasting description can have substantial impacts on purchasing decisions. Furthermore, this paper provides evidence that expert consumers exhibit a bias against the use of the “sweet” descriptor, with it negatively influencing their perception of wine quality and purchasing intent.

Finally, the third paper moves away from examining the impact of consumers’ taste physiologies on their wine purchasing decisions and considers more broader marketing issues in the wine industry. The “*Does passion for wine matter? The effects of owner motivation on pricing and quality decisions in non-traditional wine regions*” paper uses a survey instrument and develops hypotheses based on a utility maximizing framework, explicitly measures winery owner motivation to enter the winery industry, and empirically examines how the motivation influences winery pricing and quality decisions. This paper tests the hypotheses using data collected from 700 wines from 102 wineries in non-traditional wine regions of Missouri, Michigan and New York in 2012. The results indicate that a winery owner driven more by a passion for wine (labeled as passion-oriented owner) tends to produce higher quality wines and charge higher quality-adjusted prices. In contrast, a winery owner mainly driven by the

opportunity to make profits (labeled as profit-oriented owner) tends to produce lower quality wines and are more likely to set lower quality-adjusted prices in comparison to their passion-oriented counterparts. This essay concludes with a discussion of the policy and marketing implication of these findings and suggestions for future research.

## BIOGRAPHICAL SKETCH

Jie Li received her B.A. in economics from Beijing University of Posts and Telecommunications (BUPT), China in 2009. She received her Master of Science Degree from Applied Economics and Management Department at Cornell University in 2011 and then she continued the PhD program in 2012. Her current research interests are in the fields of wine economics, consumer preferences, and wine marketing.

To my parents, Yushuang and Zhizeng, who have always believed in me.

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## **CHAPTER ONE. Introduction**

### **1.1 Background**

#### **1.1.1 U.S. Wine Industry**

The United States has been the world's largest wine market since 2010 (Wine institute, 2015). The retail value of wine sales exceeded \$55.8 billion in 2015, an impressive 112% increase from 2000 (Statista, 2016). The number of wineries in the U.S. reached 8,702 in 2016, a 37% increase from 2009, with California being the leading wine producing wine region in the U.S., followed by Washington, Oregon and New York (Statista, 2016).

In the past decade, a substantial number of small- and medium-sized wineries have been established in non-traditional wine regions such as Missouri and Michigan. These wine regions have experienced a large increase in vineyards, grape production, and number of tourists. For instance, the number of wineries in Michigan reached 147 in 2016, an impressive 250% increase from 2005 (Statista, 2016), and the area of vineyards doubled over the last 10 years (Michigan Grape and Wine Industry Council, 2014). These entrepreneurial activities also brought substantial economic benefits to these regions. For instance, in Missouri, a state with only 128 wineries and 1,700 acres of land planted to grapes, the total economic impact of the wine industry is estimated to be \$1.76 billion annually (Missouri Wines, 2015). Similarly, Michigan's 121 wineries

contribute more than \$300 million annually to Michigan's economy (Michigan Grape and Wine Industry Council, 2014). More surprisingly, the direct and indirect economic impacts generated by the New York wine industry were estimated to exceed \$5 billion in 2014 (New York Wine and Grape Foundation, 2014).

### 1.1.2 U.S. Wine Consumers

U.S. wine drinkers consumed more than 913 million gallons of wine in 2015, however wineries only produced about 583.4 million gallons (Wine Institute, 2015). Furthermore, wine consumption in the U.S. has grown at a 3% annual growth rate in the last decade, whereas the U.S. is only the number four global producer in terms of quantity (Statista, 2016). As a result, the U.S. became the focus for major wine producers in the world. The U.S. imported about 31% of the total wine consumptions worldwide in 2015. The leading import suppliers are Italy, accounting for 33.35% of the total imported wines, followed by France (22.24%), Australia (9.82%), and New Zealand (9.24%). Due to the above reasons, both domestic and international wine marketers have great interests in understanding the factors influencing American wine consumers' tastes and preferences and using those tastes and preferences to create effective marketing strategies.

The wine industry has experienced a generational change in terms of the forces driving consumption over the past 10 years. In 2015, the number of Millennial wine

drinkers surpassed Baby Boomers to become the largest wine consuming generation. Some reports show that Millennials have different characteristics in comparison with Baby Boomers. For example, Millennials are more open-minded and like to experiment with various wine styles and wines from other new world regions (e.g., Portugal and South Africa), while Baby Boomers prefer domestic wines, especially California wines (Hernandez, 2016). Hernandez (2016) also indicates that Millennials are more likely to be cross-drinkers in comparison with other generations, with only 4% of them exclusively drinking wine and 40% drinking across all alcoholic beverage categories.

In addition to these changing generational forces, wine consumers' tastes and preferences evolve very quickly. American consumers tend to have both predictable and contradictory preferences (Thach and Chang, 2015). For example, Thach and Chang (2015) indicate that although Chardonnay has been Americans' favorite varietal for the past decade, they drink more red wine than white wine. In addition, American's favorite wine taste is fruity (58%), followed by semi-sweet (57%), and sweet (56%), while only 16% of the survey respondents report to liking dry wines; though drier wines seem to be a more dominant wine style in the wine industry. These findings confirm an old saying that "Americans talk dry but drink sweet" and that Americans drink under false pretenses (Barras, 2013).

Wine is not only an agricultural product, it is also associated with social status. While it is common sense that consumers purchase certain luxury goods as a status symbol, such trends in wine consumption have recently become more obvious. For example, sweet wine drinkers considered novice, unsophisticated, and less educated wine drinkers (Burzynska 2013; Teeter 2014). On the other hand, people who drink dry and heavy red wines are considered experts who are very sophisticated with mature palates. The social status component of different wine styles is further suggested by the survey reports (Thach and Chang, 2015) that self-reported wine connoisseurs are more willing to pay more for drier wines and prefer dry/tannic styles, although more than half of the survey respondents reported their preferences for fruity, sweet and semi-sweet tastes. As a result, it is crucial for wine marketers to understand what drives wine consumers' preferences as well as their likes and dislikes.

From the marketing research perspective, previous research indicates that exogenous product information on the label affects consumers' wine choices as well as their hedonic and sensory judgements (Deliza and MacFie, 1996). In particular, product tasting information on the label could have the most positive influence on consumers' taste experience and their purchasing decisions.

From the consumers' perspective, an individual's taste physiology like taste phenotypes and bitterness sensitivities can substantially influence an individual's food and wine preferences (Duffy, Peterson and Bartushuk, 2004; Pickering et. al., 2004).



Bartoshuk (1994) stated that individuals are born with different taste sensitivities due to genetic variation, which may significantly influence wine and food preferences as well as wine consumption patterns in adulthood. In particular, research shows that consumers with extreme taste sensitivities tend to experience the bitterness, irritation, and burning sensation from red wines more intensively than others.

Finally, previous consumer research indicates that consumers' product expertise, a learned experience, significantly impacts their purchasing behaviors. Particularly, consumers with different levels of wine expertise tend to differ in their preferred wine styles and tastes as well as purchasing outlets. However, little is known about how consumers' innate taste physiologies and levels of wine expertise interact with and influence their tastes, preferences and choices.

## **1.2 Dissertation objectives**

The main objectives of this dissertation are to investigate in detail how consumers taste physiologies influence their behaviors when the exogenous wine tasting information is presented as well as to investigate whether and how wine marketers could segment the market based on different consumer taste types and their responsiveness. To that end, one economic lab experiment with non-student participants was designed, focusing on wine tasting information that the wine industry currently is confused with as well as the impact of individuals' taste physiology.

Although a better degree of control is allowed in a lab setting in terms of the observed characteristics and identification of the treatment effects, these results might be not perfectly generalized to the field because of the atypical environment and lack of possibly important factors presented in real life settings (Levitt and List, 2007). For this reason, data from various wineries in the Finger Lake wine region is used to investigate how taste physiology influences wine consumers' behaviors as well as how they perceive different wine tasting information when taking into account their learned expertise.

Another objective of this dissertation is to examine broader marketing issues in the wine industry. As discussed above, a substantial number of entrepreneurs have entered the wine industry in non-traditional wine regions in the recent decades. These entrepreneurial activities in non-traditional wine regions generate substantial economic benefit for their regions. However, it is not well understood what factors are driving these entrepreneurs to enter the wine industry, and to what extent these factors influence a winery's overall quality and pricing strategies as well the impact of these entrepreneurial activities on the market equilibrium price in these regions. Previous research on well-established wine regions indicate that winery owners may be motivated by business opportunity, or they may also be driven by a passion for wine and associated lifestyle. These different motivations to enter the wine industry may lead to different quality and pricing decisions as well as associated marketing

strategies. Therefore, one objective of this dissertation is to study how the entrepreneurs' activities influence market equilibrium prices in these wine regions. Due to above objectives, survey data from winery owners in three non-traditional regions of New York, Michigan and Missouri as well as secondary data regarding wine prices and quality rating scores were collected to investigate the impact of owners' motivations on a winery's pricing and product quality decisions.

The specific objective of this dissertation can be summarized as follows:

1. To examine the impact of consumers' taste physiologies on how they interpret different wine tasting information as well as their purchasing decisions (i.e., likelihood of purchase) in a lab setting;
2. To extend this lab experiment to wineries, estimating how consumers' heterogeneous taste physiologies and level of product expertise influence their purchasing behaviors, particularly when wine description cues are presented;
3. To look into broader marketing issues, estimating the effects of an owner's motivation to enter the wine industry on his winery's pricing and product quality decisions; and to study the industry dynamics (e.g., entry and exit decisions) in non-traditional wine regions.

### 1.3 Dissertation outline

The rest of the dissertation is organized as follows. Chapter 2 presents the first paper, entitled “*Taste physiology and consumer behavior---A Lab Experiment*”. This paper uses wine, a hedonic product, as a focal product category to examine the impact of consumers taste physiologies on their purchasing decisions as well as how they interpret different wine tasting information in a lab setting. This paper uses a between subject experiment, estimates the data using ANOVA and pairwise comparison methods, provides insights into how to use the taste physiology concept to segment wine consumers and make effective market segment strategies. This paper also illustrates how to better target consumers with extreme taste sensitivities (labeled as supertasters) and keep them in the wine industry.

Chapter 3 extends the research of the lab experiment by taking into account consumers’ heterogeneous prior product experience, in the paper “*Nature versus nurture? The influence of taste physiology and learned experience on consumers’ purchasing behavior---A Field Experiment*”. Using the data collected from various wineries in the Finger Lake wine regions, this paper attempts to examine how consumers heterogeneous taste physiologies and product expertise interact and influence their purchasing behaviors, particularly when the wine tasting information is presented. From the perspective of consumer research, consumers’ learned product expertise influences their wine preferences and purchasing behaviors as well as how they perceive information.

However, it is also possible that consumers' heterogeneous taste physiologies (innate characteristics) greatly influence their wine preferences and purchasing behaviors.

This paper attempts to measure to what extent consumers' preferences and behaviors are learned and to what extent they are innate.

Chapter 4 moves from studying wine consumers' behaviors to investigating wine producers' behaviors as well as the marketing issues in the wine industry from a big picture. The paper "*Does passion for wine matter? The effects of owner motivation on pricing and quality decisions in non-traditional wine regions*" uses a survey instrument to collect data from winery owners in non-tradition wine regions of Michigan, Missouri and New York in 2012. This paper attempts to measure how a winery owner's motivation, mainly driven by good profit margin or mainly driven by a passion for wine and associated lifestyle, to enter the wine industry influences a winery's pricing and quality decisions. In addition, this paper investigates how the co-existence of passion-driven and profit-driven wineries in non-traditional wine industry affects the entry and exit dynamics of the wine industry as well as the long-term sustainable growth of these non-traditional wine regions.

## **CHAPTER TWO. Taste Physiology and Consumer Behavior--A Lab**

### **Experiment**

#### **2.1 Introduction**

Food and wine marketers have great interest in finding out the factors influencing consumers' tastes, preferences and choices. Extant marketing research has pointed out that product information substantially influences consumers' hedonic and sensory judgments for food and beverages. As a result, marketers use product information on packaging to provide consumers with favorable sensory expectations that could positively influence consumers' product experience (Deliza and MacFie, 1996). In particular, product information can shape consumers' tasting experience for wine, a complex sensory hedonic product (Siegrist and Cousin, 2009; Thomas, 2012; Wansink, 2007).<sup>1</sup>

On the other hand, from a sensory perspective, an individual's taste physiology such as taste phenotypes and bitterness sensitivities can significantly influence his/her food and wine preferences (Duffy, Peterson and Bartushuk, 2004; Pickering et. al., 2004). Bartoshuk (1994) states that individuals are born with different taste sensitivities due to genetic variation, which significantly influence wine and food

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<sup>1</sup> A complex sensory hedonic product means that consumers' experience with this product has not been completely revealed and may be interpreted in multiple ways (Hoch and Deighton, 1989).

preferences as well as consumption patterns. Individuals who have extreme taste sensitivities are classified as supertasters (labeled hereafter as ST). Previous research shows that supertasters tend to dislike certain bitter food and beverages, including kale, Brussels sprouts, grapefruit, dark chocolate and black coffee (see the literature review below for details).

Although marketers value these insights, we still do not understand how this genetic variation influences consumer behavior as well as whether and how marketers could segment the market based on consumers' taste sensitivity. Furthermore, the interaction between product tasting information and consumer taste physiology has not been studied. However, ignoring this critical link may lead to misinterpretation of consumer data. In response, we design and implement two lab experiments using wine as a focal product category to examine this relationship. These experiments focus on wine tasting information and its interaction with taste physiology.

In recent decades, the prevalent opinion in the wine industry has been that dry wines are of superior quality than sweet wines, and sweet wine drinkers are often associated with being novices and beginners with immature palate. As a result, the “sweet” descriptor is likely associated with cheap wines of inferior quality, whereas the “dry” descriptor tends to be an indicator of superior quality. Consequently, for sweet table wines, winemakers are likely to use the “fruity” descriptor as an alternative to the “sweet” descriptor. However, previous research suggests that supertasters are more

likely to experience bitter, burning, irritated, and astringent sensations from alcoholic beverages (Pickering et al, 2004). They tend to prefer sweet wines because of their extreme taste sensitivities rather than their immature palate (Hanni, 2013). Motivated by the above arguments, the first experiment uses the “sweet” and “dry” descriptors as information treatments to examine how these descriptors influence supertasters and non-supertasters’ purchasing decisions. Later, the second experiment uses the “fruity” and “sweet” descriptors as treatments to examine the impacts of the tasting information and taste physiology on consumers’ purchasing decisions.

The experimental results indicate a significant interaction effect between the tasting information and consumers’ taste status for higher price wines, whereas no such impact is found for lower price wines. We also find that the “sweet” descriptor increases supertasters’ likelihood of purchase for sweet wines in comparisons to its “fruity” counterparts. This study also identifies certain common eating behaviors, personalities and other social-demographic characteristics associated with being a supertaster. These findings could provide insights into how to create effective marketing strategies targeting consumers with different taste sensitivities. In addition, these findings shed light on how taste physiology can be used for segmentation purposes. They can also help the wine industry devise strategies to stimulate wine purchases among the supertaster segment.



## 2.2 Conceptual background

### 2.2.1 Taste physiology

Sensitivity for bitter taste varies across individuals. Previous research suggests that genetic variation in orosensation explains differences in response to a bitter compound 6-n-propylthiouracil (PROP) across individuals, which in turn influences food and wine preferences (Bartoshuk, 1994; Pickering, Jainand and Bezawada, 2013).<sup>2</sup> Furthermore, previous studies have discovered that some individuals are ultrasensitive to bitterness while others are very insensitive. Those with ultra-sensitivity for bitterness are often categorized as supertasters (about 25% of the population), and the rest as non-supertasters (Bartoshuk, 1991). Supertasters tend to have a greater-than-normal amount of taste bud papillae on their tongues, which allows them to experience all flavors more intensely, not just bitterness (Delwiche, Buletic and Breslin, 2001). For example, supertasters and non-supertasters often differ in their perception of sweet compounds (Gent and Bartoshuk, 1983), salty compounds (Bartoshuk et al., 1998), substances that produce oral irritation or pain (Karrer and Bartoshuk, 1991; Cunningham, 2000), and tactile sensations (Duffy and Bartoshuk, 1996; Tepper and Nurse, 1997).

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<sup>2</sup> Orosensation comprises the prototypical tastes (sweet, sour, salty, bitter, and umami) and somatosensory sensations, such as astringency and creaminess, and is a key component of the flavor construct (Pickering and Klodnicki, 2016).

The implications of supertasters' preferences also apply to wine because wine can evoke different taste sensations including sweet, sour, bitter, and salty as well as many tactile sensations (Thorngate, 1997). Research shows that supertasters are more likely to experience irritation and burning sensation (Bartoshuk, 1993 & 1994; Prescott and Swain-Campbell, 2000), along with tasting greater bitterness (Chandrashekar et al., 2000) as well as astringency and acidity in red wines (Pickering, Simunkova and DiBattista, 2004). As a result, supertasters are likely to consume alcoholic beverages less frequently compared with non-supertasters (Duffy, Peterson and Bartoshuk, 2004; Hanni, 2013). In addition, supertasters tend to avoid wines with high levels of bitterness and astringency (Pickering, Simunkova and DiBattista, 2004).

The addition of sweeteners is usually employed to help supertasters mitigate the bitter taste and irritated sensation. For example, Ly and Drewnowski (2001) find that adding a sweetener to caffeine drinks and to PROP solutions lead to a great reduction in bitterness rating among supertasters. Similarly, Yee, Duffy and Bartoshuk (2003) find that adding a sweetener reduces the bitter sensation of strong coffee among supertasters. Hanni (2013) also shows that sweetness in wines can help individuals with extreme taste sensitivity mitigate the burning, bitter and astringent tastes of certain wines. In sum, previous research suggests that supertasters may experience wines with higher sweetness as less bitter and unpleasant, and more enjoyable in comparison to drier wines.

### 2.2.2 Tasting information

Compared with other food and beverage products, wine consumption exhibit higher risk levels given its social cachet, varied nature, and complexity (Lacey, Bruwer, and Li, 2009). Detailed product information may help consumers increase knowledge, minimize uncertainty and reduce risk. Research shows that printed tasting notes on the label are the most common form of wine promotional strategies used by wineries (LaTour, LaTour and Feinstern, 2011). This is because printed tasting description influences choice more effectively in comparison with other attributes such as winery history and wine cellaring/aging advice (Charters et al., 1999; Mueller et al., 2010). Furthermore, detailed sensory information could enhance consumers' perception of wine quality and contribute to increased sales (Thomas et al., 2014). However, what sensory information (i.e., sensory descriptors) could positively influence consumers' tasting experience is somewhat unknown.

In the wine industry, current marketing practices are aggressively promoting heavier and darker dry wines; and these wines tend to garner higher points from expert wine reviewers (Hanni, 2013). In fact, marketers tend to highlight the dry characteristics of their wines in order to lead consumers into thinking that the wine has superior quality and is worth its price tag. For example, it is common that producers add extra sugar in their finished wines but still market them in the dry wine category (Mahoney and Rickard, 2016). On the other hand, sweet wine drinkers are

often perceived as being “green”, “old-fashioned” and “unsophisticated” (Burzynska, 2013; Teeter, 2014). It is commonly heard that when consumers’ palates become more mature, they will often enjoy drier and heavier red wines. As a result, the descriptor “sweet” is often associated with cheap and inferior quality wines.

Producers are reluctant to use the attribute “sweet” anywhere on the label, instead using certain colors or images to indicate that the wine is sweet. For example, Veseth (2015) finds that producers often use black labels and red scripts or images to imply a sweet red wine. On the other hand, producers may use some alternative descriptors such as “fruity” for sweet, light and less astringent wines. One reason is that consumers tend to associate fruity with sweet in their minds (Ortmann, 2016). Another reason is that the “fruity” descriptor seems to be more upscale than the “sweet” descriptor when discussing or ordering wines in public settings (Hanni, 2013). It is common that consumers in restaurants, tasting rooms, or wine stores look for fruit-forward wines (not necessarily sweet) when they actually may want to purchase sweet wines.

However, the truth is that dry wines could still possess an intensive fruit flavor without any residual sugar. For example, a very fruit-forward wine such as Albariño from Spain or Chardonnay from Burgundy could be bone-dry with very high acidity levels that consumers with extreme taste sensitivity may not enjoy. This double use of the “fruity” descriptor for both sweet and dry wines, to some extent, may confound

the wine's aroma versus its taste. Consumers may be misled by the “fruity” descriptor in a wine tasting note and end up drinking a very dry wine. In addition, previous research suggests that descriptions such as “floral” or “essence of peaches and dried apricots” may not add real value to consumers but instead may make consumers more uncertain about their wine choices. It may be possible that the “dry” or “sweet” descriptors are more useful for consumers than metaphorical descriptors (Barber, Almanza and Donovan, 2006).

Motivated by the above reasons, we select different wine descriptors as information treatments in the experiment. In Experiment A, we use the “sweet” and “dry” descriptors as treatments to examine how these descriptors influence supertasters and non-supertasters' purchasing decisions. Later, Experiment B uses the “fruity” and “sweet” descriptors as treatments to examine how sensory information and consumers' taste physiology interact and influence purchasing behavior.

## **2.3 Study A. Tasting information: “Sweet” versus “Dry”**

### **2.3.1 Experimental design**

A 3x2 between-subjects experiment was designed and conducted in the Lab for Experimental Economics and Decision Research at Cornell University. A total of 201 adults' subjects were recruited with a mix of staff, faculty, and residents from the local community. Participants were given \$20 as an incentive to participate in the experiment. Subjects were seated randomly at individual computer terminals with

privacy shields and were informed that all decisions they made would be kept strictly confidential. After signing a consent form, participants were instructed to read the instructions, followed by an oral presentation about the experiment including the amount of money they would earn and the rules of the experiment. The experiment consisted of evaluation of two wines, a PROP paper strip test to identify participants' taste types and a final exit survey to record participants' eating behaviors, personality and socio-demographic information.

Participants were randomly assigned into one of the three groups: one control group, one sweet treatment group and one dry treatment group. In each group, they were given different tasting notes to read. In the control group, participants were given the control tasting note, which was the regular tasting note written by the winemaker without any objective descriptors such as “sweet” or “dry”. For example, the control tasting note read “this wine...”. In the sweet treatment group, participants were given the sweet tasting note, which was the control tasting note with the “sweet” descriptor included. For example, the sweet tasting note read: “this sweet wine...”. Similarly, participants who were in the dry treatment group were given the dry tasting note, which was the regular tasting note with the “dry” descriptor included.

After reading the tasting notes, subjects were instructed to taste and evaluate two wines chosen for use in the experiment, following the suggestions of a master sommelier. One was a red wine. The red wine was a dry, tannic, and intensive dark

California cabernet sauvignon that supertasters tend not to enjoy. The other was a white wine. The white wine was a sweet, juicy, and fruit-forward Finger Lake Riesling with a low acidity level that supertasters tend to prefer. Subjects were asked to indicate their likelihood of purchase for each wine at different price levels (i.e., \$10 and \$30), using a Likert scale from 1 to 7 (with 1 being ‘least likely’ and 7 being ‘absolutely yes’).

Participants were then instructed to perform a PROP paper strip test. That is, participants put a filtered paper strip, which had been previously soaked in a PROP solution and dried, into their mouth for about 30 seconds or until fully wet. Subjects then rated the intensity level of the paper strip sensation using the general Labeled Magnitude Scale (Bartoshuk et al., 2003). This scale ranges from 0 to 100 points, with 0 being tasteless and 100 having the strongest imaginable sensation (See Appendix 2.A for details on the PROP test). Subsequently, following Zhao et al.’s (2003) method, either each participant was categorized as a supertaster or a non-supertaster based on the PROP scores.

### 2.3.2 Hypothesis development

A participant’s likelihood of purchase was measured at different price levels in the experiment. It is expected that the influence of product information on participants’ likelihood of purchase for wine priced at \$10 and \$30 are different. It has been shown that consumers tend to perceive lower risk associated with buying low price products in comparison to higher-price products (See Bauer 1960 for a detailed

review of this literature). This lower perceived risk tends to reduce consumers' information search (Cox, 1967). Therefore, one expects that consumers would pay little attention to wine tasting information for lower-price wines. In contrast, in the case of higher-price wines, one expects that wine tasting information would substantially influence likelihood of purchase.

On the other hand, the literature suggests that taste physiology influences how consumers perceive sensory information. In theory, supertasters should experience red wine with bitter, astringent, irritated and burning sensation more intensively than non-supertasters. Adding sweetness to wine can help mitigate the intensive sensations experienced by supertasters. Therefore, the “sweet” descriptor should have a positive influence on supertasters' purchasing decisions. In contrast, the “dry” descriptor should have a negative influence on supertasters' purchasing decisions. The reason is that the “sweet” descriptor may moderate the intensive bitter and burning sensation of the wine, whereas, the “dry” descriptor may remind them of those sensations. Non-supertasters, who have less taste sensitivity, may not appreciate the sweetness in wine in comparison to supertasters. Therefore, we hypothesize that the “sweet” descriptor may not increase the likelihood of purchase among non-supertasters. However, it is not clear whether or not using the “dry” descriptor would have a positive impact on non-supertasters' purchasing decisions.



### 2.3.3 Results

Among the 201 participants, 66 received a sweet tasting note, 65 received a dry tasting note, and 70 participants received a dry tasting note. Regarding participants' taste status, 51 were identified as supertasters, accounting for 25% of our sample, which is comparable to the percentage of supertasters in the population (Bartoshuk et al., 2004). The rest were classified as non-supertasters (n=150). In our sample, 62% of participants were female. In our sample, 44% of participants were 21-30 of age, 11% were 31 to 40 of age, 16% were in the age group between 41 and 50, and the rest of the participants were over 50 years old. In addition, 44% of the participants reported drinking wine at least once a week, 15% of them reported drinking wines 3 to 5 times a week, and the rest reported drinking wines only occasionally. In our sample, 60% of participants reported drinking wine for less than 10 years, while 30% reported drinking wines for more than 20 years.

STATA statistical software was employed for the two-way ANOVA analysis and pairwise comparison for red and white wines. Table 2.1 reports the ANOVA results, including the mean and standard deviation of each dependent variable for the red and the white wines in the experiment.

**Table 2.1. The impact of taste status and wine tasting information on consumers' likelihood of purchase**

Dependent Variables	Sweet treatment group		Dry treatment group		Control group		F-stats		
	NST (n=49)	ST (n=17)	NST (n=46)	ST (n=19)	NST (n=55)	ST (n=15)	Taste status	Tasting information	Interaction term
<b>Red wine</b>									
Likelihood of purchase at \$10	4.571 (2.102)	5.471 (1.875)	4.717 (2.062)	5.000 (2.160)	4.891 (2.006)	5.000 (2.104)	1.66	0.08	0.51
Likelihood of purchase at \$30	1.490 (0.982)	2.118 (1.933)	1.935 (1.237)	1.159 (0.769)	1.527 (0.959)	2.267 (1.751)	3.07*	0.18	3.37**
<b>White wine</b>									
Likelihood of purchase at \$10	5.633 (2.058)	6.412 (1.228)	5.913 (1.503)	5.526 (1.954)	5.491 (1.884)	5.667 (2.127)	0.40	0.76	1.32
Likelihood of purchase at \$30	1.939 (1.281)	2.706 (1.726)	2.283 (1.456)	2.105 (1.487)	1.782 (1.228)	2.667 (1.543)	4.68*	0.12	2.25

Note: \* = statistically significant at 0.10 level (10%), \*\* = statistically significant at 0.05 level (5%), \*\*\* = statistically significant at 0.01 level (1%). Robust standard errors are reported in parentheses.

- **ANOVA results for red wine**

The red wine results shown in Table 2.1 indicate that the main effects of taste status and tasting information, as well as the interaction term, are not statistically significant when the price is \$10. This suggests that consumers pay little attention to sensory descriptors regardless its appropriateness when the price of wine is low. The ANOVA results at \$30 price level show that taste physiology has a significant impact on consumers' purchasing decisions ( $F=3.07$ ,  $p<0.1$ ). In addition, the interaction effect is significant ( $F=3.37$ ,  $p<0.05$ ), indicating that tasting information influences supertasters and non-supertasters differently. The pairwise comparison results of consumers' likelihood of purchase at different price levels shown in Figures 2.1 and 2.2 are discussed in more details below.

- **ANOVA results for white wine**

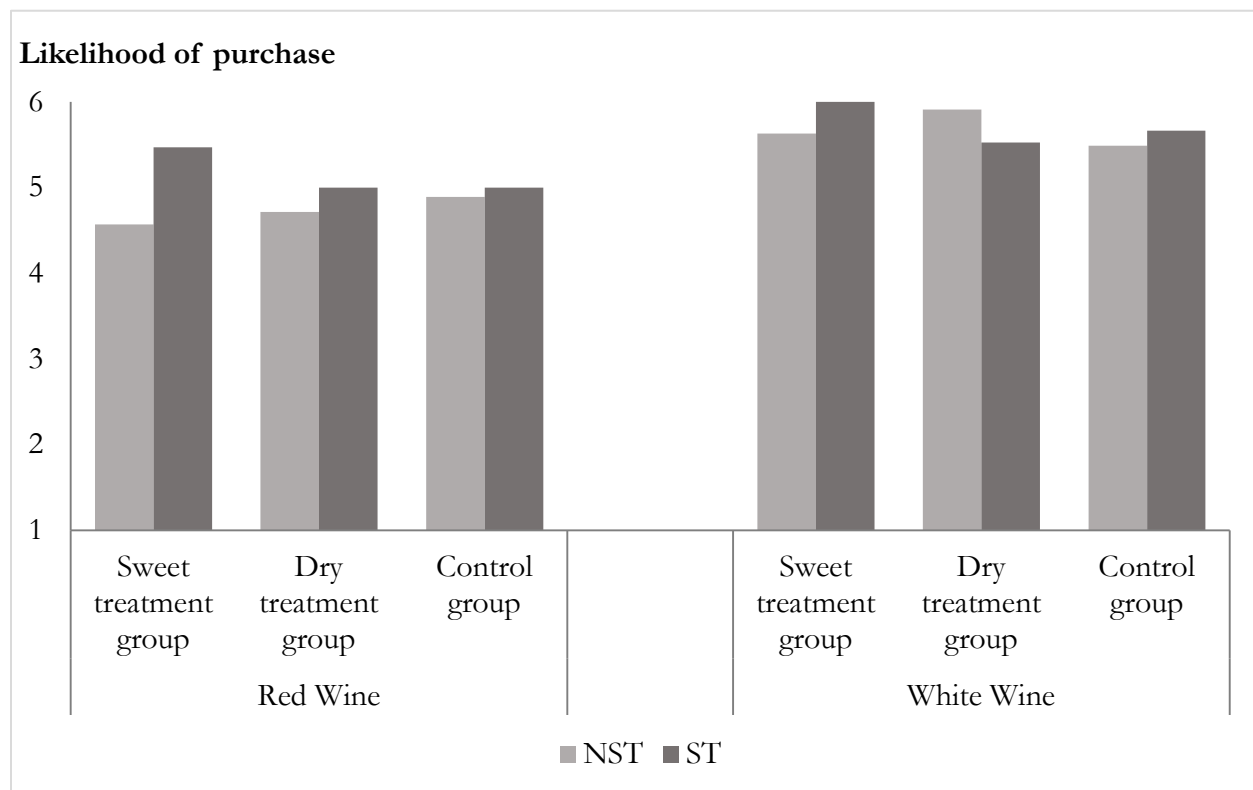
The ANOVA results for the white wine are also reported in Table 2.1. Similar to the red wine results at \$10 level, the main effects of taste status and tasting information, as well as the interaction term are found to be not statistically significant. The ANOVA results at \$30 price level indicate that consumers' taste status significantly influence their likelihood of purchase ( $F=4.68$ ,  $p<0.05$ ). That is, supertasters are more likely to purchase the white wine than non-supertasters do at \$30 price level. However, the main effect of tasting information and the interaction term are not significant at this price level. The pairwise comparison results of

consumers' likelihood of purchase at \$10 and \$30 level are shown in Figure 2.1 and 2.2.

- **Pairwise comparison results at \$10**

The pairwise comparison results are shown in Figure 2.1. The red wine results, shown on the left side of Figure 2.1, indicate that there is no significant difference in consumers' likelihood of purchase across treatment groups at the \$10 price level. This result indicates that there is no treatment effect at this price level. Participants' purchasing decisions are not influenced by the tasting information regardless of their taste status. Although the "sweet" descriptor is not an appropriate portrayal for the red wine, it appears that participants are not negatively influenced by this inaccurate information.

**Figure 2.1. Pairwise comparison results at \$10 level**



Note: NST indicates Non-supertasters; whereas NT indicates supertasters. These above results come from the Tukey's post-hoc comparison.

The white wine results, shown on the right side of Figure 2.1, are similar to the red wine results at the \$10 price level. The results indicate no significant differences in likelihood of purchase across treatment groups as well as between supertasters and non-supertasters. This finding suggests that participants are less likely to be influenced by the “sweet” and “dry” descriptors in the tasting notes, regardless of their taste status. Participants pay little attention to the sensory profile of the wine. Neither the “sweet” descriptor nor the inappropriate “dry” descriptor has a significant impact on likelihood of purchase. These findings, combined with the results for red wine, are

consistent with the expectation that consumers pay little attention to the sensory information when shopping for low-price wines. That is, for low-price wines, the perceived risk associated with the decision to purchase is small or the tasting information attribute is not as salient as the price attribute when purchasing for a \$10 wine. As a result, they are less likely to seek detailed information (i.e., wine tasting information) to make purchasing decisions.

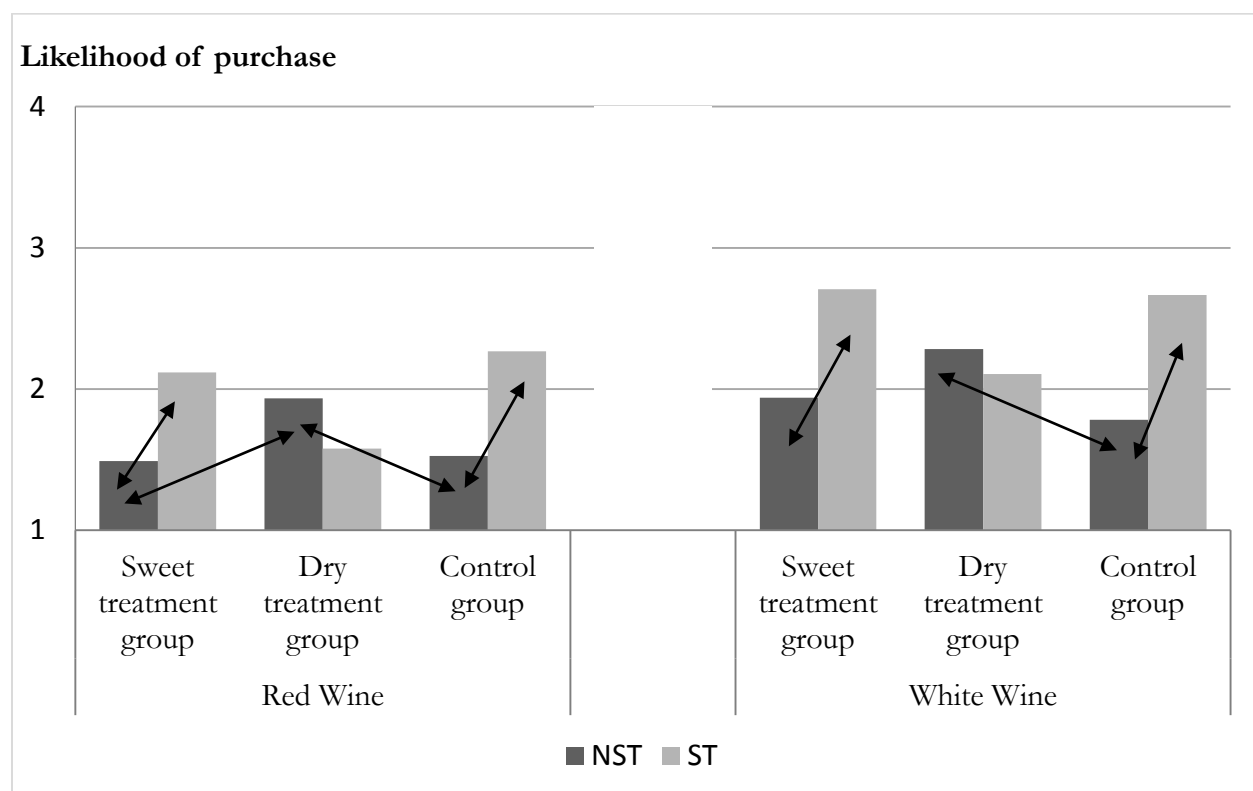
- **Pairwise comparison results at \$30**

The red wine results, shown on the left side in Figure 2.2, indicate that non-supertasters' likelihood of purchase is significantly higher in the dry treatment group than in the sweet treatment group ( $t=1.83$ ,  $p<0.1$ ) and the control group ( $t=-1.73$ ,  $p<0.1$ ). This finding suggests that non-supertasters respond very positively to the “dry” descriptor for a more expensive red wine. Including the “dry” descriptor in the tasting note increases their likelihood of purchase in comparison to the same wine without such descriptor. The reason might be that non-supertasters who have less taste sensitivities do not experience intense bitter, astringent, and irritated sensations from red wine. They may associate the “dry” descriptor with superior quality of a high-price red wine.

Another reason for non-supertasters' higher likelihood of purchase in the dry treatment group than in the sweet treatment group might be that they detect the inconsistency between the sweet tasting note and the actual dry taste of the red wine.

Furthermore, this inconsistency may have negatively influenced non-supertasters' likelihood of purchase in the sweet treatment group. However, the white wine results for non-supertasters suggest that this is not the case and support the argument that non-supertasters prefer the “dry” descriptor and have a negative attitude toward the “sweet” descriptor.

**Figure 2.2. Pairwise comparison results at \$30 level**



Note: NST indicate Non-supertasters; whereas NT indicate supertasters. These above results come from the Tukey's test. The arrow indicates that the mean between those two groups are statistically significantly different from each other.

In addition, the red wine results show that supertasters' likelihood of purchase is significantly lower in the dry treatment group than in the control group ( $t=1.69$ ,  $p<0.1$ ). This indicates that supertasters' purchasing decisions are negatively influenced

by the “dry” descriptor despite it being an accurate description for red wines. In contrast to non-supertasters’ results, supertasters show a negative attitude toward the “dry” descriptor. Including the “dry” descriptor in the label decreases supertasters’ likelihood of purchase for higher price red wines. Supertasters are more likely to purchase the red wine in the control group ( $t=2.16$ ,  $p<0.1$ ) and the sweet treatment group ( $t=1.89$ ,  $p<0.1$ ) relative to the dry treatment group, though the “sweet” descriptor is not appropriate.

The white wine results at the \$30 price level are shown on the right side of Figure 2.2. The results indicate that non-supertasters’ likelihood of purchase is significantly higher in the dry treatment group than in the control group ( $t=-1.80$ ,  $p<0.1$ ). Although the “dry” descriptor is not appropriate for the sweet white wine, it significantly increases non-supertasters’ likelihood of purchase for the sweet white wine. The results suggest that non-supertasters may perceive the “dry” descriptor as an indicator of superior quality for higher price wines regardless of the wine type. They are more likely to purchase the wine when given the “dry” descriptor. These findings further confirm that non-supertasters’ lower likelihood of purchase for red wines in the sweet treatment group is not due to inconsistencies between the tasting notes and the actual wine type.

The white wine results indicate that supertasters are more likely to purchase than non-supertasters in the sweet treatment group ( $t=1.95$ ,  $p<0.1$ ) and the control



group ( $t=2.81$ ,  $p<0.05$ ), while no such relationship is found in the dry treatment group. These results imply that supertasters may be negatively influenced by the “dry” descriptor in the case of higher price white wines.

#### 2.3.4 Summary

This study uses a 3x2 between subject experiment to examine how product tasting information and taste physiology interact and influence consumers’ purchasing decisions. The results indicate that consumers, regardless of their taste status, appear to pay little attention to the wine sensory information when the price of wine is low. However, for an expensive red wine, consumers care about the tasting information; and supertasters and non-supertasters respond differently to the tasting information provided. Specifically, the “dry” descriptor increases non-supertasters’ likelihood of purchase; and they may associate the dry characteristic of red wines with superior quality. Consequently, emphasizing the dry characteristic of the dry wine increases their likelihood of purchase for higher price red wines. However, supertasters are less likely to purchase the drier wines if the dry characteristic is emphasized in the tasting note.

### 2.4 Study B. Tasting information: “Fruity” Versus “Sweet”

In this experiment, the “fruity” and “sweet” descriptors are used as the information treatments to examine how consumers with various taste sensitivity

respond to the “fruity” descriptor, and whether it is a better alternative to the “sweet” descriptor for sweet wines.

#### 2.4.1 Experimental Design

This experimental design is similar to Experiment A. A 2x3 between subject experiment was conducted in the Lab for Experimental Economics and Decision Research at Cornell University. In total, 148 subjects participated in the experiment. The participants were randomly assigned into one of the three groups: one control group (n=48), one fruity treatment group (n=46), and one sweet treatment group (n=44). In the control group, participants were given the control tasting note, which was the regular tasting note written by the winemakers without any subjective descriptors such as “fruity”, “sweet”, or “dry”. In the fruity treatment group, participants were given the fruity tasting note, which was the regular tasting note with the “fruity” descriptor included. Similarly, in the sweet treatment group, participants were given the sweet tasting note, which was the same regular tasting note with the “sweet” descriptor included. The control, fruity, and sweet tasting notes were alternated in each experiment session; participants were only given one type of tasting note in each session. Participants evaluated the same wines used in Experiment A: the sweet white New York Riesling and the dry California Cabernet Sauvignon. After they tasted each wine, they were asked to report their likelihood of purchase for the wine they just tasted.

They were later instructed to perform a PROP paper strip test. Participants were categorized as either supertasters or non-supertasters based on their PROP scores. Among the 148 participants, 34 were identified as supertasters, and the rests as non-supertasters.

#### 2.4.2 Hypothesis development

Due to limited research on this issue, how consumers with various taste sensitivities respond to these two descriptors is somewhat unknown. It is expected that supertasters would prefer the “sweet” descriptor to its fruity counterpart. Their likelihood of purchase is higher in the sweet treatment group than in the fruity treatment group as the “sweet” descriptor may actually help them mitigate the strong sensation and focus on the sweet and soft tannins of the wine, while the “fruity” descriptor may not have such function. However, how non-supertasters respond to these descriptors is somewhat unknown. The results from Experiment A have shown that non-supertasters respond more negatively to the “sweet” descriptor, as a result, one could expect that non-supertasters would prefer the “fruity” descriptor relative to its “sweet” counterparts.

#### 2.4.3 Results

The STATA statistical software were employed for the two-way ANOVA analysis and pairwise comparisons for red and white wines. Tables 2.2 reports the ANOVA results, including the mean and standard deviation of participants’ likelihood

of purchase for the red and white wines in this experiment. Figure 2.4 reports the pairwise comparison results for both red and white wines.

- ANOVA analysis results

The ANOVA results for white wine, shown in Table 2.2, indicate that the main effect of taste status has a significant impact on participants' purchasing decisions ( $F=14.42$ ,  $p<0.01$ ). The manipulated tasting information also has a significant impact on participants' purchasing decisions ( $F=2.98$ ,  $p<0.1$ ). Specifically, participants regardless of their taste status are more likely to purchase the white wines in the sweet group than in the fruity group ( $t=1.71$ ,  $p<0.1$ ) and in the control group ( $t=-2.42$ ,  $p<0.05$ ).

**Table 2.2. The impact of taste status and wine tasting information on consumers' likelihood of purchase for red and white wine**

Dependent Variables	Fruity treatment group		Sweet treatment group		Control group		F-stats		
	NST (n=32)	ST (n=14)	NST (n=34)	ST (n=10)	NST (n=38)	ST (n=10)	Taste status	Tasting information	Interaction term
<b>White wine</b>									
Likelihood of purchase	2.63 (1.56)	3.43 (1.41)	3.12 (1.44)	4.45 (1.48)	2.39 (1.31)	3.60 (1.90)	14.42***	2.96*	0.31
<b>Red wine</b>									
Likelihood of purchase	2.03 (1.03)	2.5 (1.22)	2.07 (1.18)	3.40 (2.09)	2.30 (1.22)	2.60 (1.35)	7.73***	1.21	1.53

Note: \* = statistically significant at 0.10 level (10%), \*\* = statistically significant at 0.05 level (5%), \*\*\* = statistically significant at 0.01 level (1%). Robust standard errors are reported in parentheses

Not surprisingly, the ANOVA results for red wine show that taste physiology significantly impacts consumers' purchasing decisions ( $F=7.73$ ,  $p<0.01$ ). However,

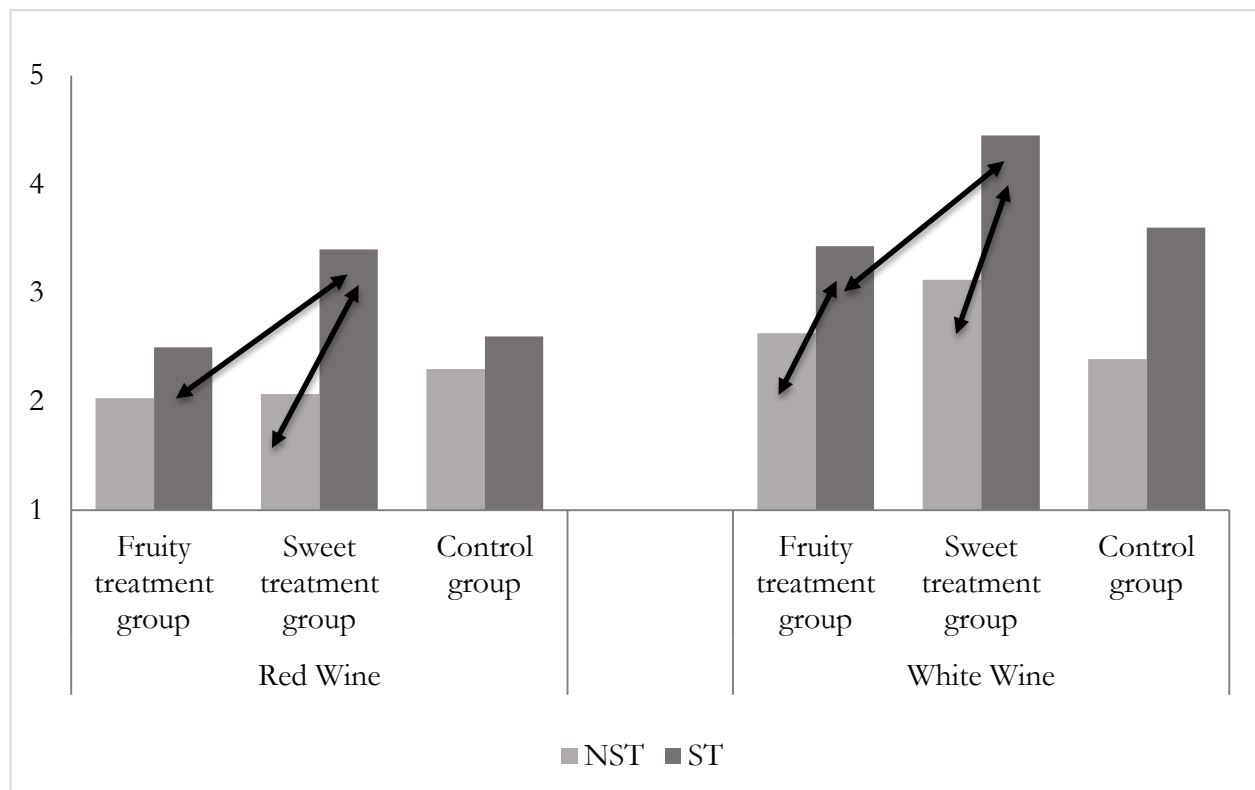
the tasting information is found not significant. The interaction effect between taste physiology and the tasting information is not significant.

- Pairwise comparison results

### ***White wine results***

The post-hoc pairwise comparison results for white wine, displayed on the left side in Figure 2.4, show that supertasters are more likely to purchase the white wine than non-supertasters when presented with the “fruity” descriptor ( $t=1.71$ ,  $p<0.1$ ). In addition, supertasters are even more likely to purchase the wine than non-supertasters in the sweet group ( $t=2.52$ ,  $p<0.1$ ). The results also show that supertasters’ likelihood of purchase is significantly higher in the sweet treatment group than in the fruity treatment group ( $t=1.68$ ,  $p<0.1$ ), and including the “sweet” descriptor in the tasting note substantially increases supertasters’ likelihood of purchase by 30% in comparison to including the “fruity” descriptor. Supertasters appear to prefer the “sweet” descriptor to its fruity counterpart for a sweet white wine. However, no significant differences are found for non-supertasters between the sweet treatment group and the fruity treatment group.

**Figure 2.4. Pairwise comparison results for red and white wines**



Note: NST indicates Non-supertasters; whereas NT indicates supertasters. These above results come from the Tukey's test. The arrow between those two groups indicates that the means are statistically significantly different from each other.

### ***Red wine results***

The post-hoc pairwise comparison results for red wine, shown on the right side of Figure 2.4, indicate that supertasters' likelihood of purchase is significantly higher in the sweet treatment group than in the fruity treatment group ( $t=1.73$ ,  $p<0.1$ ).

Similar to the white wine results, supertasters are even more likely to purchase the red wine than non-supertasters in the sweet treatment group ( $t=2.93$ ,  $p<0.01$ ). Although the "sweet" descriptor is inappropriate for the red wine, including it increases supertasters' likelihood of purchase. It seems that the "fruity" descriptor may not help

supertasters relive the bitter sensation of the wine; what supertasters need is the residual sugar in the wine rather than the fruity aroma. However, there is no significant difference of non-supertasters' likelihood of purchase in different groups. It seems that both "sweet" and "fruity" descriptors are not ideal for dry red wines. Because non-supertasters have less taste sensitivities and do not perceive the red wines as dry, bitter, and irritated as supertasters.

#### 2.4.3 Summary

This study uses a 3x2 between subject experiment to examine how product tasting information and taste physiology influence consumers' purchasing decisions. The results indicate that using the "sweet" descriptor for a sweet wine increases consumers' likelihood of purchase in comparison with using the "fruity" descriptor. Furthermore, the results suggest that the "sweet" descriptor increases supertasters' likelihood of purchase for a dry red wine despite it being inappropriate for a dry red wine. It seems that supertasters have a very positive attitude toward the "sweet" descriptor regardless of the wine style. These findings suggest that the "sweet" descriptor appears to perform better than the "fruity" descriptor for sweet table wines, and the intentional use of the "fruity" descriptor by wine producers as an alternative for sweeter wines may be unjustified.

## 2.5 Supertasters and social demographic characteristics

After examining the influence of taste physiology and sensory tasting information on consumers' purchasing behaviors, a natural question relevant to marketing practitioners is: are there specific consumer demographic and behavioral characteristics associated with each consumer taste status? In response, the demographic, eating behaviors and motivational focus questions completed by subjects during the experiment were used to examine this issue. A binary logit model was specified to determine how those characteristics influence the probability of a consumer being classified into the supertaster groups.

Participants were asked to indicate their eating and drinking behaviors in the exit survey (See Appendix 2.B for the complete questionnaire). Therefore, those eating behavior variables, *Sugarscore* and *Flavorscore*, were included in the binary logit regression. The variable *Sugarscore* is a continuous variable from one to five, representing how much sugar a participant put in the coffee. The variable *Flavorscore* is also a continuous variable from one to five, representing how much a participant likes drinking flavored coffee.

In addition to the eating behaviors, some evidences suggest that people with similar taste sensitivities may share some common personalities more than the food and wine preferences. For example, Hanni (2013) states that supertasters tend to be very sensitive to the clothing tag, strong light and noise. Saliba, Wragg and Richardson



(2009) find that sweet wine consumers, likely supertasters, are associated with a high level of impulsiveness but lower openness. Therefore, the logit regression also included the participants' motivational focus variable to examine whether people with different taste sensitivities exhibit some common personality attributes that may predict performance.

Motivational focus (promotion pride versus prevention pride) is a way to identify people's personality and behavior. It is widely used in business, marketing and social physiology to understand people's personality such as how they approach life's challenges and demands and how they approach a new task goal (Higgins et al., 2001). The participants were asked to answer the Event Reaction Questionnaire (See Appendix 2.C for the complete questionnaire) to identify one's personality types.

People with a promotion dominant personality tend to focus more on hopes, accomplishments, and advancement needs; but less on safety, responsibility, and security need. On the other hand, people with a prevention dominant personality are more driven by criticism and the looming possibility of failure than by accomplishments; and tend to be more conservative.<sup>3</sup> Each participant's promotion focused score and the prevention focused score are calculated according to their answers to these 11 items following Higgins's method (2001). A participant is

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<sup>3</sup> Although everyone is concerned at various times with both promotion and prevention, most of us have a dominant motivational focus

classified to have a promotion dominant personality if he/she has a higher promotion focused score than prevention focused score, and vice versa. Therefore, a *Promotion* dummy variable was included in the logit regression. Other social demographic characteristics such as age, gender and ethnicity were also included in the regression.

The marginal effects of the logit regression are presented in Table 2.3. Overall, the results indicate that some demographic, eating behaviors and personality characteristics influence a person's propensity of being a certain taste type. The marginal effects indicate that people with promotion dominant personality have a 14% higher probability to be supertasters in comparison to those with prevention dominant personality. In addition, the marginal effects indicate that people who put more sugar into their coffee have a 6% higher probability of being supertasters. Interestingly, the marginal effects show that people who are more likely to drink coffee with steamed milk or flavoring such as almond or vanilla tend to be associated with being non-supertasters. These results further confirm with the previous research that adding sugar is a way to help mitigate the bitterness sensation in black coffee, while adding other flavorings may not be that helpful. The results also indicate that Asians tend to have a 26% of probability to be supertasters in comparison to other races. Though the coefficient of the variable *female* is not significant, the coefficient of the interaction variable *male\_age* is significant. The negative marginal effect indicates that older male are more likely to associate with being non-supertasters.

**Table 2.3. The logit regression results on taster types and the marginal effects**

	Binary Taster Types	
	<i>Logit model</i>	
	Coefficient	Marginal Effect
<i>Sugarscore</i>	0.339* (0.182)	0.055* (0.029)
<i>Flavorscore</i>	-0.477** (0.185)	-0.078*** (0.029)
<i>Asian</i>	1.292*** (0.465)	0.257** (0.103)
<i>Promotion</i>	1.084* (0.608)	0.141** (0.061)
<i>Female</i>	-2.563 (1.596)	-0.491 (0.300)
<i>Male_age</i>	-0.079* (0.046)	-0.013* (0.001)
<i>Female_age</i>	0.012 (0.017)	0.002 (0.003)
<i>Constant</i>	0.153 (1.535)	
#		
Observations		186
Wald Chi2/F		23.29
Prob >		
Chi2/F		0.0015
Pseudo R2		0.1132

Note: \* = statistically significant at 0.10 level (10%), \*\* = statistically significant at 0.05 level (5%), \*\*\* = statistically significant at 0.01 level (1%). Robust standard errors are reported in parentheses

## 2.6 Conclusion and implications

This study uses wine, a sensory hedonic product, to examine how taste physiology influences consumers' perception of wine tasting information and their purchasing decisions. The results indicate that, regardless of taste status, consumers pay little attention to wine tasting information for lower price wines. The results also

suggest that both supertasters and non-supertasters' purchasing behaviors are influenced by the tasting information for higher price wines. Furthermore, the experimental results provide evidence that supertasters and non-supertasters respond differently to the tasting information provided. Specifically, supertasters tend to have a positive attitude toward the “sweet” descriptor. In contrast, non-supertasters exhibit a negative attitude toward the “sweet” descriptor and a positive attitude toward the “dry” descriptor. In addition, the results suggest that consumers, particularly supertasters, are more likely to purchase a sweet wine when exposed to the “sweet” descriptor in comparison to the “fruity” counterpart.

This study has several marketing implications for the food and beverage industry. Firstly, it is important for marketers to note that taste physiology plays an important role in determining tastes and preferences. This influence should be taken into account when developing new products or targeting specific consumer segments. Several companies have already incorporated this concept into their marketing strategy. For example, the newly developed “blonde” line by Starbucks is mainly targeting those who like a lighter roast coffee (McKeever, 2012). Similarly, winemaker giant Gallo's has developed products appealing to different taste profiles (Siegel, 2012).

In addition, it is important to train sales and tasting room staff, as well as sommeliers, on how to identify supertasters so that they can make personalized

recommendations. For example, wine clubs could send selective samples to target subscribers with different taste status. In addition to the relevance of the findings to traditional marketing strategies, this research also has implications for digital marketing. Wine marketers can develop initiatives so that target consumers can self-select as supertasters or non-supertasters. For example, Morrisons, a large supermarket chain in the United Kingdom, offers an online “taste test” that gives consumers the opportunity to look for favorable wines according to their taste profiles.

Furthermore, firms need to factor in the type of consumers targeted when creating wine labels. They should be mindful of sensory tasting notes as marketing vehicles to target different consumer segments, particularly the supertaster segment. For instance, when a brand is mainly targeting supertasters, using a “sweet” descriptor of any kind may have a positive influence on purchasing decisions. In addition, non-supertasters tend to favor of “dry” descriptor. For these consumers, emphasizing the dry characteristic of wines could positively influence their wine perceptions, particularly for higher-price red wines.

How can firms identify consumer characteristics that would enable them to segment the market to take advantage of taste sensitivities? While this is an area for further research, the study identifies certain demographic and behavioral characteristics that appear to influence a consumer’s probability of being a supertaster.

The results suggest that promotion dominant individuals, Asians and people who add extra sugar in their coffee are more likely to be supertasters. In contrast, older males and people who like flavoring black coffee have a higher probability of being non-supertasters.

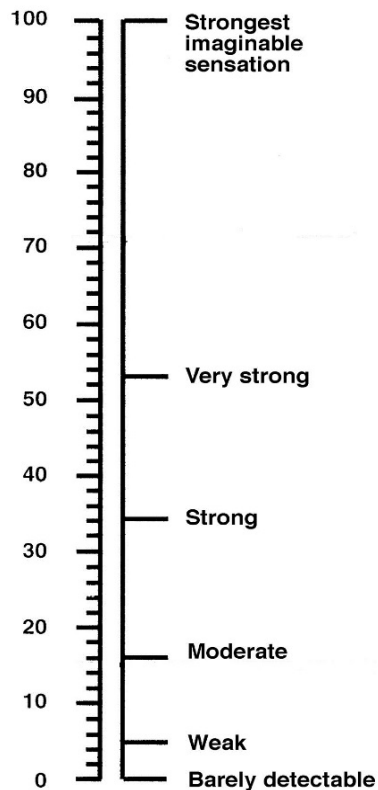
Furthermore, it is also crucial for wine educators to realize the misconception that consumers may have with fruity aroma and sweet taste, and to educate consumers to recognize that there are no right or wrong choices. This article is just a starting point in bringing some insights into understanding the influence of taste physiology on consumer behavior from a marketing perspective. While the experiments illustrate that consumers with distinctive taste physiology tend to differ in their purchasing behaviors, it gives limited insights about how these findings can be applied in a business context. Future work should investigate how these results can be turned into actionable recommendations for producers.

## Appendix 2. A. RPOP paper strip test

**Step 1:** Take a sip of water and swish it around your mouth to clean it.

**Step 2:** Take the paper strip out and place it on your tongue for 30 seconds or until it's fully wet.

**Step 3:** Please draw a horizontal line — at any place on the scale below to indicate your feeling for this paper strip.



## Appendix 2. B. Eating behaviors questions

Your preference for salted snacks such as nuts, pretzels and potato chips:

- ☐ I find most snacks too salty. (1)
- ☐ I like salty snacks. (2)
- ☐ I am addicted to salty snacks. (3)

Your salt preferences (try to answer by your taste preference, not from a health standpoint)

- ☐ I find many foods too salty. (1)
- ☐ Food usually tastes fine as it is and/or I add a modest amount of salt when I cook. (2)
- ☐ I usually add a little extra salt to my food, or would like to but don't for health reasons. (3)
- ☐ People give me a hard time for adding too much salt. (4)

Describe the perfect cup of coffee/tea:

- ☐ I like it very strong (espresso or black tea: English Breakfast tea). (1)
- ☐ I like it strong (Starbucks, Peet's or Earl Grey tea). (2)
- ☐ I like it medium ( the weak coffee served at work, green or herbal tea). (3)
- ☐ Coffee/tea tastes terrible; I can't stand it. (4)

Sugar in your coffee/tee (if you don't drink either of them, please answer by your taste preference):

- ☐ I drink coffee/tea with no sugar. (1)
- ☐ A touch. (2)
- ☐ One teaspoon or the equivalent. (3)
- ☐ Two or more teaspoons. (4)

How do artificial sweeteners taste such as in diet sodas? (try to answer by your taste preference, not from a health standpoint)

- ☐ No taste problem or I can not tell the difference. (1)
- ☐ Do not know-I've never tried an artificial sweetener in my life. (2)
- ☐ Taste funny, but not too bad. (3)
- ☐ I can tell a big difference but have adapted OR some are much better than others. (4)
- ☐ They taste horrible. (5)

Cream/milk in your coffee/tea:

- ☐ I drink coffee/tea black. (1)
- ☐ Touch of cream/milk. (2)
- ☐ Moderate cream/milk. (3)
- ☐ Lots of cream/milk. (4)



Do you enjoy coffee with steamed milk or flavoring such as almond, vanilla, Irish Cream? (if you don't drink coffee, please answer by your taste preference):

- ☐ No. (1)
- ☐ Cappuccino, latte, or cafe au lait - but not flavorings. (2)
- ☐ Sometimes. (3)
- ☐ Yes. (4)

Do you occasionally drink very strong liquors such as straight Scotch, Cognac or Armagnac?

- ☐ Yes. (1)
- ☐ Sometimes. (2)
- ☐ Never. (3)

## Appendix 2. C. Event reaction questionnaire

This set of questions asks you HOW FREQUENTLY specific events actually occur or have occurred in your life.

	1 Never or seldom	2	3 sometimes	4	5 very often
1. Compared to most people, are you typically unable to get what you want out of life?					
2. Growing up, would you ever “cross the line” by doing things that your parents would not tolerate?					
3. How often have you accomplished things that got you “psyched” to work even harder?					
4. Did you get on your parents’ nerves often when you were growing up?					
5. How often did you obey rules and regulations that were established by your parents?					
6. Growing up, did you ever act in ways that your parents thought were objectionable?					
7. Do you often do well at different things that you try?					
8. Not being careful enough has gotten me into trouble at times.					
9. When it comes to achieving things that are important to me, I find that I don’t perform as well as I ideally would like to do.					
10. I feel like I have made progress toward being successful in my life.					
11. I have found very few hobbies or activities in my life that capture my interest or motivate me to put effort into them.					

## **CHAPTER THREE. Nature versus Nurture? The influence of taste physiology and learned experience on consumers' purchasing behavior--A Field Experiment**

### **3.1 Introduction**

Consumers' preferences and tastes are constantly changing. Understanding the factors that influence preferences and choices allows marketers to develop and test new products, provide better customer experience, and tailor marketing tactics for different consumer segments. Previous research addressing this fundamental marketing question has suggested two main determinants of consumer choices: consumer product expertise and consumer taste physiology. Previous research shows that consumer product expertise, gained from learning about and using a product, influences taste preferences and thereby consumer purchasing behavior (Ballester et al. 2008). Extant marketing research predominantly focus on how consumer experiences, rather than innate characteristics, affect shopping behavior. Most marketing research subscribes to the belief that our culture and product experiences overwhelm the potential effects of heterogeneous consumer physiology on shopping behavior and taste perception. Woolfolk, Castellan, and Brooks (1983) argue that differences between consumer choices in blind tastings versus in market settings (where labels are presented) support the view that consumer taste experiences may be dominated by learned experiences.

On the other hand, some physiologists maintain that taste physiology, an inherited trait, significantly influences consumer perceived taste and preferences for food and beverages (see Hayes and Keast 2011 for an extensive literature review). Bartoshuk (1993, 1994) states that individuals are born with different taste sensitivities due to genetic variation. In particular, individuals with extreme sensitivity to bitterness are labeled as ‘supertasters’. Previous research shows that supertasters differ in their preferences for such foods and beverages as brussel sprouts, spinach and broccoli (Kaminski et al. 2000), black coffee (Glanville and Kaplan 1965), red wine (Pickering et. al. 2004), dark chocolate and chili peppers (Catanzaro et al. 2013), among others.

Food scientists have researched supertasters for the past twenty years, focusing primarily on how this inherited trait relates to individual’s food preferences. The insights coming from this stream of research are valuable, however, little has been done to examine individual taste sensitivity from a marketing perspective. The marketing literature has largely ignored this taste sensitivity when analyzing purchasing behavior and developing consumer segmentation strategies. These innate differences may explain the sometimes curiously wide variation in the hedonic valuations in blind taste tests, expert panels and crowd-sourced review systems (Hanni, 2013). It is reasonable to argue that taste sensitivity may not only affect individual perceived tastes and preferences, but may also influence consumer purchasing behavior.

This paper examines how consumer heterogeneity in taste physiology and in product expertise interact and influence purchasing behaviors in the presence of external cues (i.e., printed tasting descriptions). This paper also explores whether the influence of learned experience dominates the influence of taste physiology when consumers make purchasing decisions. To do this, this study focuses on the wine product category, a sensory hedonic beverage for which consumer preferences are strongly affected by both culture and experience. Consumers perceive higher risk associated with wine purchasing decisions, and detailed product taste information could help consumers increase their knowledge, minimize uncertainty and reduce risk (Lacey, Bruwer and Li 2009). LaTour, LaTour and Feinstern (2011) find that printed tasting descriptors are the most common form of wine promotional strategies used by wineries. This is because printed descriptors influence choice more effectively, in comparison with other attributes such as winery history and wine cellaring/aging advice (Charters et al. 1999; Mueller et al. 2010). In addition, Thomas et al. (2014) show that detailed sensory descriptors enhance consumers' perception of wine quality and contribute to increased sales.

To exam these issues, a between-subject field experiment was designed and implemented in two wineries located in the Finger Lakes Wine Region in New York State, during the period between July 2015 and August 2015. Our results indicate that the interaction between consumer wine expertise and taste physiology contributes to

explain the observed differences in consumers' purchasing decisions. Furthermore, our results provide evidence that wine experience and knowledge may be more important than supertasters' taste sensitivity when a consumer is making wine choices. The results also suggest that seemingly small differences in wine tasting descriptor cues can have a significant influence on purchasing decisions. For example, the results indicate that expert consumers exhibit a bias against the use of the 'sweet' descriptor because it negatively influences their perception of wine quality and choices.

## **3.2 Conceptual background**

### **3.2.1 Consumer taste physiology**

Sensitivity for bitter taste varies across individuals. Previous research suggests that genetic variation in orosensation<sup>4</sup> explains differences in response to bitter tastes across consumers, and can therefore influence preferences for food and beverages (Bartoshuk 1994; Pickering, Jain and Bezawada 2013). Bartoshuk (1991) categorizes individuals into three groups according to their taste sensitivity: 'nontasters' (about 25% of the population), 'tasters' (50% of the population) and 'supertasters' (25% of the population). These groups are formed based on their taste sensitivity to bitter compounds, often represented by Phenylthiocarbamide (PTC) and 6-n-

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<sup>4</sup> Orosensation is comprised of the prototypical tastes (sweet, sour, salty, bitter, and umami) and somatosensory sensations, such as astringency and creaminess, and is a key component of the flavor construct (Pickering and Klodnicki, 2016).

propylthiouracil (PROP). The supertaster category includes individuals who strongly dislike bitter compounds. Supertasters seem to have a greater-than-normal amount of taste bud papillae on their tongues, which allow them to experience all flavors more intensely, not just bitterness (Delwiche, Buletic and Breslin 2001). For example, supertasters and non-supertasters often differ in their perception of sweet compounds (Gent and Bartoshuk, 1983), salty compounds (Bartoshuk et al. 1998), substances that produce oral irritation or pain (Karrer and Bartoshuk 1991; Cunningham 2000), and tactile sensations (Duffy and Bartoshuk 1996; Tepper and Nurse 1997).

Supertasters tend to dislike such products as dark chocolate, chili peppers (Catanzaro et al. 2013), and bitter vegetables like Brussel sprouts, spinach and broccoli (Kaminski et al. 2000). In addition, supertasters tend to dislike black coffee (Glanville and Kaplan 1965) and therefore are associated with a low preference for and a low consumption of caffeine (Ly and Drewnowski 2001). The implications of supertasters' preferences also apply to wine, a complicated hedonic sensory product. There is evidence that supertasters are more likely to experience irritation and burning sensations (Bartoshuk 1993, 1994; Prescott and Swain-Campbell, 2000), along with tasting greater bitterness (Chandrashekar et al. 2000) particularly in red wines. Pickering, Simunkova and DiBattista (2004) also show that supertasters tend to give significantly higher ratings of bitterness, astringency and acidity to red wines than their non-supertaster counterparts. Supertasters also tend to consume alcoholic beverages

less frequently than non-supertasters due to their innate taste sensitivity (Duffy, Peterson and Bartoshuk 2004; Hanni 2013). In addition, supertasters tend to avoid wines that exhibits high levels of bitterness and astringency (Pickering, Simunkova and DiBattista 2004).

The addition of sweeteners is usually employed to help supertasters mitigate the bitter taste and irritated sensation. For example, Ly and Drewnowski (2001) find that adding a sweetener to caffeinated drinks and to PROP solutions lead to large reductions in bitterness ratings among supertasters. Similarly, Yiee, Duffy and Bartoshuk (2003) find that adding a sweetener reduces the bitter sensation of strong coffee among supertasters. Hanni (2013) also shows that sweetness in wines can help individuals with extreme taste sensitivity mitigate the burning, bitterness and astringent tastes of certain wines. In sum, the literature suggests that supertasters may experience wines with higher sweetness as less bitter and unpleasant, and more enjoyable than drier wines.

### 3.2.2 Role of product experience and expertise

Rozin (1996) argues that, unlike other food and beverage products, consumers “learn to like” such products as wine, coffee, beer and liquor due to the bitter taste of these products, among other sensory characteristics. He also indicates that consumers may perceive most alcoholic beverages as unpleasant initially, but they start to develop



preferences for these beverages because the “post-digestive” consequences may surpass the unpleasant sensory experience. Germov and Williams (1999) argue that, if the innate taste characteristic is the only factor influencing consumers’ food choices and preference, then no products with bitter taste such as coffee, beer, or chili peppers would be popular in the market. This suggests that the role of learning and experience, through using the product, should play an important part in driving consumers’ choices and preferences.

This is particularly true for wine, a product with social cachet, varied nature, and inherent product complexity, which makes it difficult to evaluate quality (Ballester et al. 2008). Lawless (1984) finds that experts are more disciplined than novices when they taste wines. They inspect the visual, olfactory, and taste profiles of a wine while novices generally do not. In subsequent research, Lawless (1994) indicates that expert consumers are better at discriminating, recognizing and describing wines than their novice counterparts. The reason might be that expert consumers have more wine knowledge and therefore can analyze more attributes of the wine during a tasting than their novice counterparts (Solomon 1990). In addition, Solomon (1997) states that expert consumers use more specific wine descriptors (e.g., ‘cherry’, ‘apricot’, ‘peach’ or ‘apple’) aromas than intermediate consumers, who in turn use more specific descriptors than novice consumers for describing wines. However, whether wine

experts are innately endowed or have lower absolute thresholds for chemosensory stimuli in general or for detecting wine-related compounds remains unclear.

Although product expertise plays an important role in determining consumers' preferences, no decisive relationship has been found between preference for wine styles and consumer level of expertise. Furthermore, it is not clear what role taste sensation as an inherited ability plays when performing tasks related to discriminating a wine, when evaluating product information and making purchasing decisions. As both beer and wine consumption are embedded into social experiences, Germov and Williams (1999) argue that the cultural meaning associated with consumption of these beverages overrides any inherited taste preferences. Only one study examining this issue found that those in the hospitality and wine trade have a higher likelihood of being a supertaster than the rest of the population (Hayes and Pickering 2012). Whether innate sensitivity led them to expertise in this area, or if other external variables caused them pursue their career paths is unknown, given the correlational nature of the study.

Previous marketing research has also investigated how consumers with various levels of knowledge and experience differ in terms of information processing and evaluation (see Rao and Monroe 1998 for a review). Consumers with varied levels of product experience rely on different information when evaluating products. These issues have been also examined in the context of wine evaluations, with evidence

suggesting that expert consumers are less likely to rely on external cues such as price and awards when choosing wines (Lockshin et al. 2006). Expert consumers might prefer more “elaborate” descriptions of wine, such as “displaying elements of dark chocolate, ripe plums, and finely chalky tannins”, while novice consumers prefer more straightforward descriptions (Charters and Pettigrew 2006; Gawel 1997; Solomon 1990).

Extensive research has shown that the level of knowledge and experience significantly influence consumers’ wine preferences and information evaluation. However, little is known about the role inherited taste sensitivity plays when consumers evaluate external cues and make purchasing decisions. This is relevant, given the importance of taste sensitivity in driving sensation, perception, and potential downstream behavior characteristics. Ignoring physiological taste preferences might lead to misleading assessments of consumer wine preferences and thereby to inappropriate marketing strategies. To fill this gap in the literature, this study examines purchasing behaviors of wine consumers with heterogeneous wine expertise and taste sensitivities, while manipulating tasting description cues. This paper contributes to the literature by proposing a new vein of consumer segmentation that may shed light on the observed differences in laboratory experiments, expert evaluations and crowd-sourced evaluations involving matters of taste.

### 3.3 Experimental design

To best examine the aforementioned relationships, a 3 x 2 x 3 between-subject experiment was designed and carried out in two wineries in the Finger Lakes wine region of New York State, during the period between July 2015 to August 2015. In total, there are three information treatment groups, two consumer taste status groups (supertasters and non-supertasters), and three types of consumers based on their level of wine expertise (novices, aficionados, and experts). In collaboration with winemakers of each participating winery, the most appropriate white and red wines were selected for the field experiment.<sup>5</sup> Several trainings with the tasting room staff were conducted, reviewing the objectives and logistics of the experiment, and the terms they should use or avoid during the experiment. They were reminded to avoid expressing their personal feelings about the wine so as to minimize any influence from the tasting room staff on the experiment. A pilot taste was conducted before the real experiment was conducted to familiarize the tasting room staff with the logistics of the experiment. Upon arrival at the wineries, visitors were first greeted by front desk staff and then asked whether they were interested in participating in an evaluation of

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<sup>5</sup> I selected White wines that were sweet with high residual sugar, relatively low acidity and alcohol level (supertasters are likely to enjoy these wines, while expert consumers are likely to consider them as low quality wines). I selected red wines that were dry, heavy and tannic (supertasters are less likely to enjoy these wines, while expert consumers with higher product knowledge are believed to enjoy and consume these type of wines more frequently).

two wines. If they were, they were led to the bar and then instructed by the tasting room staff to follow the procedures of the experiment step by step.

### 3.3.1 Three sensory information treatment groups

In recent decades, the prevalent opinion in the wine industry has been that dry wines are of superior quality than sweet wines. Current marketing practices are aggressively promoting heavier and darker dry wines; these wines tend to garner higher points from expert wine reviewers (Hanni, 2013). In fact, marketers tend to highlight the dry characteristics of their wines in order to lead consumers into thinking that the wine has superior quality and is worth the price tag of the product. For example, it is common for producers to add extra sugar in their finished wines but still market them in the dry wine category (Mahoney and Rickard 2016)

On the other hand, sweet wine drinkers are often perceived as being “green”, “old-fashioned” and “unsophisticated” (Burzynska 2013; Teeter 2014). As a result, the descriptor “sweet” is likely associated with cheap wines of inferior quality. Producers are reluctant to put “sweet” anywhere on the label, instead using certain colors or images on their label to indicate that the wine is sweeter. For example, Veseth (2015) argues that a bottle of wine with a black label and red script or image tends to be a sweeter red wine.

These mainstream industry and expert opinions may influence consumers' consumption and purchasing behaviors. Sweet wine drinkers, especially supertasters who prefer sweet wines due to their extreme taste sensitivities, are more likely to be influenced by mainstream opinions. Supertasters drink wine less often, and they may have less confidence in purchasing wines than non-supertasters (Hanni and Utermohlen, 2010). Producers' intentional use of the "dry" descriptor and avoidance of the "sweet" descriptor may be a barrier for them to purchase the wine they would prefer most. In addition, peer and social pressure are likely to induce them to choose more socially acceptable beverages such as cocktails or beer in public settings. For the above reasons, the "sweet" and "dry" descriptors were selected as different treatments in the experiment in Study 1 below. In summary, these two wine descriptors indicate the major sensory aspect of the wine and also characterize industry categorizations.

The field experiment considers three groups: one control group, one sweet treatment group and one dry treatment group. In the control group, winery visitors were given the control tasting note, which is the regular tasting note written by the winemaker without any objective descriptors such as "sweet" or "dry". For example, the control tasting note reads "this wine...". In the sweet treatment group, participants were given the sweet tasting note which is the control tasting note with the "sweet" descriptor included. For example, the sweet tasting note reads: "this sweet

wine....” Similarly, participants who are in the dry treatment group were given the dry tasting note that is the regular tasting note with the “dry” descriptor included.<sup>6</sup>

### 3.3.2 Two consumer taste status groups (Supertasters and Non-supertasters)

After evaluating both red and white wines, participants were instructed to perform a PROP paper strip test used to identify their taste status. Following the method of Zhao et al. (2003), participants were instructed to put filtered paper strips, that had been soaked into PROP solution and dried, in their mouths for 30 seconds or until fully wet. They then rated the intensity level of the paper strip using the general Labeled Magnitude Scale (Bartoshuk et al. 2003). The scale ranges from 0 points to 100 points, where 0 means the paper strip is tasteless and 100 point means the paper strip has the strongest imaginable sensation. See Appendix I for a detailed description of this procedure.

Following Zhao et al. (2003) method, each participant was ranked based on their PROP score, and then I calculated the upper bound and the lower bound of the 95 percent confidence interval for participants who rated their intensity level over 52 points (which is indicated as very strong in the scale). The lower bound is the cutoff point for supertasters. In our sample, the cutoff point is 65. Therefore, participants

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<sup>6</sup> To emphasize the treatment effect, tasting room staff gave each participant the written tasting note first and asked them to read it for about 10 to 20 seconds. Later, tasting room staff reiterate the tasting note to the participants while pouring wines to them.

who have a score equal to or more than 65 points are categorized as supertasters (ST), accounting for 30% of the total sample. The rest are identified as non-supertasters (NST).

### 3.3.3 Three types of consumers based on level of wine expertise

Park, Mothersbaugh, and Feick (1994) distinguish perceptual knowledge (experiential knowledge through high usage frequency) from conceptual knowledge (general, non-experiential knowledge of the product category). Perceptual knowledge is often measured by the product usage frequency. In contrast, conceptual knowledge consists of general knowledge about the product category as well as concrete sensory descriptions about product characteristics. LaTour and LaTour (2010) indicate that experts are high in both perceptual and conceptual knowledge. Whereas, novice consumers are low in both. Aficionado consumers have asymmetric perceptual and conceptual knowledge. They are high in perceptual knowledge (drink wine frequently) but are low in conceptual knowledge (fail to obtain product expertise from these experiences).

In our study, participants' perceptual knowledge is measured by asking "how frequently do you drink wine in each week" in the survey instrument. The answer has seven levels ranging from "never" to "drink wine every day". Likewise, participants' conceptual knowledge is measured by a wine knowledge test that consists of five



questions regarding general knowledge of wine category (See Appendix II for detailed information of the questions). This wine knowledge test was initially developed by Forbes, Cohen and Dean (2008), and was employed in several other studies (Robson et al. 2014). Participants were asked to choose one correct answer out of five choices. Following the LaTour and LaTour (2010) method, participants are categorized into three groups (i.e., experts, aficionados, and novices) according to their conceptual knowledge test scores and their product usage frequency. A participant is identified as an expert wine drinker if he/she drinks wine at least once a week and has a high score (answers at least 2 questions right out of five questions) on the conceptual knowledge test. A participant is identified as an aficionado wine drinker if he/she drinks at least once a week but scores very low on the conceptual knowledge test. The rest of respondents are classified as novices.

To summarize, there are three different versions of the tasting note: sweet tasting note, dry tasting note and control tasting note. Winery visitors were only given one tasting note on a certain day, and the tasting notes presented to participants alternated each day. All visitors were given a white wine and a red wine to evaluate. Participants were identified as supertasters or non-supertasters based on their taste sensitivity, and also were grouped as experts, aficionados, or novices according to their wine knowledge test results. In the survey, participants were asked to answer a few questions regarding their taste evaluations (e.g., perceived sweetness, bitterness

and wine quality) and their behavior evaluations (e.g., affinity level, the overall feeling of the wine, and their likelihood of purchasing the wine) for each wine. Consumers' likelihood of purchase, scaled from 1 (very unlikely) to 9 (definitely), was used as a dependent variable to measure purchasing decisions.

### **3.4 Hypotheses**

Supertasters tend to experience red wine with bitter, astringent, irritated and burning sensation more intensively than non-supertasters; sweetness in wine can help them mitigate those intensive sensations. It is expected that the “sweet” descriptor has a positive influence on supertasters' purchasing decisions while the “dry” descriptor has a negative influence on consumers' purchasing decisions. The reason is that the “sweet” descriptor may moderate the intensive bitter and burning sensation of the wine, whereas, the “dry” descriptor may remind them of those sensations.

On the other hand, the common opinion concerning the evolution of wine consumers is that beginner drinkers (novices) start with lighter and sweeter wines. As they drink more wines and know more about wine, their palates become more mature, and they are more likely to enjoy heavier, drier and darker wines. Though there is no fact or research supporting this specific argument, Mahoney and Rickard (2016) indicate that as people age, they tend to consume more dry wines. Hence, it is expected that participants with higher product knowledge (i.e., expert consumers) are more likely to prefer dry wines to sweet wines, and therefore may react more

positively to the “dry” descriptor in comparison to the “sweet” descriptor. However, it is not clear which descriptor have more positive impact on consumers purchasing behavior, given the interaction between taste sensitivity and product expertise. Therefore, the additional purpose of this study is to investigate this issue.

### **3.5 Results**

#### **3.5.1 Descriptive statistics**

In total, 290 winery visitors participated in this experiment across the control group (n=94), dry treatment group (n=99), and sweet treatment group (n=97). Supertasters account for 30% of the sample, the rest are non-supertasters. In our sample, 22% of participants are in the 21-29 age group, 17% are in the 30-39 age group, 34% are in the 40-60 age group, the remaining 27% are older than 60 years old. Table 3.1 presents descriptive statistics for these three wine expertise groups: novices (n=90), aficionados (n=113), and experts (n=87). The PROP scores, taste statuses, and gender composition of the sample are similar across all three groups. As is evident from these figures, novices are younger in age than aficionados and experts. Consequently, novices have shorter wine drinking history than aficionados, who in turn, have shorter drinking history than experts. In addition, experts and aficionados have a similar drinking frequencies, and they both drink more frequently than novices. Regarding subjective wine experience reported by participants about their wine

experience compared with others, the table shows that experts have more wine experience than aficionados, who in turn have more experience than novices. However, aficionados seem to have less conceptual knowledge of wine than novices though they self-reported to have more experience than novices. Experts have the most conceptual knowledge among all groups.

**Table 3.1. Descriptive statistics of demographic and characteristics variables by groups**

	Novices	Aficionado	Experts
	N=90	N=113	N=87
PROP score	29.850 (28.361)	32.539 (30.812)	31.322 (30.658)
Taste status	.247 (.434)	.325 (.470)	.290 (.456)
Age group	2.550 (1.492)	3.138 (1.469)	3.259 (1.465)
Gender	.333 (.474)	.359 (.481)	.406 (.493)
Years been drinking wine	15.436 (13.507)	17.374 (13.100)	20.185 (13.136)
Consumption frequency	2.185 (.450)	4.722 (.656)	5.066 (.663)
Subjective wine experience	1.917 (1.131)	2.593 (.922)	3.143 (1.014)
Conceptual knowledge	1.637 (1.188)	1.393 (.587)	3.605 (.713)

Note: the number in the parentheses is the standard deviation of the variables.

### 3.5.2 Correlation estimations

The correlation between PROP scores and participants' social demographic characteristics are also estimated. The correlation between PROP scores and age levels is significant and negative at the 10% significance level, indicating that younger

people tend to have higher PROP scores and are therefore more likely to be supertasters. In addition, the correlation between PROP scores and gender is statistically significant at the 1% level, indicating that females, compared with males, tend to have higher PROP scores and therefore to be supertasters. This result is consistent with previous research on supertasters. The correlation between the age level and the product usage frequency is significant and positive, indicating that older consumers tend to drink more frequently than younger consumers. This finding is consistent with Newman (2013), who shows that boomers and generation X are still the solid base of wine consumers compared with millennials. The results also indicate a significant and positive correlation between consumers' conceptual knowledge scores and their wine usage frequencies, indicating that participants who have a higher wine knowledge test score tend to drink wines more frequently. In sum, the descriptive analysis is consistent with theories relating tasting status, wine knowledge, and consumer socio-demographic characteristics.

### 3.5.3 Results for novices

- *Red wine*

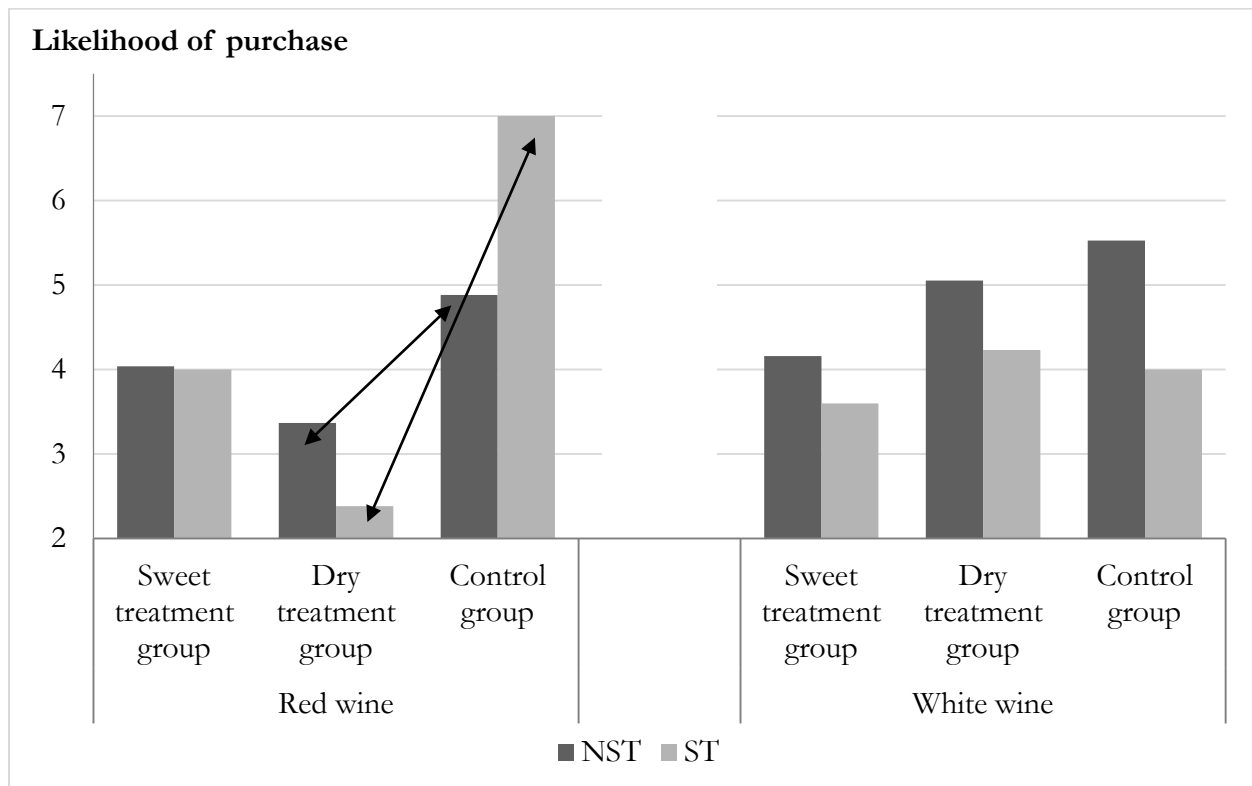
The results for novice consumers are presented in Figure 3.1. The left graph in Figure 3.1 shows the red wine results. The results show that there is a significant difference in novice non-supertasters' likelihood of purchase between the dry treatment group

and the control group ( $t=-3$ ,  $p<0.01$ ), indicating that non-supertasters are less likely to purchase the red wine when given the dry tasting note in comparison to when they are given the control descriptions. For supertasters, the difference in consumers' likelihood of purchase between the dry treatment group and the control group is even more pronounced. Supertasters are three times more likely to purchase the wine when given the control tasting note than when given the dry tasting note ( $t=-2.45$ ,  $p<0.05$ ). Therefore, the above results indicate that the "dry" descriptor has a significant, negative impact on novices' purchase decisions for dry red wines. In particular, this negative response toward the "dry" descriptor is much more distinct for supertasters, indicating that taste sensitivity further reinforces the negative response to the "dry" descriptor for dry wines. These findings are substantial given that the only difference between the dry treatment group and the control group is including the word "dry" in the dry treatment, yet consumers' purchasing likelihood is significantly different. The results show no statistical significant difference in the purchasing likelihood for novice consumers in sweet and dry group, or sweet and control group.

The overall results suggest that consumers' level of product knowledge plays an important role in determining their responses to different sensory descriptions. This influence is even greater for supertasters. In addition, the results indicate that, contrary to marketers' perceptions, the "dry" descriptor does not positively influence

novices' purchasing decisions. That is, they are not in favor of the “dry” descriptor for a dry red wine.

**Figure 3.1. Pairwise Comparison Results for Novices**



Note: NST indicate Non-supertasters; whereas NT indicate supertasters. These above results come from the Tukey's test. The arrow indicates that the mean between those two groups are statistically significantly different from each other.

- *White wine results*

The right graph in Figure 3.1 shows the white wine results. The results show that there is no significant difference in the purchasing likelihood for novices among different groups (dry/sweet treatment and control), indicating that novices have no preference for any descriptors for a sweet white wine.

It is presumed that consumers perceive sweet wines as inferior and it is expected the “sweet” descriptor would negatively impact consumers’ perception of wine quality and purchasing intention. However, the results show that the perceived quality of wine is not statistically different among these three groups, indicating that novices do not associate the “sweet” descriptor with inferior and lower quality for sweet wine. Using the “sweet” descriptor for a sweet wine does not negatively influence their perception of wine quality and purchasing decisions.

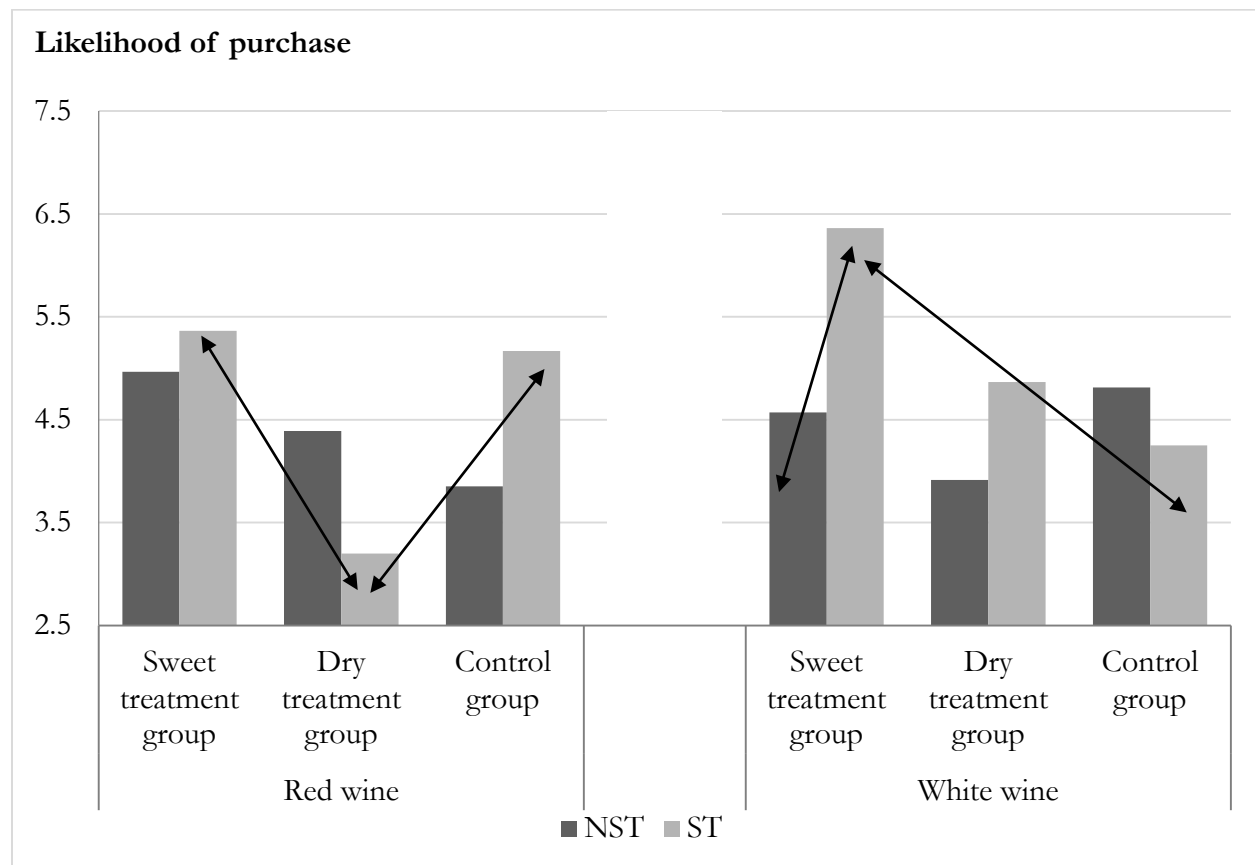
#### 3.5.4 Results for aficionados

- *Supertaster’s results*

Aficionados drink wines very frequently but fail to obtain product expertise (LaTour and LaTour 2011). The post hoc comparison results for aficionados are shown in Figure 3.2. The red wine results, shown on the left side of the graph, indicate that the supertasters’ likelihood of purchase is significantly lower in the dry treatment group compared with those in the control group ( $t=1.91$ ,  $p<0.1$ ). The results indicate that this single “dry” descriptor has a pronounced negative effect on supertasters’ purchasing likelihood given the only difference between the dry treatment group and the control group is including the “dry” descriptor. It is possible that the dry descriptor of this wine induces supertasters to focus on the bitter, astringent and burning sensation of wine, which reinforces the unpleasant feelings.



**Figure 3.2. Pairwise Comparison Results for Aficionados**



Note: NST indicate Non-supertasters; whereas NT indicates supertasters. These above results come from the Tukey's test. The arrow indicates that the mean between those two groups are statistically significantly different from each other.

More interesting is the impact of the inaccurate “sweet” descriptor on consumers’ purchasing likelihood for this group. The results show that aficionado supertasters’ likelihood of purchase is significantly higher in the sweet treatment group than in the dry treatment group ( $t=2.05$ ,  $p<0.05$ ), indicating that the “sweet” descriptor performs better than the “dry” descriptor. Though the “sweet” descriptor is not an accurate one for the dry and tannic red wines, including this inaccurate descriptor in the tasting note increases aficionado supertasters’ likelihood of purchase

in comparison to the accurate “dry” descriptor. The reason may be that the “sweet” descriptor helps them moderate the actual intensive feeling of the red wine and makes the wine more enjoyable. When they taste the dry wine, the sweet sensory description of the wine may give them the feeling of sweet tannins, and a soft and smooth sensation. Despite the fact that these consumers have much perceptual knowledge, their extreme taste sensitivity still dominates their preference for different descriptors. Therefore, results suggest that this type of consumers is easily influenced by the sensory information provided, and rely very much on this information to guide their purchasing decisions.

These findings are further confirmed by the white wine results (right side of Figure 3.2). The white wine results show that aficionado supertasters’ likelihood of purchase is significantly higher in the sweet treatment group than in the control group ( $t=1.84$ ,  $p<0.1$ ). The results also show that aficionado supertasters are more likely to purchase than their non-supertaster counterparts in the sweet treatment group ( $t=1.83$ ,  $p<0.1$ ). In addition, the results indicate that supertasters’ perception of the white wine quality is significantly higher when given the sweet tasting note in comparison to when given the control tasting note for the same wine ( $t=1.71$ ,  $p<0.1$ ). This finding suggests that aficionado supertasters who drink wine very frequently but have less conceptual knowledge tend to associate the “sweet” descriptor with superior quality wines. These consumers do not perceive the “sweet” descriptor as a cheap and

inferior descriptor. The reason might be that aficionados are more likely to drink wine for fun and enjoyment. They like what they like, they may be unaware of and be less likely influenced by the mainstream opinions of the “sweet” descriptor and sweet wines. Again, the difference between the sweet tasting note and the control tasting note is just one descriptor, and the results are striking.

- *Non-supertasters’ results*

The red wine results show that the difference in purchasing likelihood for non-supertasters between the dry treatment group and the control group was not significant. Compared with novices, aficionados have more perceptual knowledge (drink more frequently). The novice non-supertasters’ purchasing likelihood was negatively impacted by the “dry” descriptor; however, the negative response to the “dry” descriptor was not found for non-supertaster aficionados. This suggests that product usage frequency diminishes the negative impact of the “dry” descriptor on purchasing decisions. For non-supertasters, who have limited taste sensitivities, these findings suggest that novices are more likely to rely on tasting notes to guide their purchasing decisions than other consumers. In contrast, aficionado non-supertasters may utilize more of their perceptual knowledge and less of the sensory descriptions to guide their purchasing decisions.

In addition, the results show that there is no significant difference for non-supertasters’ purchasing decisions across three groups for sweet white wines. This

suggests that different product sensory descriptions have no significant influence on non-supertasters' purchasing decisions. The reason might be that this type of consumers has less taste sensitivity and drinks wine more frequently, and therefore is open to all kinds of wine styles. They may rely more on their extensive drinking experiences to evaluate wine and to guide their purchasing decisions.

Overall, these results indicate that, for aficionados, taste physiology may play a more important role in determining their attitudes toward product sensory information and their purchasing decisions, despite their extensive drinking experience. Particularly, the “sweet” descriptor has a positive influence on supertasters' perception of wine quality. The results further imply that aficionados may not have bias against the “sweet” descriptor or sweet wines; instead supertasters find this descriptor very appealing and encouraging. Non-supertasters' purchasing decisions are not influenced by different sensory descriptions, they may rely on their drinking experience to guide their purchasing decisions.

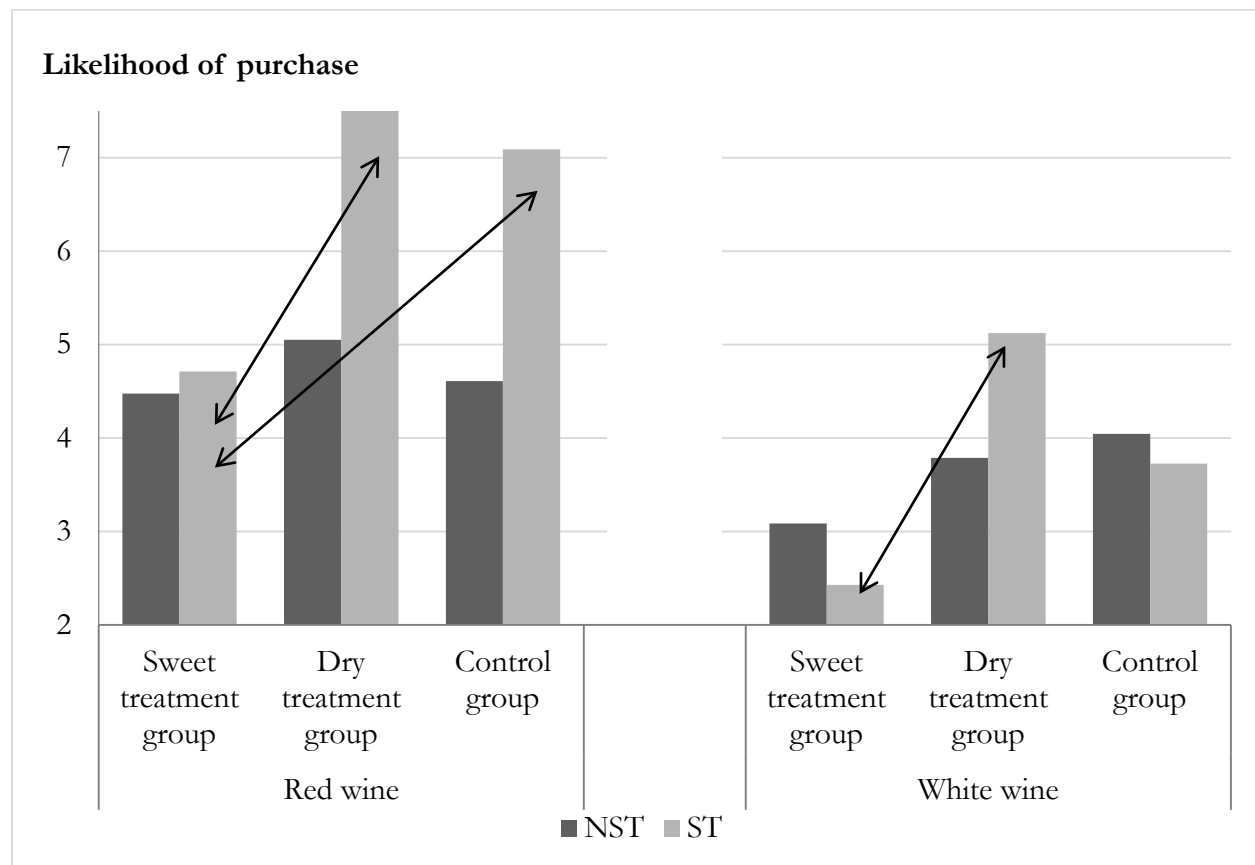
### 3.5.5 Results for experts

- *Supertasters' results*

The post-hoc comparison results for expert consumers are shown in Figure 3.3. The results for experts differ notably from the results for aficionados and novices. The pairwise comparison results show that expert supertasters' likelihood of purchase

is significantly higher in the dry treatment group than in the sweet treatment group for red wines ( $t=-2.06$ ,  $p<0.05$ ). In addition, supertasters' likelihood of purchase is significantly higher in the control group than in the sweet treatment group for red wines ( $t=-1.88$ ,  $p<0.1$ ). The above results indicate that the “sweet” descriptor has a significant negative impact on supertasters' purchasing decisions among expert consumers. That is, the sweet tasting note decreases their purchasing likelihood in comparison to both, the dry tasting note or the regular tasting note. One plausible reason is that supertaster experts in general are not in favor of the “sweet” descriptor and have a bias against this descriptor. This argument is in line with the mainstream wine industry's opinions that the “sweet” descriptor is often associated with inferior quality wines. As a result, supertaster experts are less likely to purchase the wine when the “sweet” descriptor is included in the tasting note even if the actual taste of the wine is dry, tannic and complex. Another possible reason is that they detect the inconsistency between the “sweet” descriptor in the tasting note and the actual taste of the dry wine. This inconsistency may negatively influence the purchasing likelihood for supertasters in the sweet treatment group. However, the white wine results for supertasters suggest this is not the case and support the argument that expert supertasters have a bias against the “sweet” descriptor. The next section presents the white wine results.

**Figure 3.3. Pairwise Comparison Results for Experts**



Note: NST indicate Non-supertasters; whereas NT indicates supertasters. These above results come from the Tukey's test. The arrow indicates that the mean between those two groups are statistically significantly different from each other.

If the inconsistency between the sensory description of the actual taste of the wines has a negative impact on supertaster experts' purchasing likelihood, the results should show that supertasters' likelihood of purchase is significantly lower in the dry treatment group than in the sweet treatment group for the sweet white wines. This is because the "dry" descriptor in the dry treatment group is an inappropriate and inconsistent descriptor for the sweet white wines. However, these numbers indicate the opposite results. The white wine results show that supertasters' likelihood of

purchase is significantly lower in the sweet treatment group than in the dry treatment group ( $t=-2.17$ ,  $p<0.05$ ) despite the fact that the “dry” descriptor is an inappropriate descriptor in this case. That is, this inconsistent sensory descriptor of the white wine does not have a negative impact on expert supertasters’ purchasing decisions; rather it increases supertasters’ likelihood of purchase. However, the accurate “sweet” sensory descriptor decreases supertasters’ likelihood of purchase.

In addition, the results show that supertasters’ perception of white wine quality is significantly lower in the sweet treatment group than the perceived quality in the control group ( $t=-1.79$ ,  $p<0.1$ ). Therefore, it seems that expert supertasters are not negatively influenced by the inconsistency between the tasting descriptions and the actual taste of the product. They may have a bias against the “sweet” descriptor. When given the “sweet” descriptor in the tasting note, expert supertasters may perceive that the wine is inferior, whereas, expert supertasters sampling the same wines without the “sweet” descriptor did not perceive the wine as inferior.

Experts may be influenced by the sensory description, and their purchasing decisions could be influenced by the sensory description of the wine, in addition to the actual taste of the wine. This is quite similar to the “real perceptual illusion” reported by Morrot, Brochet and Dubourdieu (2001), in which experts’ description of wine aromas are almost entirely based on what they see from the wine color rather than the actual flavor of the wine. Similar to aficionado supertasters, expert

supertasters also have extreme taste sensitivities. However, expert supertasters have much more conceptual knowledge about wine. The results indicate that these two types of consumers have distinct responses to the “sweet” and “dry” descriptors. The reason might be that although the conceptual learning of wine knowledge does not change consumers’ taste physiology, it changes how the sensory information is processed and evaluated by these two groups (Hanni 2013).

- *Non-supertasters’ results*

In terms of non-supertasters, the results indicate that there is no significant difference in their likelihood of purchase of the red wines between the treatment groups (dry/sweet treatment) and the control group. However, similar to supertasters, the red wine results show that non-supertasters’ perception of red wine quality is significantly higher in the dry treatment group than in the sweet treatment group ( $t=-2.47$ ,  $p<0.05$ ) and the control group ( $t=1.67$ ,  $p<0.1$ ). Furthermore, the white wine results show that non-supertasters’ perception of the sweet white wine quality is significantly lower in the sweet treatment group than in the control group ( $t=-1.7$ ,  $p<0.1$ ). That is, non-supertasters associate the “sweet” descriptor with inferior quality and believe that the wine with the “sweet” descriptor is inferior to the same wine without such descriptor.

These findings from non-supertasters further support the argument that supertaster experts’ lower purchasing likelihood in the sweet treatment group may be



explained by their bias against the “sweet” descriptor rather than by their detection of the inconsistency between the wine tasting notes and the actual taste of the wine. Non-supertasters would not be expected to detect the inconsistency between the tasting descriptions and the actual taste of the wine due to their limited taste sensitivities. Yet both supertaster and non-supertaster experts have similar responses to the “sweet” descriptor. Regardless of their taste sensitivities, the “sweet” descriptor decreases experts’ perception of wine quality. Therefore, these results provide evidence that experts’ negative response to the “sweet” descriptor is primarily because of their bias against the “sweet” descriptor.

These findings show that expert consumers, both supertasters and non-supertasters, believe the wine labeled with the “dry” descriptor has a superior quality than the same wine without this descriptor. It seems that expert consumers, regardless of their taste statuses, are primarily influenced by the sensory information, not only by the actual taste of wine to make judgements. Furthermore, the results suggest that the bias against the “sweet” descriptor and the preference for the “dry” descriptor is more pronounced among expert supertasters than among non-experts. Though their extreme taste sensitivities make the drier, bitter and tannic red wine less enjoyable, the over-time trainings seem to overcome the influence of the innate taste sensitivity and signal the brain that dry wine is better and should taste better.

### 3.6 Summary

Previous marketing research primarily focuses on how various external cues influence consumption behaviors. At the same time, extensive consumer research has studied how consumer product expertise influences their choices and shopping behaviors. However, it seems that the role of consumer taste physiology has been somewhat ignored by marketing and consumer behavior literatures, despite its importance in determining individual's taste perceptions and food and beverage preferences. To bridge this gap, a field experiment was conducted to examine how both consumer heterogeneous taste physiology and their product expertise influence purchasing behavior, particularly when wine tasting description cues are presented. The results show that the interaction between consumer taste physiology and wine expertise explains some of the observed differences in consumers' purchasing decisions, and seemingly small differences in wine tasting descriptions can have a substantial impact on consumers' purchasing decisions. Furthermore, this paper provides evidence that expert consumers exhibit a bias against the use of the "sweet" descriptor, with it negatively influencing their perception of wine quality and purchasing intent.

To be more specific, for novices, the fact that they have limited product knowledge (both perceptual and conceptual knowledge) seems to play a more important role in determining their purchasing behaviors in comparison to the role of

taste physiology because of their negative response to the “dry” descriptor. Moreover, this negative response is even more pronounced among supertasters. Regarding aficionados, who have asymmetric product knowledge, it appears that innate characteristics (taste physiology) play a more important role in determining their purchasing behaviors. Aficionado supertasters rely more on product tasting descriptions to make purchasing decisions. However, aficionado non-supertasters show no particular preference for certain wine styles and wine descriptions; they rely more on their own perceptual experiences to guide their purchasing decisions.

In terms of expert consumers, expert supertasters and aficionado supertasters exhibit distinct purchasing behaviors when given different tasting notes, which might be driven by the differences in their conceptual knowledge about wine. Furthermore, experts tend to have a bias against the “sweet” descriptor and prefer the “dry” descriptor regardless of wine styles. This bias is even more pronounced among expert supertasters than among their non-supertaster counterparts. While, one would expect supertasters to have a positive response to the “sweet” descriptor due to their extreme taste sensitivities, the results indicate the opposite. It appears that the influence of conceptual training and wine education overrules the influence of supertasters’ extreme taste sensitivities. Though the taste physiology does not change the way experts taste wines, training and wine education seem to change how they process and evaluate information. The results also suggest that experts rely more on the sensory

descriptions and their previous conceptual knowledge rather than the actual taste of the wine to make purchasing decisions.

### **3.7 Conclusion and implications**

This study has several implications for the food and beverage industry. It is important for marketers and producers to recognize that consumer taste physiology plays an important role in determining their choices. This influence should be taken into account when developing new products or targeting specific consumer segments. Several companies have already incorporated this concept into their marketing strategies. For example, the newly developed “blonde” line by Starbucks is mainly targeting those who like a lighter roast coffee (McKeever, 2012). Likewise, winemaker Gallo has developed a variety of products appealing to different taste profiles (Siegel, 2012).

This research also sheds light on how to deliver personalized product sensory information to consumers. It is helpful for training sales staff, tasting room staff or sommeliers who directly interact with consumers to understand this concept and make personalized recommendations. For example, wine clubs could make personalized recommendations and send selective samples to target subscribers with different taste status and expertise. In addition to traditional marketing strategies, this work has implications for digital marketing as well. For example, Morrisons, a leading

supermarket chain in the UK, offers an online “taste test” that gives consumers the opportunity to look for their favorable wines according to their taste profiles.

More specifically, this study suggests that wine marketers should be mindful of sensory descriptions as a marketing tactic to target different consumer segments. When a brand is mainly targeting novice consumers, using the “dry” descriptor of any kind for a dry red wine may have a negative influence on novice consumers’ purchasing decisions and therefore may not be an effective marketing tactic. In addition, novices may not associate the “sweet” descriptor with inferior quality, implying that including the “sweet” descriptor for sweet wines could be an option when targeting this segment of consumers. Aficionado consumers might be the most important customer segment in the sweet wine market. Including the “sweet” descriptor is likely to increase their purchasing likelihood. However, when dealing with expert consumers who tend to have a bias against the “sweet” descriptor and are in favor of the “dry” descriptor, emphasizing the dry characteristic of wines could positively influence their perceptions of the wine.

This paper also has implications for emerging cool climate wine industries that produce fine quality lighter and sweeter wines. New York State, a cool climate wine region, is famous for producing fine quality Riesling and Ice wines. This industry could use effective marketing strategies to attract novices and aficionados, particularly supertasters, who like sweet wines. In addition, supertasters tend to be female and

younger in age (i.e., Millennials). These two types of consumers have been and continue to be the major consumer segments in the wine industry. Therefore, it is a great business opportunity for such wine regions to attract these consumers through effective promotion of sweeter and lighter wines.

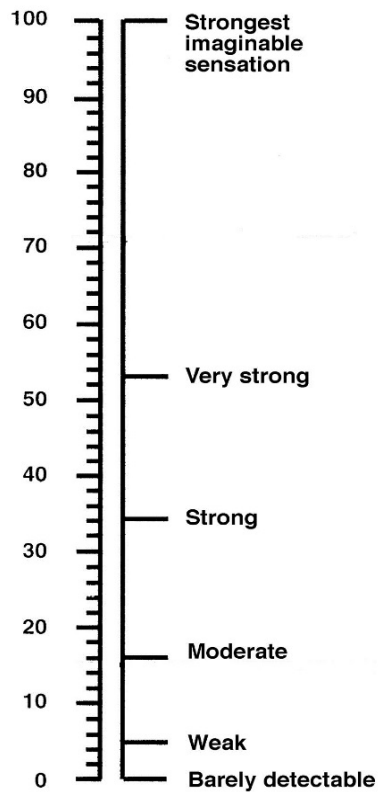
In addition, this paper suggests that expert consumers in general have a bias against the “sweet” descriptor. Since experts’ opinions represent the mainstream industry opinion about wine quality, some major changes in attitudes and wine education may be required to eliminate the stereotype associated with sweet wines and the “sweet” descriptor in order to develop the ignored but potentially large sweet wine market segment and increase sweet wine consumption. To achieve this goal, more comprehensive marketing plans are needed to change the negative perceptions about sweet wines and sweet wine drinkers in order to encourage sweet wine drinkers to consume the wine they enjoy. This may also require collaborative action from the industry, educators and opinion leaders to change the industry norm and encourage consumers to experimentation.

### Appendix 3. A. The PROP paper strip test

**Step 1:** Take a sip of water and swish it around your mouth to clean it.

**Step 2:** Take the paper strip out and place it on your tongue for 30 seconds or until it's fully wet.

**Step 3:** Please draw a horizontal line — at any place on the scale below to indicate your feeling for this paper strip.



### Appendix 3. B. Wine conceptual knowledge questions

Which of the following is a red wine?	Riesling Chardonnay <i>Merlot</i> Sauvignon Blanc Don't know
A peppery character is most associated with which wine?	Merlot <i>Shiraz/Syrah</i> Semillion Pinot Noir Don't know
Which grapes are never used to make Champagne?	Chardonnay <i>Riesling</i> Pinot Noir Pinot Meunier Don't know
Which is not a famous French wine region?	Bordeaux Champagne <i>Rheingau</i> Alsace Don't know
Which is the name of New Zealand's famed Sauvignon Blanc region?	Kapiti Hawkes Bay Waipara <i>Marlborough</i> Don't know



## **CHAPTER FOUR. Does passion for wine matter? The effects of owner motivation on pricing and quality decisions in non-traditional wine regions**

### **4.1 Introduction**

In the last decade, a substantial number of small- and medium-sized wineries have been established in non-traditional wine regions.<sup>7</sup> The number of U.S. wineries in these regions (excluding California) reached 4,292 in 2014, an impressive threefold increase from 2000 (Wine Institute, 2016). This entrepreneurial activity is believed to have the potential to become an engine for economic development in many rural areas nationwide. For instance, research shows that wineries foster growth in related industries such as tourism and hospitality, given that tasting rooms are the primary sales outlets (Sun et al., 2014). For example, in Missouri, a state with only 128 wineries and 1,700 acres land planted to grapes, the total economic impact of the wine industry is estimated to be \$1.76 billion annually (Missouri Wines, 2015). Similarly, Michigan's 107 wineries contribute more than \$300 million annually to Michigan economy (Michigan Grape and Wine Industry Council, 2014). More surprisingly, the direct and indirect economic impacts generated by the New York wine industry were estimated to exceed \$5 billion in 2014 (New York Wine and Grape Foundation, 2014).

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<sup>7</sup> Non-traditional wine regions exclude California and established wine regions in Oregon and New York.

In the neoclassical economic paradigm, when modeling firm behavior, it is typically assumed that a firm's objective is to maximize profits, minimize costs and create efficiencies to compete and survive in the long run (Alchian, 1950). Under this paradigm, firms are solely driven by profit maximization to make pricing and product quality decisions. However, theories grounded on labor economics argue that a firm's owner may also obtain utility from other aspects of the business other than just profits, such as from the production process and/or the products themselves (Demsetz, 1983). For instance, Scott-Morton and Podolny (2002) indicate that there are winery investors driven by a passion for wine and its associated lifestyle in California wine industry. These owners maximize utility rather than profit may, as a result, their wineries' pricing and quality decisions deviate from the ones made by profit maximizing wineries. For these individuals, the utility gained from operating a winery business and from the products produced could compensate for the lower financial returns received, ensuring the survival of their wineries.

On the other hand, a substantial number of entrepreneurs have entered the wine industry in the non-traditional wine regions in the recent decades, as discussed. Similar to the other well-established wine industry, these entrepreneurs may be motivated by a good business opportunity, or they may also be driven by a passion for making good quality wines and operating wineries. As a results, we argue the high variability in quality of wine produced and quality-adjusted wine prices in the non-

tradition wine industry may not only be driven by consumers' taste but also by winery investors' preferences. Previous research has studied the market consequences caused by the co-existence of utility-maximizing wineries and profit-maximizing wineries in California wine industry. In this paper, we focus on the analysis of non-traditional wine industries and explore whether and to what extent wineries market decisions are influenced by owners' preferences. Following on Scott-Morton and Podolny's (2002) work, we develop a set of hypotheses based on a utility maximization framework, and empirically measure the quality and pricing decisions under different winery owner motivations using data collected from 700 wines from 102 wineries in non-traditional wine regions of New York, Missouri and Michigan in 2012. Our econometric results provide support to the developed hypotheses. That is, we find that wineries owned by passion-oriented owners tend to produce wines of higher quality and charge higher quality-adjusted prices than wineries owned by profit-oriented individuals.

In this paper we propose that non-profit-maximizing wineries should be observed in the non-traditional wine industry when winery owners gain some sorts of utility from the production process and the associated lifestyle. This paper also provides an explanation of the high variability of wine quality and prices produced in the non-traditional wine regions. The findings are helpful for policy makers and stakeholders in these regions to recognize that the new entrants have heterogeneous motivations to enter into the industry, which consequently influence the operational

choices of the wineries and the equilibrium of the non-traditional wine industry in the long run.

## **4.2 Literature review**

In the neoclassical economic paradigm, a fundamental assumption is that a firm maximizes profits because its owner(s) can use these profits for consumption, and hence, to gain utility. However, Demsetz (1983) argued that some producers gain utility indirectly from the production process or products that may ease their household budget constraints. Pioneering research with respect to these issues has focused on non-profit firms in the 1970s. For instance, Newhouse (1970) developed an economic model to study the services provided by non-profit hospitals. The author suggests that, unlike for-profit hospitals, non-profit hospitals exhibit inefficient behaviors regarding resource allocation which often generate higher cost. Therefore, the primary concern of these hospitals is not to minimize cost and maximize profits because of the substantial donations from third parties. Subsequently, Weisbrod (1983) examined differences in workers' earnings between non-profit sectors and for-profit sectors in the labor market. The author points out that lawyers working in non-profit sectors have different 'preferences' than those working in for-profit sectors. Specifically, Weisbrod (1983) finds that some lawyers gain utility from work that is in the public interest and that this utility can compensate for the lower wage rates that lawyers earn in non-profit sectors.

Research studies have also explored how different motives or objectives can affect firm behavior. For instance, Lakdawalla and Philipson (1998) examined the consequences of having firms with different motives co-existing in a competitive market. Their model suggests that profit-maximizing firms will exit the market if there are sufficient altruistic' firms to satisfy the demand. Stern (2004) studied how alternative motivations to adopt science as a career affect scientists' wages in R&D organizations. The author finds that wages are significantly different between the scientists who enter the profession to follow their passion versus those who are motivated by the commercial applications of science. Another study by Hortacsu and Puller (2008) examined the differences of bidding behaviors between larger firms and smaller firms to supply electricity. Smaller firms exhibit behaviors that depart from the profit-maximization benchmark, and tend to submit "excessively steep" bid schedules causing significantly efficiency loss. In a similar study, Garcia-del-Barrio and Szymanski (2009) shows that the behavioral choices of professional soccer teams are best approximated by a strategy of maximizing team wins rather than by maximizing profits. Dunkelberg et al. (2013) examined how alternative entrepreneurial goals (i.e., utility maximization versus profit maximization) affect resource allocation strategies of start-up firms. They find that utility-maximizing entrepreneurs would like to spend more time working in their companies rather than hiring outside workers.

The determinants of market outcomes such as pricing and quality decisions in wine industry have also been explored in the literature. In their study of the Californian wine industry in the mid-1990s, Scott-Morton and Podolny (2002) investigated how winery owner motivation affects product quality and pricing decisions. Specifically, they find that owners with strong preferences for wine (i.e., utility-maximizers) tend to produce higher quality wines and sell them at higher prices in relatively low quantities in comparison to their profit-maximizing counterparts. More recently, Delmastro (2007) also finds that the utility-maximizing behavior of winery owners increases the probability of specialization in high-end wine markets. Studies have shown that ownership structure and configuration may affect winery pricing and quality decisions as well. Delmastro (2007) finds that cooperative wineries face more difficulties when coordinating members' efforts to elevate wine quality in comparison to the group-managed wineries. Dilger (2009) further points out that the management type (professional versus owner-managed wineries) has a substantial influence on quality and pricing decisions of wineries in Germany. Specifically, the author finds that professional managers prefer higher wine quality to larger wine quantities. Consequently, wineries with this type of management tend to produce better wines, at higher prices and in lower volumes than owner-managed wineries.

Previous research mainly focuses on the analysis of well-established wine industries such as California and Germany, and examine the market consequence due

to the co-existence of the utility-maximizing wineries and profit-maximizing wineries. We broaden the current literature by using the data collected from the emerging non-traditional wine regions to test whether the similar phenomenon exist in these wine regions study the implications for these wine industries. This paper contributes to the literature by explicitly measuring the entrants' motivation to enter the non-traditional wine industry and its associated influence on market consequences such as quality and pricing strategy.

### 4.3 Economic model

Building on Scott-Morton and Podolny's (2002), a theoretical model and the hypotheses are developed to examine the effect of owner motivation on winery quality and pricing decisions. Specifically, we formalize a dual maximization problem: the profit maximization problem for owners who are primarily motivated by profits, and the utility maximization problem for owners who are primarily driven by a passion for wine.

In our model, we assume that for ambiguous products such as wine, consumer demand is particularly influenced by product quality and price. Therefore, the profit-maximizing problem for a profit-oriented owner can be written as:

$$\max Profit(p, s) = D(p, s) * p - C(D(p, s)), \quad (1)$$

where  $D(p, s)$  denotes the demand at wine price  $p$  and quality level  $s$ ; and  $C$  denotes the total cost of the wine demanded.

While passion-oriented winery owners gain utility from profits, they also gain utility from other winery-related activities as well. Specifically, they may gain utility from the premium wines they produce, denoted as  $g(s)$ ,<sup>8</sup> and from the wine production activities they practice, denoted as  $h(t)$ , where  $t$  is the passion-related cost incurred only in utility-maximizing wineries.<sup>9</sup> That is,  $t$  measures the extent to which a winery owner enjoyed the production process and the winery owner lifestyle.

Consumers, however, do not value the passion-related input  $t$  because this input may not improve the overall product quality. For example, owners may spend substantial resources socializing with people with a similar passion for wine, but this expenditure may not improve the overall wine quality. Under this scenario, the utility-maximizing problem for a passion-oriented owner is written as follows:

$$\max \text{Utility } (p, s) = D(p, s) * p - C(D(p, s), t) + g(s) + h(t). \quad (2)$$

We assume that  $g_s(s) > 0$ ,  $g_{ss}(s) < 0$ ,  $h_t(t) > 0$ ,  $h_{tt}(t) < 0$ ,  $C_D(D) > 0$  and  $C_{DD}(D) < 0$ , where the single and double subscript represents the first and second order derivatives, respectively.

Intuitively, passion-oriented owners who care about quality may produce better quality wines and sell them at higher price levels than owners without such a quality preference in their utility functions (Dilger, 2009). These owners care more about

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<sup>8</sup> We assume that passion-oriented owners gain utility only from premium quality wines they produced not from any type of wines.

<sup>9</sup> We assume that  $t$  is an exogenous variable determined by the producer's idiosyncratic preference.



quality rather than quantity produced, and additional quantity may not increase these owners utility because the small scale production could supply enough wines for themselves, to their friends, restaurants, and competitors. In addition, Scott-Morton and Podolny (2002) argues that utility-maximizing wineries exhibit inefficiencies such as paying employees' wages that are higher than their marginal product and willing to offer a job to family members without human capital considerations. These inefficiencies can generate higher marginal costs for the operation. As a result, although passion-oriented owners tend to produce better quality wines, they may also charge higher quality-adjusted prices to cover their increased costs. Consequently we expect that passion-oriented producers tend to produce higher quality wines and they are likely to charge higher quality-adjusted prices in comparison to profit-oriented producers.

We also attempt to use the concept of supermodularity to mathematically examine how the passion-related cost ( $t$ ) influences a winery's quality ( $s$ ) and pricing ( $p$ ) decisions. If the utility function is supermodular, then the choice variables ( $p$  and  $s$ ) are increasing in the exogenous variable  $t$ , and decreasing otherwise (Milgrom and Shannon, 1994). One method to determine whether the utility function is supermodular is to check the signs of the cross partial derivatives of the utility function with respect to  $p$  and  $s$  ( $\frac{\partial^2 U}{\partial s \partial p}$ ),  $p$  and  $t$  ( $\frac{\partial^2 U}{\partial p \partial t}$ ), as well as  $t$  and  $s$  ( $\frac{\partial^2 U}{\partial s \partial t}$ ). The

utility function is supermodular if all the cross partial derivatives are non-negative. In order to test for supermodularity, we take the derivative of the utility function with respect to  $s$  and  $p$ , the derivative of the utility function with respect to  $p$  and  $t$ , and the utility function with respect to  $s$  and  $t$ . We then mathematically check whether the signs of these cross partial derivations. We expect that, particularly in the wine industry, all the cross partial derivations to be positive and the utility function to be supermodular (see Appendix I for detailed derivation and argument).

Based on the above discussion, two hypothesis are developed:

*H1: Wineries owned by passion-oriented individuals produce higher quality wine than wineries owned by profit-oriented individuals.*

*H2: Wineries owned by passion-oriented individuals select higher quality-adjusted prices than wineries owned by profit-oriented individuals.*

#### **4.4 Data**

To empirically test the aforementioned hypotheses, an extensive survey of winery owners was conducted in three non-traditional wine regions: New York, Missouri and Michigan. Surveys were mailed to 244 winery owners in May-June 2011, and 102 survey responses were received representing a 42 percent response rate. The response rate for Michigan was 45 percent ( $n=40$ ); Missouri was 44 percent ( $n=34$ ); New York was 29 percent ( $n=28$ ). The survey includes information on owner motivation to enter the wine industry, winery characteristics, procurement methods,

distribution channel mix, and degree of horizontal and vertical industry collaboration, among others.

Based on the survey responses, 57 percent of winery owners directly indicated that they entered the wine industry for non-monetary motives, including because of a passion for wine, enjoyment of this lifestyle or enjoyment of working in the countryside. Several questions were also included in the survey to measure owner motivation indirectly. These questions included, among others: 1) to what extent they focus on producing novel tasting wines (scale from 1 to 7), 2) percentage of wine production that is outsourced to other wineries (from 0 to 100), 3) percentage of the winery's investment coming from outside funding (from 0 to 100), and 4) to what extent the owners are socializing with other wine people (scale from 1 to 7).

In addition, we collected wine-specific secondary data on prices and quality rating scores from Wine Spectator (<http://www.winespectator.com/>). The Wine Spectator reports the ratings (on a 100-point scale) given to numerous wines by wine experts in a blind tasting. For the 16 wineries (covering 302 different wines) that responded to the above survey and whose wines are included in the Wine Spectator ratings database, data were collected on each wine's rating score, price, varietal, vintage, and appellation. To further enrich our dataset, we also collected wine quality rating scores from Cellar Tracker ([www.cellartracker.com](http://www.cellartracker.com)). Unlike Wine Spectator, this database relies heavily on consumers to input wine rating scores. There were 62

wineries (covering 700 different wines) that responded to the above survey that had also received ratings on Cellar Tracker. The rating scores of each of the 700 wines, as well as information on each wine's vintage, varietal and appellation were collected. Price data for each of the wines was not available from Cellar Tracker.

These data allow us to conduct an analysis at the winery level and at the wine level. Therefore, three datasets were created, including: 1) a winery-level database from the survey (102 winery-level observations), 2) a wine-level database using data from the 16 wineries with wines rated in Wine Spectator (302 wine-level observations), and 3) a wine-level database using data from the 62 wineries with wines rated in Cellar Tracker (700 wine-level observations).<sup>10</sup>

## **4.5 Empirical model**

The empirical model consists of three parts: 1) a principal component factor analysis to identify independent owner motivations for entering the wine industry, 2) a regression analysis to examine the effect of owner motivation on wine quality decisions, and 3) a regression analysis to examine the effect of owner motivation on winery pricing decisions. Each regression analysis is estimated at the wine- and winery-levels.<sup>11</sup>

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<sup>10</sup> There is little overlap between wines rated by Wine Spectator and Cellar Tracker as these two websites operate in different ways and rely on different input sources.

<sup>11</sup> Wineries in the non-traditional wine regions exhibit varied features and qualities, independent of wine-specific characteristics, such as ambience of the tasting room, service of the tasting room staffs and retail execution. Therefore, we conduct the analysis at both the wine level and winery level.

Using the survey data on winery owner motivations, we conduct a principal component factor analysis using the Varimax factor rotation technique to identify the two factors with the highest contribution to the variance. These two factors, denoted as  $F_1$  and  $F_2$ , capture both an owner's profit-oriented motivation and passion-oriented motivation for entry into the wine industry.  $F_i$  represents the score of the factor  $i$  ( $i=1, 2$ ). Each factor is considered intuitively as the linear combination of the original survey questions. We then employ these factors as explanatory variables in the regression analysis to explain wineries' quality and price decisions. Four empirical models will be discussed below, including wine-level quality model, winery-level quality model, wine-level price model, and winery-level price model.

In the wine-level quality model, the dependent variable is the quality rating score of each wine collected from Wine Spectator or Cellar Tracker. In addition to the owner motivation factors ( $F_i$ ), it is expected that the varietal type, the vintage, and the appellation are determinants of wine quality (Scott-Morton and Podolny, 2002; Bombrun and Sumner, 2003; Dilger, 2004). Winery size is also controlled in the regression to reflect winery specific determinants (Scott-Morton and Podolny, 2002; Dilger, 2004; Delmastro, 2007). This variable is measured by taking the natural log of gallons of wine produced in each winery in 2011. This empirical model is expressed as follows:

$$\begin{aligned} \text{Wine Quality Score} = & \beta_0 + \beta_1 F_1 + \beta_2 F_2 + \beta_3 \text{Varietal Dummy} + \beta_4 \text{Vintage Dummy} + \\ & \beta_5 \text{Appellation Dummy} + \beta_6 \text{Winery Size} + \varepsilon_i. \end{aligned} \quad (3)$$

In the winery-level quality model, the dependent variable, *average winery quality score*, is generated by taking the average of each wine's quality score collected from Cellar Tracker for each winery. We do not use the scores from Wine Spectator because many wineries in our sample do not have wines evaluated in this publication. The explanatory variables for this model include several factors that may affect the average wine quality produced by the winery in addition to the owner motivation factors. For example, procurement strategies, such as the *percentage of estate-grown grapes*, may affect the average winery quality rating. It is expected that wineries that grow grapes in their vineyards (i.e., vertically integrated) are better able to control grape quality than those wineries that acquire grapes from a spot market. The *percentage of wines bottled as varietals* is also included in the model and expected to have a positive relationship with the overall winery quality because varietal wines are generally superior in quality than those made from blended fruits. The model also includes control variables for winery size and location (*State Dummy*) to reflect winery specific characteristics. Therefore, the empirical model is as follows:

$$\begin{aligned} \text{Average Winery Quality Score} = & \alpha_0 + \alpha_1 F_1 + \alpha_2 F_2 + \alpha_3 \text{Percentage of Estate-grown Grapes} + \\ & \alpha_4 \text{Percentage of Wines Bottled as Varietal} + \alpha_5 \text{Winery Size} + \alpha_6 \text{State Dummy Variables} + \varepsilon_2. \end{aligned}$$

(4)

Next, the empirical model used to predict wine prices is also estimated at the wine-level and at the winery-level. In the wine-level price model, the dependent variable is calculated as the natural logarithm of each wine price obtained from the Wine Spectator website. Wine prices are regressed on the motivation factors, while controlling for wine quality indicated by the wine quality rating scores (Oczkowski, 1994; Landon and Smith, 1997; Scott Monton and Podolny, 2002; Schamel and Anderson, 2003). Other variables such as a varietal dummy, an appellation dummy and a vintage dummy are also included in the empirical model as further determinants of price. In addition to wine-level characteristics, the model also includes other factors reflecting winery specific determinants. For example, it is expected that the distribution channels through which wines are sold will affect the winery's pricing strategy. This variable is measured by the *percentage of sales that occurred within the state*. Other factors that affect a winery's overall pricing strategy include the winery's marginal cost that is represented by the winery size, the owner's experience in winemaking and the owner's experience in grape production. The estimation equation is expressed as follows:

$$\begin{aligned}
\text{Log Wine Price} = & \delta_0 + \delta_1 F_1 + \delta_2 F_2 + \delta_3 \text{Wine Rating Score} + \delta_4 \text{Varietal Dummy} + \delta_5 \text{Vintage} \\
& \text{dummy} + \delta_6 \text{Appellation Dummy} + \delta_7 \text{Owner's Experience in Winemaking} + \delta_8 \text{Owner's} \\
& \text{Experience in Grape production} + \delta_9 \text{Percentage of Sales Occurred within the State} + \gamma_{10} \text{Winery} \\
& \text{Size} + \varepsilon_3.
\end{aligned} \tag{5}$$

In the final model, pricing strategies at the winery level are examined. The dependent variable is calculated as the natural logarithm of the average wine price charged by each winery. Data for this variable was collected from the winery owner survey. The average winery price is regressed on the motivation factors, average winery quality rating scores and other control variables. It is expected that the average wine price charged by the winery will be positively related to the *winery quality score* measured by the winery's average wine quality score. *Percentage of wines that bottled as varietals* is also included as an independent variable in the model. It is expected that this variable is positively related to the average wine price in a winery since varietal wines generally cost more to produce than blended wines. Other factors that affect overall winery pricing strategies are also included in the estimation model such as percentage sales occurred within the state, owner's experience in winemaking, owner's experience in grape production and winery size. The empirical winery-level price model is written as follows:



$$\begin{aligned} \text{Log Average Winery Price} = & \gamma_0 + \gamma_1 F_1 + \gamma_2 F_2 + \gamma_3 \text{Winery Quality Score} + \gamma_4 \text{Percentage of Wines} \\ & \text{Bottled as Varietal} + \gamma_5 \text{Percentage of Sales Occurred within the State} + \gamma_6 \text{Owner's Experience in} \\ & \text{Winemaking} + \gamma_7 \text{Owner's Experience in Grape production} + \gamma_8 \text{Winery Size} + \varepsilon_4. \end{aligned} \quad (6)$$

#### 4.6 Factor analysis results and descriptive statistics

The results of the principal component factor analysis are shown in table 4.1. The results reveal that the first factor loads on winery owners motivated to enter the wine industry by their passion for wine. Winery owners with this type of motivation also tend to be relatively new to the industry (i.e. fewer years of winery ownership) and are more likely to produce wine with a novel taste. In other words, these owners are less willing to replicate the business models of other wineries and are more willing to produce novel tasting wines that consumers may not be familiar with. Since the first factor clearly refers to owners with a non-monetary motivation for entering the wine industry, this factor is labeled to represent a *passion-oriented motivation*.

**Table 4.1. Principal component factor analysis result**

Factor	Attributes in Factor	Factor Loadings
<i>Passion-oriented motivation factor</i> Eigenvalue = 8.10	Owner enters wine industry driven by a passion for wine	0.429
	Length of time that the winery has been operated	-0.713
	The extent the winery focus on producing a novel tasting wine rather than simply replicating the taste	0.724
<i>Profit-oriented motivation factor</i>	The winery is primarily funded by investors	0.660

Eigenvalue = 1.31	Percentage of wine production that is outsourced to other wineries	0.720
	The winery is self-owned	-0.770

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The second factor loads on survey items that include primary funding from external sources, a larger percentage of winemaking outsourced to another winery, and lower levels of self-ownership. With more external money invested in the winery, wineries with this type of motivation are likely to have more pressures to meet the financial expectations of investors/lenders and therefore more likely to focus on the returns and/or managing the efficiency of the winery business. Similarly, with lower levels of self-ownership, wineries are more likely to have financial pressure and care more about profits. However, self-owned wineries are less likely to have that financial pressure. Besides, outsourcing winemaking to another winery is a strategy usually used by small wineries to reduce cost. Therefore, wineries outsourcing a larger percentage of wine production to another winery mainly focus on minimizing production cost. However, by doing this, the wineries cannot control their wine quality. Since the second motivational factor picks up the monetary motivation and business attitude of an owner, it is labeled as a *profit-oriented motivation*.

Tables 4.2a and 4.2b present the descriptive statistics for the wine level estimation. The average wine quality score collected from Wine Spectator is 82.74 points and ranges from 55 to 91 points. The average price is \$16 per bottle (2.738 in

log form) with a price range of \$6 to \$80. The Wine Spectator sample includes wine from 4 appellations, and represents 6 different grape varieties and 23 different vintages during the 1998 and 2011 period. Column 4 of Table 4.2a shows the mean/frequency of each variable. For example, white vitis vinifera is the most common varietal, accounting for 47.48% in the sample, followed by red vitis vinifera (24.93%), red blend (18.1%), hybrid white (6.63%) and hybrid red (2.86%). The mean age of the wines in the Wine Spectator sample is 9.5 years. In terms of the Cellar Tracker sample, the average wine quality score ranges from 50 to 98 points with a mean score of 85.09 points. The Cellar Tracker sample includes 19 appellations, and represents 8 grape varieties and 17 different vintages. The frequency of each variable is shown in Column 4 of Table 4.2b. The most common varietal is also white vitis vinifera (31.29%), followed by red vitis vinifera (27.71%), red blend (17.14%), white blend (11.57%), hybrid white (6.14%) and fruit wine (3.43%). The mean age of the wines in this sample is 6.4 years. In this sample, Michigan wines account for 64% of the total sample, and the rest are from New York (26%) and Missouri (10%).

**Table 4.2. Descriptive statistics from Wine Spectator**

Variable	Description	Obs	Mean/ Frequency	Std. Dev.
<i>Wine quality rating score</i>	Bottle wine rating score	302	82.735	4.465
<i>Varietal dummy</i>	Hybrid Red	302	2.86%	
	Hybrid White	302	6.53%	
	Red Blend	302	18.1%	
	Red Vitis Vinifera	302	24.93%	
	White Blend	302	2.08%	

<i>Appellation dummy</i>	White Vitis Vinifera	302	47.48%	
	Finger Lake regions (NY)	302	88.43%	
	Northeast (MI)	302	8.31%	
	Southwest (MI)	302	1.78%	
	Central Wine Region (MO)	302	1.48%	
<i>Vintage</i>	Years of the wines that have been produced	302	9.500	5.160
<i>Log wine price</i>	Price of bottle of wine	297	2.783	0.385

**Table 4.2b. Descriptive statistics from Cellar Tracker**

<i>Wine quality rating score</i>	Bottle wine rating score	700	85.085	5.080
<i>Varietal dummy</i>	Hybrid Red	700	1.57%	
	Hybrid White	700	6.14%	
	Red Blend	700	17.14%	
	Red Vitis Vinifera	700	27.71%	
	White Blend	700	11.57%	
	White Vitis Vinifera	700	31.29%	
	Fruit	700	3.43%	
	Native	700	1.14%	
<i>Appellation dummy</i>	Hudson region (NY)	700	0.57%	
	Niagara Escarpment region (NY)	700	0.14%	
	Finger Lake region (NY)	700	26.29%	
	Lake Erie region (NY)	700	0.29%	
	Southeast (MI)	700	0.57%	
	Northeast (MI)	700	50.14%	
	Southwest (MI)	700	14.29%	
	Hermann Wine Region (MO)	700	0.43%	
	Southeast Wine Region (MO)	700	0.43%	
	Central Wine Region (MO)	700	3.14%	
	Ozark Mountain Wine Region (MO)	700	2.00%	
	Western Wine Region (MO)	700	0.86%	
	Ozark Highlands Wine Region (MO)	700	0.43%	
	Others	700	0.43%	
	Years of the wines that have been produced	700	6.422	2.600

Note: Wine information about quality score, price, vintage, varietal and appellation in Table 4.2a are collected from Wine spectator website. Wine information in 4.2b regarding quality score, vintage, varietal and appellation are collected from Cellar Tracker Website, however there is no corresponding wine price data in Cellar Tracker Website. Vintage variable is also dummy variables; however, we did not include each specific vintage in above tables in order to conserve space. The winery characteristics are collected from the survey.

Table 4.3 presents the descriptive statistics of the variables for the winery level estimation. For the dependent variable, the lowest winery quality score in our sample is a 72 and the highest score is a 92. For the explanatory variables, the average score of the *passion-oriented motivation factor* is -0.040 with a 1.006 standard deviation. The average score of the *profit-oriented motivation factor* is 0.025 with a 1.003 standard deviation. The average winery size is 8.401 (4,452 gallons of wine). The results also indicate that, on average, 47 percent of wines are bottled as grape varietals and the remaining are bottled as blended wines, and 46 percent of wines are produced from estate-grown grapes. For the price estimation model, the average winery price in our sample is \$13.1 (2.573 in log form). Owners' experiences in winemaking range from 0 to 42 years, with an average 11 years of experience. In terms of the distribution channel, 95 percent of sales are generated within the state (tasting room, farmers market and local chain stores) on average.

**Table 4.3. Winery Level Descriptive Statistics**

Variable	Description	Obs	Mean	Std. Dev.
<b>Quality Estimation Model</b>				
<i>Average winery rating</i>	Average wine rating score of the winery	81	79.014	6.793
<i>Passion-oriented motivation factor</i>	Passion-oriented factor loading score	81	-0.040	1.006
<i>Profit-oriented motivation factor</i>	Profit-oriented factor loading score	81	0.025	1.003
<i>Winery size</i>	Total wine production in 2011 in gallons	81	8.401	1.491
<i>Percentage of wines bottled as varietal</i>	Percentage of total wine production that is bottled as	81	0.469	0.281

	grape varietal			
<i>Percentage of estate-grown grapes</i>	Percentage of grapes produced in their own vineyard (estate-grown)	81	0.456	0.372
<i>NY (appellation)</i>	=1 if the winery is in New York state, =0 otherwise	81	0.284	0.454
<i>MI (appellation)</i>	=1 if the winery is in Missouri, =0 otherwise	81	0.358	0.482
<b>Price Estimation Model</b>				
<i>Log average winery price</i>	Average price of wine in the winery	86	2.573	0.300
<i>Average winery rating score</i>	Average winery rating score	86	78.612	6.677
<i>Percentage of wine bottled as varietal</i>	Percentage of total wine production that is bottled as grape varietal	86	0.440	0.285
<i>Percentage of sales within the state</i>	Percentage of total wine sales generated within the state that the winery locates	86	94.710	13.128
<i>Owner's experience in winemaking</i>	Years of experience the owner has in winemaking	86	11.302	9.739
<i>Owner's experience in grape production</i>	Years of experience the owner has in grape	86	10.843	10.699

## 4.7 Estimation results

Estimation results for the quality and pricing strategies used by wineries in non-traditional wine regions are presented below. For both the quality and pricing models, estimations are conducted at the wine- and winery- levels.

### 4.7.1 Quality estimation results

Tables 4.4 and 4.5 present the results of the quality decision estimations at the wine- and winery-levels, respectively.

- Wine-level Model

The wine level estimation uses a clustered error OLS regression approach allowing the error terms to be correlated within each winery. The estimation results using the wine quality rating scores from Wine Spectator are presented in columns 2, 3 and 4 of Table 4.4, while the estimation results using the wine quality rating scores from Cellar Tracker are presented in columns 5, 6 and 7 of Table 4.4.

**Table 4.4. Quality choice model estimation results at wine level**

Dependent variable:	Wine rating	Wine rating	Wine rating	Wine rating	Wine rating	Wine rating
	<i>(Data from Wine Spectator)</i>			<i>(Data from Cellar Tracker)</i>		
<i>Passion-oriented motivation factor</i>	4.017*** (0.806)	4.182*** (0.808)	3.993*** (0.812)	0.644 (0.550)	0.615 (0.649)	1.000 (0.722)
<i>Profit-oriented motivation factor</i>	-0.543* (0.303)	-0.580* (0.307)	-0.583** (0.237)	-0.922** (0.349)	-0.814** (0.354)	-0.581* (0.349)
<i>Winery size</i>	1.332 (1.309)	1.720 (1.303)	1.864 (0.808)	0.039 (0.359)	0.038 (0.366)	0.275 (0.439)
<i>Varietal dummy</i>	yes	no	no	yes	no	no
<i>Vintage dummy</i>	yes	yes	yes	yes	yes	yes
<i>Appellations dummy</i>	yes	yes	no	yes	yes	no
Clustered error regression	yes	yes	yes	yes	yes	yes
R-square	0.41	0.38	0.37	0.18	0.15	0.08
Observations	302	302	302	700	700	700

We employ STATA for estimation. \*, \*\*, \*\*\* denote coefficient estimates that are statistically significant at the 0.10, 0.05 and 0.01 level, respectively. Standard errors are presented in parentheses.

Bottle wine quality is postulated to be determined by varietal, vintage, and appellation in the short run (Scott-Morton and Podolny, 2002). Column 2 shows the estimation results when controlling for each of these wine characteristics using

dummy variables. The results illustrate that the *passion-oriented motivation factor* has a significant positive effect on the wine quality rating score with a one-unit increase in the passion-oriented factor score resulting in a 4.07-point increase in the quality score for a particular bottle of wine. On the other hand, the *profit-oriented motivation factor* has a significant negative effect on the quality score. Here, a one-unit increase in the profit-oriented factor score decreases the wine quality score by 0.543 points. These results confirm the hypothesis that winery owners who are motivated by a passion for wine tend to produce higher quality wines and sell their products in higher-end markets in comparison with their profit-oriented counterparts.

The robustness of the model is evaluated by relaxing the controls for varietals and the appellation in which the wine grapes were grown as these decisions could change in the long run. Column 3 in Table 4.4 presents the results when the varietal dummy variables are not included as controls. The results are consistent with the results reported when the varietal, vintage, and appellation are controlled in the estimation model (see column 2). Similarly, when both the varietal and appellation are not controlled in the estimation model, the results do not report significant differences between the estimated coefficients across the three models (see column 4). This result further indicates that utility-maximizing wineries tend to produce higher quality wines in comparison with their profit-maximizing counterparts. These results support the claim that the winery owner's motivation to enter the industry plays an



important role in their wine quality decisions. The *winery size* variable was found to be statistically insignificant under these model specifications.

In addition, we present the estimation results using the wine quality scores data from Cellar Tracker (see columns 5, 6 and 7 in Table 4.4). Using this dataset, the results indicate that the coefficient for the *profit-oriented motivation factor* is both negative and significant when controlling varietal, vintage and appellation dummy variables (see column 5). While the direction of this relationship is consistent with the findings using the Wine Spectator data, the effect size is different. Here, a one-unit increase in the profit-oriented factor score lowers the wine quality score by 0.922 points. The results using the Cellar Tracker data also illustrate that the coefficient for *passion-oriented motivation factor* is positive but statistically insignificant. Columns 6 and 7 present the estimation results in the long run situation where the varietal and appellation in which the grapes are grown may change. These results are comparable with the estimation results in Column 5. The *profit-oriented motivation factor* still has a significant negative effect on the wine quality score, and the coefficient for the *passion-oriented motivation factor* remains positive but insignificant. Overall, these models suggest that wineries with a profit motivation are less likely to produce higher quality wines and target lower-end markets in comparison with their passion-oriented counterparts. Similar to the Cellar Tracker results, the *winery size* variable was found insignificant in these analyses.

- Winery-level Model

For the winery-level quality score equation, we obtain parameter estimates from a Tobit model because the wine quality scores in Cellar Tracker are censored low at 72 points. The regression coefficients (Column 2) and the marginal effects (Column 3) are presented in Table 4.5.

**Table 4.5. Quality choice model estimation results at winery level**

Dependent variable:	Average winery rating	
	Coefficients	Marginal Effects
<i>Passion-oriented motivation factor</i>	3.372** (1.309)	1.200***
<i>Profit-oriented motivation factor</i>	-1.887** (1.098)	-0.672*
<i>Winery size</i>	5.139*** (1.036)	1.830***
<i>Percentage of wines bottled as varietal</i>	5.267 (3.618)	1.875
<i>Percentage of estate-grown grapes</i>	4.198 (2.817)	1.495
<i>NY</i>	2.390 (2.619)	0.851
<i>MI</i>	1.386 (2.458)	0.493
<i>Constant</i>	27.893** (9.318)	
Number of observations	81	-
Log likelihood	-185.795	-
LR ChiSquare	35.33	-
Prob > ChiSquare	0.000	-
Pseudo R2	0.087	-

We employ STATA for estimation. \*, \*\*, \*\*\* denote coefficient estimates that are significant at the 0.10, 0.05 and 0.01 level, respectively. Standard errors are presented in parentheses. The marginal effects for the expected value of dependent variable are calculated conditionally on being

uncensored data at the mean of the independent variables. The marginal effect results are very similar when calculated based on all the data.

The results show that the coefficient for *passion-oriented motivation factor* is positive and significant, indicating that winery owners with higher passion-oriented factor scores tend to produce higher quality wines as measured by the average wine quality score received by the winery. The estimated marginal effect for the *passion-oriented motivation factor* is 1.20. In other words, a one-unit increase in the passion-oriented factor score increases the average wine quality score by 1.20 points. Furthermore, the coefficient for *profit-oriented motivation factor* is negative and significant. This suggests that winery owners with higher profit-oriented factor score tend to produce lower quality wines as measured by the average wine quality score received by the winery. The estimated marginal effect for the *profit-oriented motivation factor* further indicates that a one-unit increase in the profit-oriented factor score lowers the average wine quality score by 0.672 points. These results support our hypothesis that passion-oriented winery owners tend to produce higher quality wines in comparison with their profit-oriented counterparts. The difference between the coefficients for *passion-oriented motivation factor* and for *profit-oriented motivation factor* is significant under this model specification. These findings, therefore, support the claim that the winery owner's motivation for entering the wine industry can have a substantial impact on their wine quality decisions.

The results also illustrate that the coefficient for *winery size* is positive and significant suggesting that wineries are more likely to produce higher quality wines as they grow larger. The marginal effect indicates that a one-percent increase in the size of the winery increases the winery rating score by 1.830 points. One explanation for this finding is that as wineries grow larger, they may have increased access to superior resources such as higher quality grape suppliers (or estate-grown grapes) and more highly skilled labor that can result in better control of wine quality. Both *percentage of wine bottled as varietals* and *percentage of estate-grown grapes* were found to be statistically insignificant in this analysis.

#### 4.7.2 Price estimation results

Tables 4.6 and 4.7 present the results of the pricing decision estimations at the wine- and winery-levels, respectively.

- Wine-level Model

Table 4.6 presents the wine level estimation results for the pricing model using data collected from Wine Spectator. The estimation results show that higher-rated wines enjoy higher prices since the coefficient of the *wine quality rating score* is positive and significant. More importantly, the results show that wineries scoring high on the passion-oriented factor exhibit higher prices. Here, a one-unit increase in the passion-oriented factor score increases the price of a wine by 28.1 percent, which is almost 5

dollars for an average bottle of wine in our sample (\$17.69). On the other hand, wineries with a higher profit-oriented factor score tend to charge lower prices on a quality-adjusted basis. A one-unit increase in the profit-oriented factor score lowers the price of a wine by 27.9 percent. The results once again confirm the hypothesis that wineries owned by passion-oriented individuals tend to charge higher wine prices relative to wine quality in comparison to wineries owned by profit-oriented individuals. Furthermore, the price difference between utility-maximizing wineries and profit-maximizing wineries is significant. These findings support the claim that owner motivation has a significant influence on winery pricing decisions.

**Table 4.6. Price choice model estimation results at wine level**

Dependent Variable:	log bottle price
<i>Passion-oriented motivation factor</i>	0.281*** (0.063)
<i>Profit-oriented motivation factor</i>	-0.279*** (0.050)
<i>Wine quality rating score</i>	0.018* (0.008)
<i>Percentage sales within state</i>	0.006*** (0.001)
<i>Winery size</i>	-0.141** (0.059)
<i>Owner's experience in grape production</i>	-0.084*** (0.016)
<i>Owner's experience in winemaking</i>	0.089*** (0.016)
<i>Vintage Dummy</i>	yes
<i>Appellation dummy</i>	yes
<i>Varietal dummy</i>	yes

R-square	0.55
Observations	233

We employ STATA for estimation. \*, \*\*, \*\*\* denote coefficient estimates that are statistically significant at the 0.10, 0.05 and 0.01 level, respectively. Standard errors are presented in parentheses.

Winery size was found to have a significant negative effect on wine prices. That is, wine prices tend to decline as wineries grow possibly reflecting the benefits of economies of scale. The results also indicate that utility-maximizing wineries tend to be smaller in size, and therefore suggest that higher quality-adjusted wine prices from utility-maximizing wineries may be expected to decline as the winery grows larger. The coefficient for the *owner's experience in grape production* was found to be negative and significant. This finding indicates that an increase in the owner's experience in grape production lowers the wine prices they charge. That is, winery owners with many years of grape production experience can make better production plans and more cost-efficient production decisions, and/or have more access to higher quality grape suppliers in comparison with winery owners with less grape production experience. However, the estimation results suggest that more years of owners' experience in winemaking tend to increase wine prices. Here, the explanation may be that the more experience winery owners have in winemaking, the more likely they are to produce

higher quality and better tasting wines, and hence the more likely for them to charge higher prices.<sup>12</sup>

- Winery-level model

The estimation results using the winery level price data are presented in table 4.7. The results indicate that the coefficient for *passion-oriented motivation factor* is both positive and significant. Here, a one-unit increase in the passion-oriented factor score increases the average winery price by seven percent, which is 99 cents for an average bottle of wine in the sample (\$13.95). The coefficient for *profit-oriented motivation factor* remains negative but insignificant. These results support our hypothesis that wineries owned by passion-oriented individuals tend to have higher average winery price in comparison with wineries owned by profit-oriented individuals. One reason may be that the higher average price is driven by the higher marginal cost associated with the inefficient features occurred in utility maximizing wineries (Scott-Morton and Podolny, 2002).

**Table 4.7. Price choice model estimation results as winery level**

Dependent Variable	log average bottle price
<i>Passion-oriented motivation factor</i>	0.070** (0.039)
<i>Profit-oriented motivation factor</i>	-0.024

<sup>12</sup> Due to the lack of price information in Cellar Tracker website, we are not able to perform a wine level price regression using the Cellar Tracker database.

	(0.028)
<i>Average winery rating</i>	0.005 (0.006)
<i>Percentage wines bottled as varietal</i>	0.348*** (0.121)
<i>Sales within the state</i>	0.006*** (0.001)
<i>Winery size</i>	-0.043 (0.035)
<i>Owner's experience in winemaking</i>	0.005 (0.006)
<i>Owner's experience in grapes</i>	0.0005 (0.005)
Number of observations	83
Prob > F	0.001
R-Square	0.25

We employ STATA for estimation. \*, \*\*, \*\*\* denote coefficient estimates that are statistically significant at the 0.10, 0.05 and 0.01 level, respectively. Standard errors are presented in parentheses.

The results also illustrate that the coefficient for *percentage of wines bottled as varietal* is significant and positive. This finding suggests that wineries where varietals make up a higher percentage of wines bottled also have a higher average price for their bottles of wine. This is because varietals tend to have a higher cost of production when compared to other wine types (e.g., blended wines). The coefficient for *percentage of sales within the state* is also significant and positive. In this case, a one-percent increase in in-state sales increases the price a winery charged for a bottle of wine by 0.6 percent. It is further noted that for the wineries in our survey sample, 95 percent of their wine sales were generated in the tasting room. Wineries that rely on tasting room



sales may price their wines higher to compensate for the additional costs of operating the tasting room (e.g., labor, displays, etc.).

#### **4.8 Conclusion**

In this paper, we develop hypotheses based on a utility maximizing framework and empirically examine the influence of winery owner motivation to enter the industry on pricing and quality decisions using data collected in 2012 from 700 wines produced from 102 wineries in non-traditional regions of New York, Michigan and Missouri. The results confirm the hypotheses that wineries owned by passion-oriented individuals tend to produce higher quality wines and charge higher quality-adjusted prices in comparison with wineries owned by profit-oriented individuals. This suggests that passion-oriented owners may consider their wines as of superior quality and therefore overprice them. In contrast, winery owners who are primarily motivated by profit are less likely to produce higher quality wines and are more likely to set lower quality-adjusted prices to target lower-end markets. Therefore, our results suggest that different winery owner motivations may lead to different marketing strategies in terms of product quality and pricing decisions.

These findings have implications for the equilibrium of the wine industry in the non-traditional wine regions. The policy makers and wine industry stakeholders in these regions should recognize that the new entrants have heterogeneous motivations to enter into the industry, which consequently influence the operational choices such

as the quality and pricing strategy and the dynamics of the wine industry. They also should be aware that the heterogeneous products in the market are not only driven by consumers' tastes, but also are significantly influenced by entrepreneur owners' preferences. The winery owners who gain utility from producing premium wines and the associated lifestyle may oversupply these characteristics to the market than consumers would demand on their own. The entry of the utility maximizing producers drives up the equilibrium prices of good quality wines and consequently may attract entry in comparison to a world without these producers.

These findings also shed light on the ongoing discussion regarding appropriate strategies for wineries in non-traditional regions to access non-local markets and to expand their sales nationwide. Particularly, the variability of wine prices (even adjusted differences) may be a critical barrier for wineries in these regions to deliver a consistent image to consumers regarding the wine quality and prices. Government agencies and universities can initiate some collaborative actions such as the region-wide marketing plans by promoting best production and processing practices to ensure consistent wine quality within a region. While this research sheds light on pricing and quality decisions that influence industry performance in emerging wine regions, the study has several limitations that require further research. First, future research may examine the relationship between owner motivation and winery performance (sales and profit margins) to get some insight into how owner

motivation influences the winery's growth and development. Second, wineries in emerging regions exhibit different ages and sizes. Future research should explore the role of leading firms to achieve greater coordination across wineries within a region. Finally, it is desirable to conduct a follow-up survey to those wineries in the sample to study the dynamics of wine pricing and quality as non-traditional regions become more established.

#### Appendix 4. A. The mathematic derivation of the utility maximization problem

This following section discusses how we utilize the supermodularity concept to examine how the passion-related cost ( $t$ ) influences a winery's quality ( $s$ ) and pricing ( $p$ ) decisions. The utility maximizing problem is already defined in equation (2), we check the cross partials of the utility function with respect to  $s$  and  $p$ ,  $s$  and  $t$ , and  $t$  and  $p$  to examine the supermodularity of the utility function. We take the derivative of utility function with respect to  $s$ , which yields

$$\frac{\partial U}{\partial s} = D_s * p + g_s - C_D * D_s \quad (1)$$

Then, we take the derivative of  $\frac{\partial U}{\partial s}$  with respect to  $p$ , which yields:

$$\frac{\partial^2 U}{\partial s \partial p} = D_s + [P - C_D] * D_{sp} - C_{DD} * D_p * D_s \quad (2)$$

In equations (3) and (4),  $D_s$  is positive because higher wine quality is normally more desirable for consumers. In fact, the magnitude of  $D_s$  may be relatively large in the case of wine, given the high level of vertical differentiation in wine markets. On the other hand,  $D_{sp}$  is expected to be negative, indicating that the derivative of demand with respect to quality  $s$ , that is  $\frac{\partial D}{\partial s}$ , will increase slower at higher price points. The intuition here is that improving the quality of low priced wines can result in larger demand increases than improving the quality of higher priced wines. That is, lower priced wines are more likely to be viewed as good value wines (i.e., quality increase

divided by price) after a quality increase than higher price wines. Furthermore, high priced wines may not be affordable to most consumers despite the higher quality.

The term  $[P - C_D]$  in equation (4) is expected to have a negative sign for utility maximizing wineries where the marginal product cannot offset the marginal cost. The rationale is that as the wine industry reaches the market equilibrium (i.e., no new entry or exit of wineries) profit-maximizing wineries should make zero profits while the utility-maximizing wineries should make negative profits (Scott-Morton and Podolny, 2002). Passion-oriented owners are assumed to have other sources of income and sufficiently large stocks of wealth to compensate for the low financial returns of the wineries. Therefore, the term  $[P - C_D(D)] * D_{sp}$  is positive, and  $D_s + [P - C_D(D)] * D_{sp}$  is positive as well. On the other hand, the third term in equation (4),  $-C_{DD} * D_s * D_p$  is negative since, by definition,  $C_{DD}$  is negative,  $D_s$  is positive and  $D_p$  is negative. We expect that the magnitude of the second order derivative  $C_{DD}$  is very small in comparison to the positive term  $D_s + [P - C_D(D)] * D_{sp}$ . Therefore, we expect the  $\frac{\partial^2 U}{\partial s \partial p}$  to be positive, that is, the cross partial derivative of the utility function with respect to  $s$  and  $p$  should be positive.

Using the same process as above, we can also examine the cross partial derivative of the utility function with respect to  $t$  and  $s$ , by first taking the derivative of the utility function with respect to  $t$ , which is,

$$\frac{\partial U}{\partial t} = -C_t + h_t(t) \quad (3)$$

Next, taking the derivative of  $\frac{\partial U}{\partial t}$  with respect to  $s$  yields:

$$\frac{\partial^2 U}{\partial s \partial t} = -C_{ts} \quad (4)$$

If we assume that the utility function is continuous on  $t$  and  $s$ , then  $C_{ts}$  equals to  $C_{st}$  by the Schwarz theorem. To check the sign of  $C_{ts}$ , one could check the sign of  $C_{st}$ . Scott-Morton and Podolny (1998) argue that  $C_{st}$  is negative. The rationale is that winery owners' expenditures on  $t$  (e.g., socializing with other like-minded people in the wine industry) may help cultivate relationship between them and quality grape growers; therefore, it may cost less for the passion-oriented owners to build a favorable relationship with quality grape suppliers at the margin. Following the Schwarz theorem,  $C_{ts}$  must be negative as well, and the term  $-C_{ts}$  in equation (6) is positive. The conclusion is that the cross partial derivative of the utility function with respect to  $s$  and  $t$  ( $\frac{\partial^2 U}{\partial s \partial t}$ ) is also positive.

To check the cross partial derivative of the utility function with respect to  $t$  and  $p$ , we take the derivative of  $\frac{\partial U}{\partial t}$  from equation (5) with respect to  $p$ , which yields:

$$\frac{\partial^2 U}{\partial t \partial p} = -C_{tD} * D_p \quad (5)$$

where  $D_p$  is negative following the law of demand for normal goods. Furthermore, if we assume that the cost function,  $C$ , is continuous on  $t$  and  $D$ , then it follows that  $C_{tD}$

is equivalent to  $C_{Dt}$  by the Schwarz theorem. It is expected that  $C_{Dt}$  (and thus  $C_{tD}$ ) is positive, since the marginal cost of production (demand) is likely to be higher for a winery owner that is motivated by his/her passion for wine (i.e., as  $t$  increases). The intuition is that the more a winery owner is driven by passion, the less he/she may prioritize production efficiency and minimize winery operation costs. For example, passion-oriented owners may often interfere in production, packaging and marketing activities following their tastes, and may spend substantial resources hosting events to socialize with wine industry colleagues. Therefore,  $C_{tD}$  is expected to be positive, so  $\frac{\partial^2 U}{\partial t \partial p}$  is positive as a result.

The analysis above reveals that the utility function is expected to be supermodular as all the cross partial derivatives  $\frac{\partial^2 U}{\partial s \partial p}$ ,  $\frac{\partial^2 U}{\partial s \partial t}$  and  $\frac{\partial^2 U}{\partial p \partial t}$  are positive. We therefore conclude that the choice variables ( $p$  and  $s$ ) are increasing in the exogenous variable  $t$ . That is, when the passion-related input  $t$  increases, the quality choice variable  $s$  and the price choice variable  $p$  both increase.

## REFERENCE

- Alchian, A. 1950. "Uncertainty, Evolution, and Economic Theory". *Journal of Political Economy* 58(3): 211-221.
- Allison, R. I., and K. P. Uhl. 1964. "Influence of Beer Brand Identification on Taste Perception." *Journal of Marketing Research* 1(3): 36-39.
- Ballester, J., B. Patris, R. Symoneaux, and D. Valentin. 2008. "Conceptual vs. Perceptual Wine Spaces: Does Expertise Matter?" *Food Quality and Preference* 19(3): 267-276.
- Barras, T. 2013. "Americans talk dry but drink sweet." Tom Barras Wine Commentary. Available online at <http://tombarraswinecommentary.blogspot.com/2013/07/americans-talk-dry-but-drink-sweet.html>. [Accessed October 2016].
- Bartoshuk, L. M. 1991. "Sweetness. History, Preference, and Genetic Variability." *Food Technology* 45(11): 112-113-108, 110.
- Bartoshuk, L. M. 1993. "The biological basis of food perception and acceptance." *Food Quality and Preference* 4(1-2): 21-32.
- Bartoshuk, L. M., V. B. Duffy, and I. J. Miller. 1994. "PTC/PROP tasting: anatomy, psychophysics, and sex effects." *Physiology & Behavior* 56(6): 1165-1171.
- Bartoshuk, L. M., and V. B. Duffy, L. A. Lucchina, J. Prutkin, and K. Fast. 1998. "PROP (6-n-propylthiouracil) supertasters and the saltiness of NaCl." *Olfaction and Taste Xii: an International Symposium* 855: 793-796.
- Bartoshuk L. M., V. B. Duffy, K. Fast, B. G. Green, J. Prutkin, D. J. Snyder. 2003. "Labeled scales (eg, category, Likert, VAS) and invalid across-group comparisons: what we have learned from genetic variation in taste." *Food Quality and Preference* 14(2):125-138.
- Bauer, R. A. 1960. "Consumer Behaviour as Risk Taking". R.S. Hancock (Ed.), *Dynamic marketing for a changing world*, American Marketing Association, Chicago, pp. 389-398



- Burzynska, J. 2013. "Wine: Sweet mystery." Available online at [http://www.nzherald.co.nz/lifestyle/news/article.cfm?c\\_id=6&objectid=10862100](http://www.nzherald.co.nz/lifestyle/news/article.cfm?c_id=6&objectid=10862100) [Accessed June 2015].
- Catanzaro, D. and E. C. Chesbro, and A. J. Velkey. 2013. "Relationship between food preferences and PROP taster status of college students." *Appetite* 68: 124-131.
- Chandrashekar J, K.L. Mueller, M. A. Hoon, E. Adler, L. Feng, W. Guo, C. S. Zuker, N. J. Ryba NJ. 2000. "T2Rs function as bitter taste receptors." *Cell* 100(6):703-711.
- Charters, S., Lockshin, L., and T. Unwin. 1999. "Consumer responses to wine bottle back labels." *Journal of Wine Research* 10(3): 183–195.
- Charters, S., and S. Pettigrew. 2006. "How effectively do we communicate about Wine?" In Proceedings of the 3rd international wine business and marketing research conference, July 6–8, Montpellier.
- Cox. D. F. 1967. "Synthesis: Risk Taking and Information Handling in Consumer Behavior." D. F. Cox (ed.), *Risk taking and information handling in consumer behavior*, Boston, MA: Harvard University Press, pp. 604-639.
- Cunningham. K. 2000. "Propylthiouracil bitterness correlates with ethanol burn on fungiform and circumvallate papillae." Thesis (M.D.) Yale University.
- Deliza, R., and H. J. H. MacFIE. 1996. "The Generation of Sensory Expectation by External Cues and Its Effect on Sensory Perception and Hedonic Ratings: A Review." *Journal of Sensory Studies* 11(2): 103–28.
- Delmastro, M. 2005. "An Investigation into the Quality of Wine: Evidence from Piedmont". *Journal of Wine Research* 16(1): 1-17.
- Delwiche, J. F., Z. Buletic, and P. A. S. Breslin. 2001. "Covariation in individuals' sensitivities to bitter compounds: Evidence supporting multiple receptor/transduction mechanisms." *Perception & psychophysics* 63(5): 761-776.
- Duffy, V. B., and L. M. Bartoshuk. 1996. *Sensory factors in feeding*. American Psychological Association. Washington. DC, US.

- Duffy, V. B., and J. M. Peterson, and L. M. Bartoshuk. 2004. "Associations between taste genetics, oral sensation and alcohol intake." *Physiology & Behavior* 82(2-3): 435-445.
- Demsetz, H. 1983. "The Structure of Ownership and the Theory of the Firm". *Journal of Law and Economics* 26(2): 375-390.
- Dilger, A. 2009. "In Vino Veritas: The Effects of Different Management Configurations in German Viniculture". *Journal of Wine Research* 20(3): 199-208.
- Dunkelberg, W., C. Moore, J. Scott, and W. Stull. 2013. "Do Entrepreneurial Goals Matter? Resource Allocation in New Owner-managed Firms". *Journal of Business Venturing* 28(2): 255-240.
- Forbes, S. K., D. Cohen, and D. Dean. 2008. "An Assessment of wine knowledge amongst global consumers." Siena, Proceedings of the 4th International Conference of the Academy of Wine Business Research, 17-19, July.
- Garcia-del-Barrio, P., and S. Szymanski. 2009. "Goal! Profit Maximization versus Win Maximization in Soccer". *Review of Industrial Organization* 34(1): 45-68.
- Gent, J. F., and L. M. Bartoshuk. 1983. "Sweetness of sucrose, neohesperidin dihydrochalcone, and saccharin is related to genetic ability to taste the bitter substance 6-n-propylthiouracil." *Chemical Senses* 7(3-4): 265-272.
- Germov, J., and L. Williams. 1999. *A Sociology of Food and Nutrition: The Social Appetite*. Oxford University Press, New York, NY.
- Glanville, E. V., and A. R. Kaplan. 1965. "Food preference and sensitivity of taste for bitter compounds." *Nature* 205: 851-853.
- Hanni, T. 2013. *Why You Like the Wines You Like: Changing the Way the World Thinks about Wine*. The New Wine Fundamentals. 1st edition. New Wine Fundamentals.
- Hanni, T., and V. Utermohlen. 2010. *Beverage Preferences, Attitudes, & Behavior of 'sweet' Vs. 'tolerant' Wine Consumers*. HanniCo LLC.

- Hayes, J. E., and R. S. J. Keast. 2011. "Two decades of supertasting: where do we stand?" *Physiology & behavior* 104(5): 1072-1074.
- Hayes, J.E., and G. J. Pickering. 2012. "Wine expertise predicts taste phenotype." *American Journal of Enology and Viticulture* 63: 80-84.
- Hernandez, J. 2016. "Wine Market Council Defines the Industry's Latest Trends." Wine Enthusiast. Available online at <http://www.winemag.com/2016/01/27/wine-market-council-defines-the-industrys-latest-trends/>. [Accessed October 2016].
- Higgins, E. T, S. R Friedman, E. R Harlow, L. C Idson, N. O Ayduk, and A Taylor. 2001. "Achievement Orientations from Subjective Histories of Success: Promotion Pride versus Prevention Pride." *European Journal of Social Psychology* 31: 3–23.
- Hortacsu, A., and S. L. Puller. 2008. "Understanding Strategic Bidding in Multi-unit Auctions: A Case Study of the Texas Electricity Spot Market". *The RAND Journal of Economics* 39(1): 86–114.
- Hirokawa, K., and K. Yamazawa. 2008. "Gendered Information on Sensory, Hedonic and Familiarity Ratings of Green Tea by Female Japanese Students." *Appetite* 51(2): 343–46.
- Hoch, S. J., and J. Deighton. 1989. "Managing What Consumers Learn from Experience." *Journal of Marketing* 53(2): 1–20.
- Johansson, L., Å Haglund, L. Berglund, P. Lea, and E. Risvik. 1999. "Preference for Tomatoes, Affected by Sensory Attributes and Information about Growth Conditions." *Food Quality and Preference* 10(4–5): 289–98.
- Kaminski L. C., S. A. Henderson, and A. Drewnowski. 2000. "Young women's food preferences and taste responsiveness to 6-n-propylthiouracil (PROP)." *Physiology & Behavior* 68(5): 691-697.
- Karrer, T., and L. M. Bartoshuk. 1991. "Capsaicin desensitization and recovery on the human tongue." *Physiology & Behavior* 49(4): 757-764.
- Krumme, C. 18-20 June. "A Nose by Any Other Name: Descriptors as Signals for

- Wine Price.” Riems, France. [www.wine-economics.com/meetings/Reims2009/programinfo/Abstracts/Krumme.pdf](http://www.wine-economics.com/meetings/Reims2009/programinfo/Abstracts/Krumme.pdf) [Accessed June 2015]
- Lacey, S., J. Bruwer, and E. Li. 2009. “The Role of Perceived Risk in Wine Purchase Decisions in Restaurants.” *International Journal of Wine Business Research* 21(2): 99–117.
- Lakdawalla, D., and T. Philipson. 1998. “Nonprofit Production and Competition”. NBER working paper No.6377. Harris School of Public Policy, University of Chicago.
- Landon, S., and C. E. Smith. 1997. “The use of quality and reputation indicators by the consumers: The case of Bordeaux wine”. *Journal of Consumer Policy* 20(3): 289–323.
- LaTour, K. A., and M. S. LaTour. 2010. “Bridging aficionados’ perceptual and conceptual knowledge to enhance how they learn from experience.” *Journal of Consumer Research* 37(4): 688-697.
- LaTour, K. A., M. S. LaTour, and A. H. Feinstein. 2011. “The effects of perceptual and conceptual training on novice wine drinkers’ development.” *Cornell Hospitality Quarterly* 52(4): 445-457.
- Lawless, H. T. 1984. “Flavor description of white wine by expert and non-expert wine consumers.” *Journal of Food Science* 49(1): 120-123.
- Levitt, S. D., and J. A. List. 2007. “Viewpoint: On the Generalizability of Lab Behaviour to the Field.” *Canadian Journal of Economics* 40(2): 347-70.
- Lockshin, L., W. Jarvis, F. d’Hauteville, and J. P. Perrouty. 2006. “Using simulations from discrete choice experiments to measure consumer sensitivity to brand, region, price, and awards in wine choice.” *Food Quality and Preference* 17(3–4): 166-178.
- Ly, A., and A. Drewnowski. 2001. “PROP (6-n-Propylthiouracil) tasting and sensory responses to caffeine, sucrose, Neohesperidin Dihydrochalcone and chocolate.” *Chemical Senses* 26(1): 41-47.

- Mahoney, B., and B. Rickard. 2016. Consumer Purchasing Patterns for Wine: National trends and regional observations. Business. Enology. Viticulture Annual meeting. Rochester.
- McKeever, A. "Starbucks will not tolerate jokes about its blonde roast." Available online at <http://www.eater.com/2012/1/13/6622843/starbucks-will-not-tolerate-jokes-about-its-blonde-roast>. [Accessed May 2015].
- Michigan Grape and Wine Industry Council. 2014. "Fast Facts". Available online at <http://www.michiganwines.com/fast-facts#sthash.UGQY73kO.dpbs> [Accessed May 2014].
- Milgrom, P., and C. Shannon. 1994. "Monotone Comparative Statics". *Econometrica* 62(1): 157-180.
- Missouri Wines. 2015. "The Economics Impact of Missouri Wine and Wine Grapes-2013". Available online at <http://missouriwine.org/sites/default/files/2015%20Missouri%20Wine%20Economic%20Impact%20Report.pdf>. [Accessed March 2016].
- Mitchell, V. W., and M. Grotto. 1988. "Consumer Risk Perception in the UK Wine Market." *European Journal of Marketing* 22(9): 1-15.
- Morrot, G., F. Brochet, and D. Dubourdieu. 2001. "The color of odors." *Brain and Language* 79(2): 309-320.
- Mueller, S., Larry L., Y. Saltman, and J. Blanford. 2010. "Message on a bottle: The relative influence of wine back label information on wine choice." *Food Quality and Preference* 21(1): 22-32.
- New York Wine and Grape Foundation. 2014. "So much to Celebrate". Available online at <http://www.newyorkwines.org/Articles?ArticleID=4439&FromHome=True> [Accessed May 2014].
- Newman, K. "Wine on the Rise. The wine market council finds that wine drinking has expanded to more venues." *Wine Enthusiast*, Available online at <http://www.winemag.com/February-2013/Wine-on-the-Rise>. [Accessed May 2015].

- Newhouse, J. P. 1970. "Toward a Theory of Nonprofit Institutions: An Economic Model of a Hospital". *The American Economic Review* 60(1): 64-74.
- Oczkowski, E. 1994. "Hedonic wine price function for Australian premium table wine". *Australian Journal of Agricultural Economics* 38(1): 93-110.
- Ortmann, A. "Sweet Vs. Fruity: What's the Deal." The Back label. Available at <http://thebacklabel.com/sweet-vs-fruity-whats-the-deal/#.WCysjdUrJaS> [Accessed June 2016]
- Prescott, J., and N. Swain-Campbell. 2000. "Responses to repeated oral irritation by capsaicin, Cinnamaldehyde and Ethanol in PROP tasters and non-tasters." *Chemical senses* 25(3): 239-246.
- Park, W. C., D. L. Mothersbaugh, and L. Feick. 1994. "Consumer knowledge assessment." *Journal of Consumer Research* 21(June): 71-83.
- Pickering, G. H., A. K. Jain, and R. Bezawada. 2013. "Super-tasting gastronomes? Taste phenotype characterization of foodies and wine experts." *Food Quality and Preference* 28(1): 85-91.
- Pickering, G. H., and C. E. Klodnicki. 2016. "Does Liking and Orosensation Intensity Elicited by Sampled Foods Vary with Thermal Tasting?" *Chemosensory Perception*, Page 1.
- Pickering, G. J., K. Simunkova, and D. DiBattista. 2004. "Intensity of taste and astringency sensations elicited by red wines is associated with sensitivity to PROP (6-n-Propylthiouracil)." *Food Quality and Preference* 15(2): 147-154.
- Prescott, J., and N Swain-Campbell. 2000. "Responses to Repeated Oral Irritation by Capsaicin, Cinnamaldehyde and Ethanol in PROP Tasters and Non-Tasters." *Chemical Senses* 25(3): 239-46.
- Ramirez, C. D. 2010. "Do Tasting Notes Add Value? Evidence from Napa Wines." *Journal of Wine Economics* 5(1): 143-63.
- Robson, K. E., K. A. Plangger, C. L. Campbell, and L. F. Pitt. 2014. "Objective and subjective wine knowledge: evidence from an online study." Geisenheim,

Proceedings of the 8th International Conference of the Academy of Wine Business Research, 28-30 June.

- Rozin, P. 1996. "Towards a psychology of food and eating: Motivation to Module to Model to Marker, Morality, Meaning and Metaphor." *Current Directions in Psychological Science*, 5, 18-24.
- Saliba, A., Wragg, K., and Richardson, P. 2009. "Sweet Taste Preference and Personality Traits Using a White Wine." *Food Quality and Preference* 20(8):572-575.
- Schamel, G., and K. Anderson. 2003. "Wine quality and varietal, regional and winery reputations: Hedonic prices for Australia and New Zealand". *Economic Record* 79(246): 357–369.
- Schamel, G. 2009. "Dynamic Analysis of Wine and Regional Reputation: The Case of Wine". *Journal of Wine Economics* 4(1): 62-80.
- Scott Morton, F. M., and J. M. Podolny. 1998. "Love or Money? The Effects of Owner Motivation in the California Wine industry". *Working paper 6743*. National Bureau of Economic Research. Available online at <http://www.nber.org/papers/w6743>. [Accessed September 2012].
- Scott Morton, F. M., and J. M. Podolny. 2002. "Love or Money? The Effects of Owner Motivation in the California Wine Industry". *Journal of Industrial Economics* 50(4): 431–456.
- Siegel, J. "How sweet it is." Beverage Media Group. Available online at <http://www.beveragemedia.com/index.php/2012/05/how-sweet-it-is/>. [Accessed June 2016].
- Siegrist, M., and M-E. Cousin. 2009. "Expectations Influence Sensory Experience in a Wine Tasting." *Appetite* 52(3): 762–65.
- Solomon, G. E. A. (1990), "Psychology of novice and expert wine talk." *American Journal of Psychology*. 103(4): 495-517.
- Solomon, G. E. A. 1997. "Conceptual change and wine expertise." *The Journal of the Learning Sciences* 6(1): 41-60.

- Statista. 2016. "Statistics and facts on the wine market in the U.S." Available online at <https://www.statista.com/topics/1541/wine-market/>. [Accessed October 2016].
- Stern, S. 2004. "Do Scientists Pay to Be Scientists?" *Management Science* 50(6): 835-853.
- Sun, L., M. I. Gomez, F.R. Chaddad, and R. B. Ross. 2014. "Distribution Channel Choices of Wineries in Emerging Cool Climate Regions". *Agricultural and Resource Economics Review* 43(1): 87-103
- Teeter, A. 2014. "Myth busted: If you like sweet wines, you're 'basic'." Available online at <http://vinepair.com/wine-blog/myth-busted-like-sweet-wines-youre-basic/>. [Accessed June 2016].
- Tepper, B. J., and R. J. Nurse. 1997. "Fat perception is related to PROP taster status." *Physiology & Behavior* 61(6): 949-954.
- Tepper, B. J, C. M. Christensen, and J Cao. 2001. "Development of Brief Methods to Classify Individuals by PROP Taster Status." *Physiology Behavior* 73(4): 571-77.
- Thach, L., and K. Chang. 2015. "2015 Survey of American Wine Consumer Preferences." Wine Business. Available online at <https://www.winebusiness.com/news/?dataid=160722&go=getArticle>. [Accessed October 2016]
- Thomas L., M. I. Gomez, C. J. Gerling, and A. K. Mansfield. 2014 "The effect of tasting sheet sensory descriptors on tasting room sales." *International Journal of Wine Business Research* 26(1): 61-72.
- Thorngate, J. H. 1997. "The Physiology of Human Sensory Response to Wine: A Review." *American Journal of Enology and Viticulture* 48(3): 271-79.
- Veseth, M. "9 responses to has sweet red wine taken over the U.S. wine market?" Available online at <http://winecurmudgeon.com/has-sweet-red-wine-taken-over-the-u-s-wine-market/>. [Accessed June 2016]
- Wansink, B., C. R. Payne, and J. North. 2007. "Fine as North Dakota Wine: Sensory



- Expectations and the Intake of Companion Foods.” *Physiology & Behavior* 90 (5): 712–16.
- Weisbrod, B. A. 1983. “Nonprofit and Proprietary Sector Behavior: Wage Differentials among Lawyers”. *Journal of Labor Economics* 1(3): 246-263.
- Wine Institute, Statistics. Varies Years. Available online at <http://www.wineinstitute.org/resources/statistics>. [Accessed March 2016].
- Wine Institute, 2016. “2015 California Wine Sales in U.S. Hit \$31.9 Billion Retail Value.” Available online at <http://www.wineinstitute.org/resources/pressroom/07082016>. [Accessed October 2016].
- Woolfolk, Mary E.; Castellan, William; Brooks, Charles I. 1983. “Pepsi versus Coke: labels, not tastes, prevail.” *Psychological Reports* 52(1): 185-186.
- Yiee, J. H., V. B. Duffy, and L. M. Bartoshuk. 2003 “Analytic nature of taste mixture interactions: contributions of PROP status.” Sarasota, FL. Annual Meeting of the Association for Chemoreception Sciences.
- Zhao, L., S. V. Kirkmeyer, and B. J. Tepper. 2003. “A paper screening test to assess genetic taste sensitivity to 6-n-Propylthiouracil.” *Physiology & Behavior* 78 (4–5): 625-633.