PAPER

INFLUENCING FACTORS ON CHINESE WINE CONSUMERS' BEHAVIOR UNDER DIFFERENT PURCHASING MOTIVATIONS BASED ON A MULTI-CLASSIFICATION METHOD

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ABSTRACT

This study investigates the importance rating of influencing factors in driving wine consumption under four specific situations, that is, gift, banquet, party, and self-drinking, and thus achieves consumer segmentation. The affecting factors containing wine quality and socio-demographic variables are measured on a national representative sample (N=609) in China. Lasso method is used to select the factors, and a binary classifier v-twin support vector machine (v-TSVM) is extended to a multi-classification case by using a "one-versus-one" approach, which predicts the purchasing behavior of consumers. The monthly income, occupation, and knowledge of a consumer toward wine, the origin of wine, the vintage, and advertisement, are critical factors in driving consumption. Wine color and packing emerge as leading factors when consumer purchase wine for gift and banquet. Promotion significantly contributes to wine price selection for banquet, party, and self-drinking. Results show that the importance ranking of determinants varies under different purchasing motivations. In addition, the recognition accuracy can be considerably increased with prior knowledge of the consumption purpose. The nonlinear classifier is recommended for application because this classifier performs better than the linear one. This paper offers a fresh perspective on wine consumption behavior in China by applying two machine learning methods to identify and quantify determinants in specific situations. The results significantly assist wine managers to provide informed decisions with regard to wine production and marketing.

Keywords: wine motives, personal traits, wine price, influential factor, consumers' purchasing behavior

1. INTRODUCTION

The Chinese wine market has been flourishing in recent years with the improvement of the living standards of people and influence of affluent western lifestyles. In 2015, China has produced and consumed 11.5 million and 16 million hectoliters of wine, respectively, and ranked sixth in the global wine production (OIV, 2016). The prediction of the purchase behavior of consumers has been recognized as a significant research topic over the past decades. The accurate prediction of purchasing behavior enables wine dealers to accurately locate consumers' demands, formulate appropriate marketing strategies, and achieve consumer segmentation.

A study on the influence of purchasing motivation will aid in understanding the progress of consumer decision-making. Previous studies have shown that a wine consumer exhibits different purchasing motivations under various consumption scenarios in a descriptive way (GERAGHTY and TORRES, 2009). The main motivations of Chinese wine consumers include health care, auxiliary dining, and social contact (LI, 2014). People perceive wine as a healthy and nutritional product that can be recommended for regular intake to prevent diseases because wine contains many kinds of organic acids, minerals, and vitamins (TANG, 2008; MU, *et al*., 2016). Consumers have different preferences for wine attributes, when they drink at home, drink with friends and give as gifts (QUESTER and SMART, 1998; LI, 2014; CHEN, 2014). Drinking with friends at parties is casual and relaxed, whereas the major function of wine is to please other people in a business banquet (HALL *et al*., 2001). Currently, an increasing number of Chinese aim to give red wine as a gift to display affection or enhance friendship, especially during festivals.

Wine consumption is influenced by many interrelating factors, such as wine product properties, lifestyle and situations of an individual, and psychological factors of consumers (PICKERING and HAYES, 2017; SCHMITT, 1997). Various attributes, such as taste, color, aroma, brand, production, and label information, are found to be important aspects that determine wine choice (THORPE, 2009). LOCKSHIN *et al*. (2017) summarized several methods used in marketing in combination with sensory science techniques to understand the changing consumer preferences in China. The consumption behavior of Chinese are highly related to the educational background of consumers, wine-related activities, wine taste, country of origin, quality, and price (BALESTRINI and GAMBLE, 2006; CAMILLO, 2012).

Most business models are based on a linear equation to estimate the weight of such factors when measuring the response of purchase intention to the contextual factors. The commonly used linear models are linear discriminant and logistic regression analyses (CULBERT *et al*., 2017; HONORÉ-CHEDOZEAU *et al*., 2017; LI, 2014; YORMIRZOEV, 2016). The prediction models for purchase behavior are over-concentrated and over-reliant on these linear models compared with other research fields. In addition, principal component analysis (PCA) is also combined with the linear models to reduce the dimensionality of factors (JOLLIFFE, 2002; CHANG, *et al*., 2015; TSOURGIANNIS *et al*., 2015). However, using PCA to extract the component feature may lose certain important information. The meaning of comprehensive evaluation function is unclear when the labels of load factor in the principal component are positive and negative; thus, this function is sensitive to the relative scaling of the original variables and has low variable interpretation. Moreover, we can collect additional consumer data information with the development of communication technologies. Analyses based on traditional linear models are insufficient in achieving the requirement of academics and practitioners (DAYKIN and MOFFATT, 2002; THONG and SOLGAARD, 2017).

In recent decades, increasing machine learning approaches have emerged. The least absolute shrinkage and selection operator (Lasso) is recognized for its capability to exploit

information from ordinary data and flexibility to capture different effects of explanatory variables (TIBSHIRANI, 1996). The Lasso method can continuously shrink certain coefficients to zero and automatically select a subset of variables. In addition, the Lasso method has better variable interpretability than other feature selection methods, such as principal component regression and least squares regression (TIAN *et al*., 2015). The support vector machine (SVM) has been considered an effective and promising binary classifier for its unique advantages (VAPNIK, 1995). The introduction of kernel function maps training variables into a high-dimensional space, thereby successfully solving the nonlinear SVM. Many variants of SVM have been proposed since then, and several binary SVMs have been successfully extended to multi-class scenarios by applying "one-versus-one" (OVO) and "one-versus-all" (OVA) strategies (TOMAR and AGARWAL, 2015; WANG and ZHOU, 2017). The SVMs have been widely applied in various aspects that range from disease diagnosis and bankruptcy prediction to consumption behavior prediction (e.g., electricity, health product, and building energy) (BAHAMONDE *et al*., 2007; GUO, 2013; KAVAKLIOGLU, 2011).
This study aims to use two representative machine learning methods, that is, Lasso and OVO v-TSVM, to investigate the determinants on the wine price selection under free and four purpose-based choices, that is, gift, banquet, party, and self-drinking, so as to predict the price of wine purchased by a consumer and estimate the effects of major factors selected through the Lasso method simultaneously.

2. MATERIALS AND METHODS

2.1. Conceptual framework

Numerous researches discipline including economics, marketing, psychology, and products, have a shared interest in consumers' behavior. More and more researchers have increasingly concentrated on consumers' attitudes, motivation, perceptions and preferences for wine. Previous studies show that the motivation for purchasing wine varies under different purchasing situations (BARREIRO *et al*., 2008). Moreover, GOODMAN (2009) found that previous tasting experience and opinion of other people significantly influence wine purchasing behavior. The knowledge of consumers toward wine positively and notably affects the wine purchasing behavior of these consumers (HUSSAIN *et al*., 2007). Consumers with higher production involvement are less sensitive to wine price, whereas consumers with lower production involvement focus more on price discounts (JAEGE *et al*., 2009). Furthermore, many researches have shown that consumers' purchase choices are well related with age and education in wine consumption. Based on the previous studies and combining with characteristics of wine consumption, the factors affecting wine consumption were summarizes in Fig. 1. It covers a range of purchasing motivations, reference group factor, marking factors, wine quality factors, the knowledge level towards wine and characteristics of consumers.

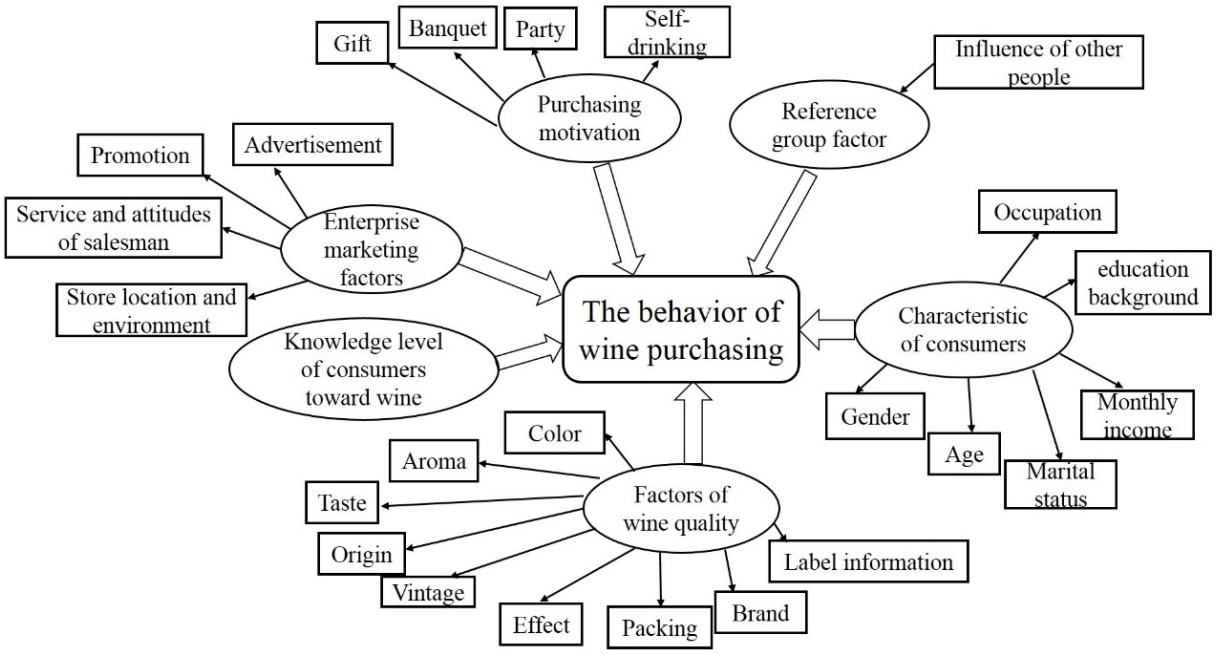


Figure 1. Conceptual framework of consumer's purchasing behavior for wine.

2.2. Questionnaire

The questionnaire of Chinese consumers' decision making behavior towards wine (It is shown in the appendix) was designed which consisted of 30 questions. This questionnaire includes the following contents:
(1) Questions regarding the purchasing behaviors of consumers (the frequency of purchasing and drinking).
(2) Questions investigating the price of wine that consumers frequently purchase. The consumers selected seven kinds of wine price, that is, 1="$0-7.5," 2="$7.6-15.1," 3="$15.2-22.6," 4="$ 22.7-30.1," 5="$ 30.2-45.2," 6="$ 45.3-75.3," and 7="$75.4 and above." Based on the literature review, four usually types of motivation (gift, banquet, party, and self-drinking) for wine consumption were extracted and described in the questionnaire. Besides, the consumers were asked to choose the price of wine that they purchase for the specific purpose;
(3) Questions that belong to multi-item scales, which measure factors that influence consumer purchasing, such as influence of others, quality of wine, enterprise marketing factors, knowledge of consumers. This study investigates the 10 items of wine quality factors, namely, the origin of wine and vintage, effects, packing, brand, label information, color, aroma, taste, and awards. The enterprise marketing factors contains 4 items, i.e. advertisement, promotion, service and attitude of the salesperson, and store location and environment. The 16-item scale was collected using a 5-point Likert scale from 1="Strongly disagree" to 5="Strongly agree."
(4) Consumers' socio-demographic characteristics: gender, age, marital status, monthly income, education background, and occupation. All the six features use the numbers "1, 2, 3, …" to assign the variable level from low to high.

2.3. Survey

Considering the sampling frame and economic development level in different regions, we hired and trained several undergraduate students from China Agricultural University to answer the survey. We realized that young people are the main force in wine consumption and many wine tasting groups are found on the Internet. The survey was conducted in 2016 and lasted for five months. A total of 1600 questionnaires were distributed in many provinces of China, and 995 questionnaires were returned. In the returned questionnaires, the respondents were instructed to evaluate the statement "In the past year, how often did you purchase wine?" The data were "cleaned" by removing responses of "Never bought wine." Therefore, the respondents in this study are consumers who, on one occasion, purchased wine. Finally, 609 questionnaires were used for final analysis.

2.4. Methods

The analysis of the data consisted of two steps. First, the Lasso method was conducted to select the determinants. In theory, the discrimination ability we can obtain is robust when we use considerable features. However, an excessive number of features may increase the learning speed and lead to "overfitting" problem. The accurate selection of features is a prerequisite for a high prediction accuracy. The Lasso method penalizes the regression coefficients with an L1 penalty, shrinking many of the features to zero. Any features with non-zero coefficients are "selected" through the Lasso method, which indicates that these selected features contribute most to the wine purchasing behavior of consumers. Second, the OVO Mv-TSVM method was used to predict the behavior of Chinese wine consumers. To the best of our knowledge, the v-TSVM (PENG, 2010) was initially proposed for binary problems. Owing to the K-class scenario, we use the ith class as the positive and jth as the negative to construct a binary v-TSVM classifier. The OVO Mv-TSVM method need to construct K(K−1)/2 binary v-TSVM classifiers. For a new testing point, we obtain the vote for each class and assign its label with a maximum vote.
For the nonlinear case, we used the Gaussian kernel function

$$Ker(\mathbf{x}_i, \mathbf{x}_j) = e^{-\left\|\mathbf{x}_i - \mathbf{x}_j\right\|^2 / 2r^2}$$

and grid research to find the optimal parameter. All algorithms were written and operated in MATLAB 2014a, and all statistical analyses were conducted using the SPSS version 20 and Microsoft Office Excel version 2013 software.

3. RESULTS

The whole Cronbach's of the questionnaire is 0.776, F=334.221, Sig=0.00, thereby indicating that the survey has a high internal consistency. The response rate of questionnaire is 62.19%. A majority of the respondents (63.71%) would purchase wine once or twice a year, and 81.94% would drink two or more bottles of wine in a year. The 609 samples were collected from 21 provinces, cities, and autonomous regions in China. We inquired the per capita monthly income of the above areas from the China Statistical Yearbook 2016, on which we calculated the global per capita monthly income as a standard, and the value is 780.06$. The provinces where the samples were collected are located in Eastern China, and most of these samples were relatively advanced in the

economic area. A total of 9.69% participants would purchase wine as a gift, 21.18% for banquet, 30.05% for parties, and 39.08% for self-drinking.
The results of wine price that the consumers purchased are listed in Table 1. Based on these samples, 65.51% would purchase wine in the price range of 7.6-30.1$ with free choice. The average price is 30.20$ (SD=0.83), with a 95% confidence interval of (28.58, 31.85). For the purpose of gift, 55.83% would select the wine price above 30.2$, and the average price is 40.64$ (SD=0.91). For the purpose of banquet, 64.20% would select the wine price in the range of 15.2-45.2$, and the average price is 30.71$ (SD=0.74). For the purpose of party, 64.86% would select the wine price in the range of 7.6-30.1$, and the average price is 27.97$ (SD=0.69). For the purpose of self-drinking, 65.19% would select the wine price in the range of 7.6-30.1$, and the average price is 28.11$ (SD=0.75).

Table 1. Statistical results of consumer's purchased wine price.

Wine price ($)	Free-choice (%)	Gift-based (%)	Banquet-based (%)	Party-based (%)	Self-drinking-based (%)
0-7.5	2.63	1.15	1.64	3.28	4.43
7.6-15.1	22.99	12.15	17.24	20.69	22.33
15.2-22.6	20.85	12.15	21.02	21.35	22.50
22.7-30.1	21.67	18.72	23.15	22.82	20.36
30.2-45.2	12.32	19.70	20.03	19.05	14.45
45.3-75.3	9.85	17.41	10.84	8.87	10.84
Above 75.3	9.69	18.72	6.08	3.94	5.09
Mean*	30.20	40.64	30.71	27.97	28.11
SD.*	0.83	0.91	0.74	0.69	0.75
95%Confidence interval*	(28.58, 31.85)	(38.89, 21.82)	(29.27, 32.17)	(26.65, 29.35)	(26.61, 29.59)

Note: *are the results of 10000 times Bootstrap resampling results.

The characteristics of the sample's demographics are detailed in Table 2. The average age is 35.18 years (SD=0.42). The average monthly income is 774.67$ in 10000 times Bootstrap estimation, which is nearly the same as the standard 780.06$. The respondents are 52.71% male and 47.29% female; a total of 32.35% are single, and 67.65% are married. A majority of the respondents who attained a college degree were 76.52%, 18.56% are senior high or in a special school, and only 4.93% are in primary or junior high school. The respondents vary in careers, 8.21% are students, 2.30% are peasantry, 25.94% are freelance, 2.96% are unemployed or retired, 11.99% are staffs of state-owned companies, 13.30% are staffs of foreign or private enterprises, 15.60% work as party and government officers, 9.36% work in education and scientific research units, and 10.34% work in other fields. Inspired by FORLEO *et al*. (2017), we lists the associations of wine consumption prices with demographics in Table 3. It is obvious that monthly income and occupation are significant no matter in what purpose-based. There are about 10% high-income and 3~4% low-income consumers choose high-priced wine. Male and female showed differences in the wine purchasing for free-choice, gift-giving and banquet-based purpose. There are 17.73% male and 14.12% female consumers choose wine price above 30.2$. The gender difference is not obvious in party-based and self-drinking based wine purchasing. There are only 8% elder people (above 46 years) choose high-priced wine (above 30.2$), and the percentage increased to 12% for gifted purpose. The single consumer and married consumer acted

different in wine price-choosing for party-based and self-drinking based purpose. Statistically significant differences between education and wine-price choosing for gifted and banquet-based purpose were identified. About 30% highly educated consumers choose high-priced wine, and only 1% consumers with Primary or Junior high school background chose high-priced wine. Fig. 2 illustrates the results of statistical affecting factors, where the mean of wine knowledge is the highest at 4.04, and the mean of advertisement is the lowest at 3.18.

Table 2. Statistical features of respondents.

Demographic characteristics	Category	Percentage	Sample population(n)
Gender	Male	52.71	321
	Female	47.29	288
Age	18-25	22.33	136
	26-35	31.86	194
	36-45	24.14	147
	46-55	17.24	105
	Above 55	4.43	27
	Mean/SD.*	35.18	0.42
	95%Confidence interval*	(34.35, 36.01)	
Marital status	Single	32.35	197
	Married	67.65	412
Per capita monthly income ($)	0-301.2	13.46	82
	301.3-451.8	14.29	87
	451.9-753.0	32.35	197
	753.1-1054.2	20.69	126
	1054.3-1506.0	9.52	58
	1506.1-2259.0	4.76	29
	Above 2259.0	4.93	30
	Mean/SD.*	774.67	21.81
	95%Confidence interval*	(732.09, 818.99)	
Educational background	Primary or Junior high school	4.93	30
	Senior high or Special school	18.56	113
	Junior college or Undergraduate	62.73	382
	Postgraduate and above	13.79	84
Job	Students	8.21	50
	Peasantry	2.30	14
	Freelance	25.94	158
	Unemployed/retired	2.96	18
	Staffs of state-owned companies	11.99	73
	Staffs of foreign or private enterprises	13.30	81
	Party and government officers	15.60	95
	Education and scientific research units	9.36	57
	Else	10.34	63

Note: *The Bootstrap estimate was calculated as the mid-value of the range.

Table 3. Association of wine consumption prices with demographics.

Items-prices	Gender	Age	Marital status	Monthly income	Education	Occupation
Free-choice	0.004*	0.111	0.097	0.000***	0.095	0.001***
Gift-based	0.014*	0.021*	0.369	0.000***	0.002**	0.000***
Banquet-based	0.017*	0.000***	0.215	0.000***	0.010**	0.000***
Party-based	0.160	0.000***	0.012*	0.000***	0.136	0.000***
Self-drinking based	0.230	0.001***	0.024*	0.000***	0.110	0.000***

Note: *0.01<p<=0.05; ** 0.001<p<=0.01; *** p<=0.001.

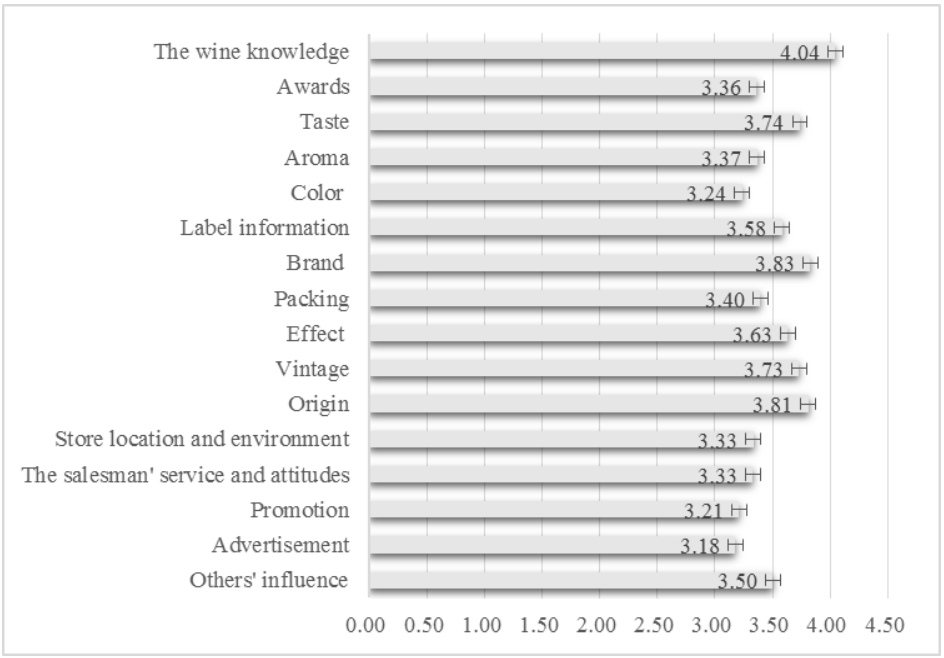
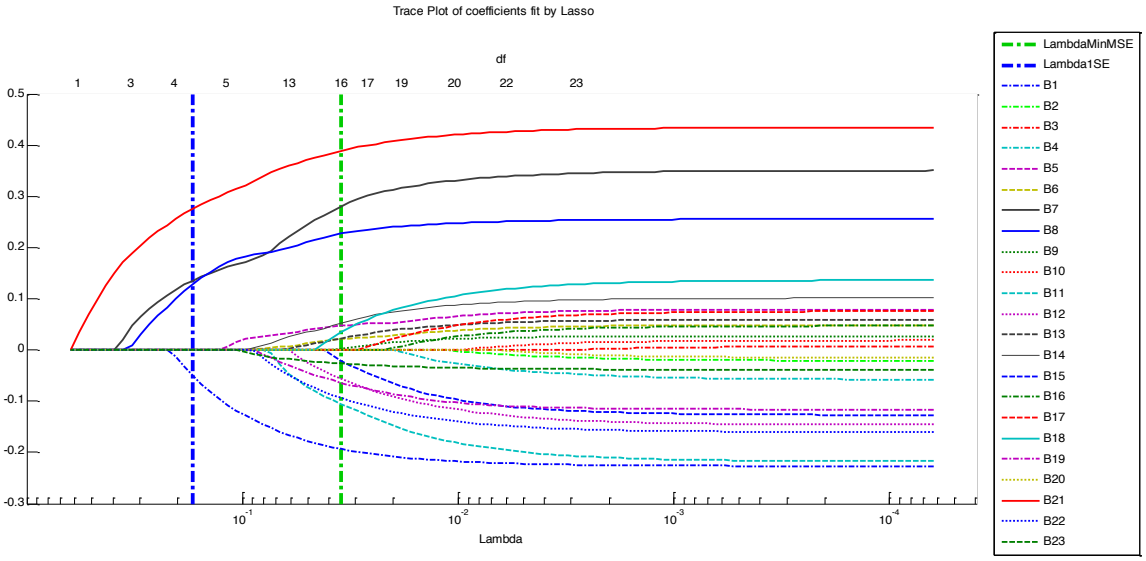


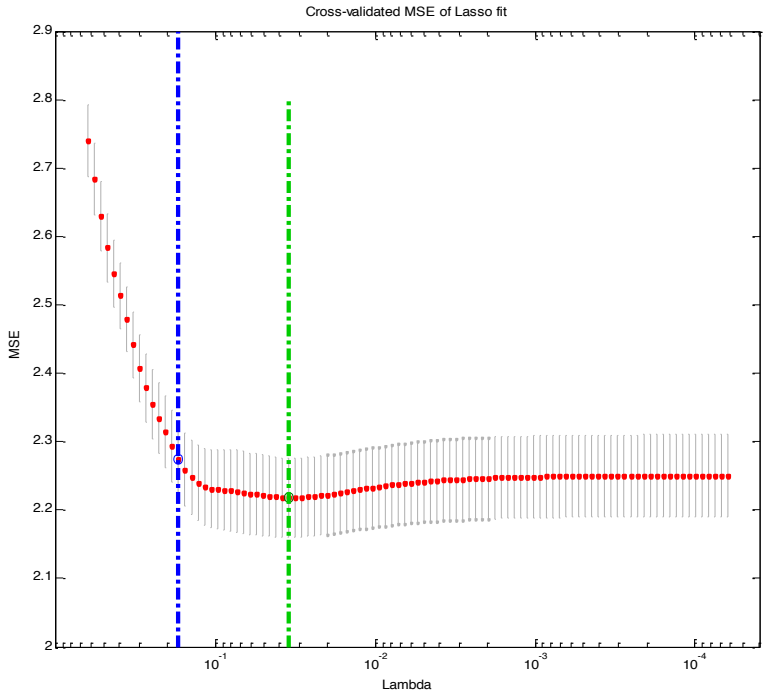
Figure 2. Statistical results of affecting factors.

The trace plot of coefficient through the Lasso method and the corresponding cross-validated MSE under free choice are depicted in Fig. 3, where different color lines represent various affecting factors (B1 to B23) in Fig. 3(a). The vertical bold blue and green dashed lines stand for the parameter under MinMSE and 1SE, respectively, and we only record the weights of factors under the minimum and 1SE in Table 4. From left to right in Fig. 3(a), the factors gradually shrink to zero, and the last factor that became zero represents the most important determinants. In the MinMSE position, 16 factors are selected. The factor selected through the Lasso method significantly affects the wine consumption behavior under free choice, which maintains a null hypothesis. In the index1SE position, only five factors are left; these factors are monthly income of consumers, the vintage, the origin of wine, purchasing motivation, and the service and attitudes of salesmen. We can achieve a prediction accuracy of 62.56% and 63.01% by using the first five important features for prediction in linear and nonlinear OVO Mv-TSVM, respectively. The algorithm relies considerably on the parameter, and the process of grid research is presented in Fig. 3(c).

(a)


Trace Plot of coefficients fit by Lasso
df
1 3 4 5 13 16 17 19 20 22 23
0.5 0.4 0.3 0.2 0.1 0 -0.1 -0.2 -0.3
10^-1 10^-2 10^-3 10^-4
Lambda
LambdaMinMSE
Lambda1SE
B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 B19 B20 B21 B22 B23

(b)


Cross-validated MSE of Lasso fit
MSE
2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2
10^-1 10^-2 10^-3 10^-4
Lambda

(c)

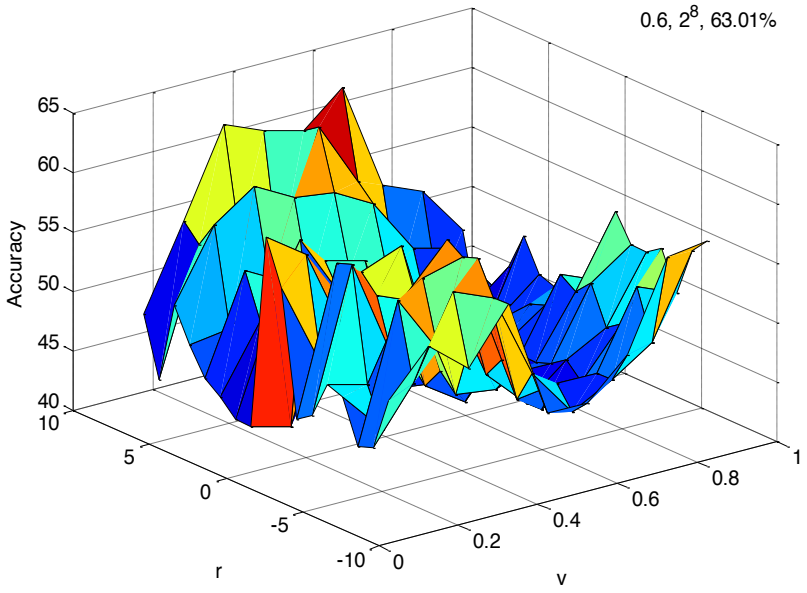


Figure 3. (a) The trace plot of coefficients by Lasso, (b) cross-validated MSE of Lasso fit under free-choice, (c) The influence of the parameter v, kernel parameter r and prediction accuracy for nonlinear OVO Mv-TSVM with free-choice.
#B1: Purchasing motivation, B2: Others' influence, B3: Advertisement, B4:Promotion, B5: Service and attitudes of salesman, B6:Store location and environment, B7: The origin of wine, B8: The vintage, B9:Effect, B10: Packing, B11:Brand, B12: Label information, B13: Color, B14: Aroma, B15: Taste, B16:Awards, B17: The wine knowledge, B18: Gender, B19: Age, B20: Marital status, B21:Monthly income, B22: Education, B23: Job.

Similarly, the parts of experimental results under four purposes, that is, gift, banquet, party, and self-drinking, are also summarized in Table 4. For the gift purpose, the first five important affecting factors are as follows: monthly income, occupation, wine knowledge of consumers, wine color, and production origin. For the banquet purpose, the first three determinants are monthly income, the origin of wine, the vintage. For the party purpose, the first five important affecting factors are as follows: monthly income, the origin of wine, wine knowledge of consumers, the vintage, and occupation. For the self-drinking purpose, the first five determinants are as follows: monthly income, the origin of wine, wine knowledge of consumers, occupation, and the vintage. The accuracy of nonlinear OVO Mv-TSVM can achieve 80.12%, 72.46%, 63.49%, and 74.69% by using the selected factors.

Table 4. Part of the Lasso results and prediction results using OVO M*v*-TSVM.

Metrics	Free-choice		Gift-based		Banquet-based		Party-based		Self-drinking based	
	Coef. Min λ	Coef Index1SE	Coef. Min λ	Coef Index1SE	Coef. Min λ	Coef Index1SE	Coef. Min λ	Coef Index1SE	Coef. Min λ	Coef Index1SE
Purchasing motivation	-0.227	0	0.067	0	0.050	0	0.078	0	0.064	0
Others' influence	-0.021	0	0.112	0	-0.017	0	-0.087	0	-0.134	0
Advertisement	0.007	0	-0.083	0	-0.119	0	-0.025	0	-0.100	0
Promotion	-0.058	0	0.008	0	-0.041	0	-0.102	0	-0.102	0
The salesman' service and attitudes	0.079	0	-0.105	0	0.005	0	0.002	0	0.015	0
Store location and environment	0.049	0	0.040	0	0.017	0	0.050	0	0.076	0
The origin of wine	0.350	0.014	0.098	0.014	0.195	0.070	0.174	0.088	0.231	0.140
The vintage	0.256	0	0.248	0	0.217	0.007	0.164	0.053	0.152	0.002
Effect	0.027	0	-0.043	0	0.049	0	0.092	0	0.045	0
Packing	0.019	0	-0.112	0	-0.022	0	-0.047	0	-0.035	0
Brand	-0.217	0	-0.111	0	-0.125	0	-0.132	0	-0.108	0
Label information	-0.146	0	-0.026	0	-0.009	0	-0.019	0	-0.015	0
Color	0.059	-0.059	-0.301	-0.059	-0.134	0	-0.058	0	0.036	0
Aroma	0.101	0	0.022	0	0.100	0	0.038	0	0.095	0
Taste	-0.127	0	0.070	0	0.016	0	-0.050	0	-0.093	0
Awards	0.047	0	-0.011	0	-0.006	0	0.065	0	-0.024	0.000
The wine knowledge	0.076	0.149	0.328	0.149	0.183	0	0.265	0.098	0.275	0.07
Gender	0.136	0	0.240	0	0.163	0	0.041	0	0.195	0
Age	-0.116	0	0.016	0	-0.020	0	-0.036	0	-0.026	0
Marital status	-0.015	0	0.025	0	-0.007	0	0.103	0	0.051	0
Monthly income	0.434	0.109	0.174	0.109	0.247	0.136	0.257	0.202	0.237	0.163
Education	-0.160	0	0.093	0	0.098	0	0.000	0	0.047	0
Occupation	-0.038	0.057	0.089	0.057	0.043	0	0.055	0.021	0.055	0.016
Intercept	2.172	3.578	1.918	3.578	1.041	3.248	0.897	2.049	0.692	2.240

df	23	5	23	5	23	3	23	5	23	5
MSE	2.250	2.573	2.542	2.573	2.035	2.068	1.938	1.938	2.233	2.249
SE	0.060	0.103	0.110	0.103	0.105	0.127	0.061	0.062	0.077	0.070
λ	6.26E-05	0.168	3.89E-05	0.168	4.62E-05	0.241	4.83E-05	0.131	4.51E-05	0.162
(I)Percentage correct prediction		62.56		79.22		65.22		49.21		61.45
(II)Percentage correct prediction		63.01		80.12		72.46		63.49		74.69

#I: Linear OVO Mv-TSVM; II: Nonlinear OVO Mv-TSVM.

4. **DISCUSSION**

This study provides a fresh perspective on the wine consumer segmentation based on importance ratings of factors by applying two popular machine learning methods. In addition, these segments are predictive in specific purchasing situations. The results provide valuable information for policymakers and marketing managers.

First, the consumers would pay a high wine price for gift giving, and a relatively low wine price for self-drinking. The importance rankings of determinants in wine consumption vary under different purchasing situations. These rankings will guide a salesperson in utilizing the key points when recommending wine products to customers. For example, a salesperson should primarily realize the monthly income, occupation, degree of wine knowledge of a consumer, wine color, the origin of wine, if the wine is purchased as a gift. The OVO Mv-TSVM can aid in predicting the type of consumers when the information is acquired. The retailer or salesman can then recommend wine with the corresponding price. If the purchasing motivation is for a banquet, then the retailer should primarily focus on the income of the consumer, the origin of wine, and the vintage. This result is our most important discovery. Furthermore, using the Lasso method can reduce the complexity before prediction because the relevant features can be selected, whereas the irrelevant features become zero under a fixed value.

Second, the nonlinear OVO Mv-TSVM behaves better than the linear OVO Mv-TSVM. These results indicate that the data we collected are linearly inseparable, thereby leading to poor testing accuracy with linear models. The kernel trick in the OVO Mv-TSVM maps the data into a high-dimensional space, hence successfully making the data linear separable in the projected space (SHAWE-TAYLOR and CRISTIANINI, 2004). Accordingly, the nonlinear model is suggested in wine consumption prediction area. Under the free choice, the nonlinear OVO Mv-TSVM can only achieve 63.01%, whereas this strategy obtains high-prediction accuracies under the four purchasing situations. The pre-knowledge of the purchasing situation of a consumer would help marketers provide an accurate recommendation to wine consumers. In terms of prediction accuracy, the case of purchasing under the gift purpose can explain the purchase behavior because its accuracy achieves 80.12%, followed by self-drinking, banquet, and party. In addition, the prediction accuracy of the OVO Mv-TSVM is significantly affected by the choice of parameters. The prediction accuracy must select the appropriate parameters beforehand in practical applications.

Third, most personal traits are the important determinants of wine consumption (PICKERING and HAYES, 2017). The monthly income and occupation of consumers are the leading positive influential factors in wine consumption regardless of the purchasing conditions, hence implying that consumers with high monthly income and a favorable job prefer wine with a high price. Occupational difference reflects the social status of consumers to a certain extent, LIU and MURPHY (2007) found that wine was seen as a symbol of one's social status and sophistication. Gender positively influence the high priced wine purchasing, especially in free choice, gift-giving and banquet purpose. Male consumer would prefer higher-priced of wine than female consumer. Education positively influences the high priced wine purchasing when the purposes are gift and banquet, whereas education is an insignificant factor for party. Age of consumers is found to be sensitive and negative to wine purchasing for banquet, party, and self-drinking purpose, thereby implying that young Chinese consumers prefer higher priced wine than elder persons who are

more thrifty. Marital status is not a leading factor for wine purchasing, while it emerges as a relatively significant factor for party-based wine purchasing.
Fourth, the knowledge of consumers about wine is a major positive driver for wine consumption (BARBER *et al*., 2008). In consumption decision-making, the consumers rely on their professional knowledge, especially on their subjective knowledge. Consumers will behave confidently and rely on their judgment when these consumers assume that they have professional knowledge, and vice versa. These results imply that consumers will spend more money on wine if they absorbed the wine culture.
Fifth, the vintage and origin of wine are found to be the more important determinants for prediction than wine taste and awards. The weights of the vintage and oration of wine are positive, which means consumers would pay more if they value the wine vintage and origin. For banquet, wine taste and aroma have a positive effect on wine price selection, which indicates that consumers would pay more money to receive a favorable quality of the wine. Wine color and packing are important factors when consumers purchase wine as a gift, whereas these factors are insignificant for self-drinking, which provides valuable suggestions for wine sellers and producers to sell or produce wine. For party, banquet, and self-drinking, the effect of wine emerges as a significant positive factor in high-priced wine selection. This result provides a hint to the winemakers to produce banquet and self-drinking wine with favorable efficacy to attract consumers, thus increasing the returns. Consumers attach wine aroma when purchasing wine for self-drinking and banquet compared with the purposes of gift and party. Furthermore, consumers are non-sensitive to wine brand and label information. Our findings are meaningful for and can be implemented by winemakers and suppliers to formulate appropriate strategies in accordance with the preference and purchasing purpose of consumers.
Sixth, this study demonstrates that purchasing motivation is a positive driver for wine consumption. Previous studies have shown that people trust their families, friends, colleagues, or acquaintances; recommendations of other people have a significant influence on the purchasing behavior of consumers (GOODMAN, 2009). Moreover, consumers are especially sensitive to opinions of other people when these consumers purchase wine for self-drinking and party, and the effect is negative to high-priced wine selection. By contrast, the influence is positive for gifts. The results suggest that wine dealers can invite wine critics to recommend gifting wine on TV or take measures for expanding the influence of friends.
Lastly, advertisement is a driver for purchasing wine regardless of the purpose, and the influence is negative for high-priced wine, which warns the wine dealers to invest reasonably in advertisements because excessive advertisement expenditure can conversely affect the sale of wine. The promotion activities of enterprises can inspire the latent purchasing behavior of consumers (POHJANHEIMO *et al*., 2010). Consumers are more influenced by the service and attitude of the salesperson than the promotion, store location, and environment when these consumers purchase wine as a gift. Managers are encouraged to improve the service and skills of their sales personnel to improve their sales of wine as a gift. Promotion becomes a significant factor when consumers purchase wine for banquet, party, or self-drinking, and the influence is negative because promotions result in an increased price of wine, thereby reminding managers to create suitable promotional activities. The store location and environment emerge as a driver when consumers purchase wine for self-drinking, and the influence is positive for selling high-priced wine, thereby indicating that consumers would pay a relatively high price for self-drinking if the store location is near their home or the environment is comfortable and clean.

5. CONCLUSION AND FUTURE WORK

The present study explored 23 factors that are associated with wine consumption under four specific purchasing situations based on a surveyed sample of the Chinese population. The Lasso method was used as a primary empirical tool for selecting the most affecting features, and the OVO M*v*-TSVM method was used to predict the purchasing behavior of consumers. The findings can be applied in various commercial fields. Limitations should be noted that may aid in drawing avenues for future research, although our study exhibits interesting results in terms of using the machine learning methods.

First, the samples collected in the study were from 21 provinces in Central and Eastern China. Although the respondents who completed the survey were rewarded with a monetary deposit into their Alipay and WeChat accounts as an incentive, the recovery rate of the questionnaire is not high enough. Owing to the limited time and resources, we were unable to collect data from Western and Southwestern China, such as Xinjiang, Xizang, and Yunnan Provinces. The samples used in this study might not be representative of the whole county.

Second, information on consumer perception for a specific wine product, such as claret, white wine, or sweet red wine can be collected. CULBERT *et al*. (2017) investigated the sensory profiles and consumer acceptance of different styles of Australian Moscato and led us to focus on the determinants of a specific wine product in China. This area helped us predict the purchasing behavior of Chinese consumers, adjust models, and provide useful suggestions for marketers and companies to create reasonable and timely adjustments.

Third, the list of factors in this study was not intended to be exhaustive, and other factors could be incorporated. For example, we only set one item to investigate the knowledge of consumers toward wine consumption. To the best of our knowledge, familiarity with wine involves various aspects, such as grape varieties, viticulture, wine process, wine tasting, and wine storage management. Further, the questions on the consumption of wine and human health (TAMBURRO *et al*., 2017) can be considered in further research.

The emergence of machine learning methods leads to new research topics on wine consumption. The other multi-classification methods, such as directed acyclic graph (TOMAR and AGARWAL, 2015), can also yield favorable performance. Accordingly, future research may examine the method that performs optimally in the wine consumption area. The prospect for wine in China is promising, and we assume that future research will contribute to the existing literature with new and interesting findings.

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REFERENCES

Bahamonde A., Díez J., Quevedo J.R., Luaces O. and Del Coz J.J. 2007. How to learn consumer preferences from the analysis of sensory data by means of support vector machines (SVM). Trends in Food Science and Technology 18(1):20-28.

Balestrini, P. and Gamble P. 2006. Country-of-origin effects on Chinese wine consumers. British Food Journal 108(5):396-412.

Barber N., Dodd T. and Ghiselli R. 2008. Capturing the younger wine consumer. Journal of Wine Research 19:123-141.

Barreiro-Hurle, J. Colombo, S. and Cantos-Villar E. 2008. Is there a market for functional wines? Consumer preferences and willingness to pay for reseratrol-enriched red wine 19(4):360-371.

Camillo A.A. 2012. A strategic investigation of the determinants of wine consumption in China. International Journal of Wine Business Research 24(1):68-92.

Chang C., Tsai J., Hung S., Lin B. 2015. A hybrid decision-making model for factors influencing the purchase intentions of technology products: the moderating effect of lifestyle. Behaviour and Information Technology 34(12):1200-1215.

Chen Y.J. 2014. The research on the Urban residents' of Urumqi wine consuming behavior. Xinjiang University of Finance and Economics.

Daykin A.R. and Moffatt P. 2002. Analyzing ordered responses:A review of the ordered probit model. Understanding Statistics: Statistical Issues in Psychology, Education, and the Social Sciences 1(3):157-166.

Forleo M.B., Tamburro M., Mastronardi L., Vincenzo G. and Ripabelli G. 2017. Food consumption and eating habits: a segmentation of university students from Central-South Italy. New Medit 16(4):56-65.

Culbert J.A., Ristic R., Ovington L.A., Saliba A.J. and Wilkinson K.L. 2018. Sensory profiles and consumer acceptance of different styles of Australian Moscato. Australian Journal of Grape and Wine Research 24:96-104.

Geraghty S. and Torres A. 2009. The Irish wine market; a market segmentation study. International Journal of Wine Business Research 21(2):143-154.

Goodman S. 2009. An international comparison of retail consumer wine choice. International Journal of Wine Business Research 21(1):41-49.

Guo W. 2013. Research on consumer behavior of health products based on support vector machine. Anhui University of Science and Technology.

Hall J., Lockskin L., O'Mahone G. 2001. Exploring lins between wine choice and dining occasions:factors of influence. International Journal of Wine Marketing 13(1):36-53.

Honoré-Chedozeau C., Lelièvre-Desmas M., Ballester J., Chollet S. and Valentin D. 2017. Knowledge representation among assessors through free hierarchical sorting and a semi-directed interview: Exploring Beaujolais wines. Food Quality and Preference 57:17-31.

Hussain M., Cholette S. and Castaldi R. 2007. Determinants of wine consumption of U.S. consumers:an econometric analysis. International Journal of Wine Business Research 19(1):49-62.

Jaeger S., Danaher P. and Brodie R. 2009. Wine purchase decisions and consumption behaviours: insights from a probability saple drawn in Auckland, New Zealand. Foot Quality and Preference 20(4):312-319.

Jolliffe I.T. 2002. Principal Component Analysis (Second Edition). Springer.

Kavaklioglu K. 2011. Modeling and prediction of Turkey's electricity consumption using Support Vector Regression. Applied Energy 88(1):368-375.

Li J.G. 2014. The consumer behavior of wine in China. Northwest A and F University.

Liu F. and Murphy J. 2007. A qualitative study of Chinese wine consumption and purchasing: Implications for Australian wines. International Journal of Wine Business Research 19(2):98-113.

Lockshin L., Corsi A.M., Cohen J., Lee R. and Williamson P. 2017. West versus East: Measuring the development of Chinese wine preferences. Food Quality and Preference 56:256-265.

Mu W., Feng J., Tian D. and Zheng X. 2016. Economic Issues of Grape Industry in China. Beijing: China Agricultural University Press.

OIV S. 2016. International Organization of Vine and Wine website. www.oiv.int/oiv/info/enconjoncture

Peng X.J. 2010. A v-twin support vector machine (v-TSVM) classifier and its geometric algorithms. Information Sciences 180:3863-3875.

Pickering G.J. and Hayes J.E. 2017. Influence of biological, experiential and psychological factors in wine preference segmentation. Australian Journal of Grape and Wine Research 23(2):154-161.

Pohjanheimo, T. Paasovaara, R. Luomala H. and Sandell M. 2010. Food choice motives and bread living of consumers embracing hedonistic and traditional values. Appetite 54(1):170-180.

Quester P. G. and Smart J. 1998. The influence of consumption situation and product involvement over consumers' use of product attribute. Journal of Consumer Marketing 15(3):220-238.

Schmitt B. 1997. Who is the Chinese consumer? Segmentation in the People's Republic of China. European Management Journal 15(2):191-194.

Shawe-Taylor J. and Cristianini N. 2004. Kernel methods for pattern analysis. Cambridge:Cambridge University Press.

Tamburro M., Ripabelli G., Forleo M.B. and Sammarco M.L. 2017. Dietary behaviours and awareness of seasonal food among college students in central Italy. Italian Journal of Food Science 29(4), 667-680.

Tang L. 2008. The red wine's health care functions in preventing cardiovascular and cerebrovascular disease. Oriental Diet Therapy and Health Care 4:4.

Thong N.T., Solgaard H.S. 2017. Consumer's food motives and seafood consumption. Food Quality and Preference, 56, 181-188.

Thorpe M. 2009. The globalization of the wine industry: new world, old world and China. China Agricultural Economic Review 1(3):301-313.

Tian S., Yu, Y. and Guo H. 2015. Variable selection and corporate bankruptcy forecasts. Journal of Banking and Finance. 52:89-100.

Tibshirani R. 1996. Regression shrinkage and selection via the lasso. J. R. Stat. Soc. Ser. B (Methodol.). 58:267-288.

Tomar D. and Agarwal S. 2015. A comparison on multi-class classification methods based on least squares twin support vector machine. Knowledge-Based Systems 81:131-147.

Tsourgiannis L., Loizou E., Karasavvoglou A., Tsourgiannis C.A., Florou G., Antonios Tsourgiannis G.F. 2015. Consumers' Purchasing Behaviour Patterns Regarding Organic Wine in a Southern E.U. Country. Paper presented at the Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment, Kavala, Greece.

Vapnik V.N. 1995. The nature of statistical learning theory. Berlin: Springer.

Wang H. and Zhou Z. 2017. An improved rough margin-based ν-twin bounded support vector machine. Knowledge-Based Systems.128:125-138.

Yormirzoev M. 2016. Determinants of fortified wine consumption in Russia: Evidence from a national sample of the Russian Population. Wine Economics and Policy 5(1):42-49.

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