A Hedonic Analysis of Wine Menu Pricing in Canada: A Study of Toronto Restaurants

by

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A Thesis
presented to
The University of Guelph

In partial fulfillment of requirements
for the degree of
Master of Science
in
Food and Agricultural Resource Economics

Guelph, Ontario, Canada
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ABSTRACT

A HEDONIC ANALYSIS OF WINE MENU PRICING IN CANADA: A STUDY OF TORONTO RESTAURANTS

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University of Guelph, 2018

Consumer demand for wine in Canada is changing. Wine sales in licenced establishments are increasing relative to direct purchases from retail stores, and consumer preference may be changing toward domestically produced product. These changes have not yet been examined. In this study, a hedonic analysis of restaurant pricing of by-the-glass white wine in Toronto, Canada is used to understand current trends and inform emerging Canadian producers. Data on wine level and restaurant level characteristics for 396 by-the-glass offerings from 66 Toronto restaurants were collected. Results indicate that region, varietal, restaurant capacity, affiliation/ownership structure, online restaurant rating, and neighbourhood significantly determine prices in this market. The results of this study will be of use to Canadian restaurateurs and members of the wine industry, particularly producers looking to expand sales in urban markets.
I would like to express my gratitude to the Ontario Ministry of Agriculture, Food and Rural Affairs for their generous support in funding this research through the Highly Qualified Persons Scholarship program.

I want to especially extend my appreciation to my advisor Dr. Andreas Boecker for his excellent guidance and support in supervising my research and for providing me with the opportunity to develop and refine important research skills necessary for this project. Very sincere thanks are also to be given to the other members of my thesis committee, Dr. Mike von Massow and Bruce McAdams, for their expertise and valuable opinions and contributions to the research.

I would also like to thank all the faculty and staff in the Department of Food, Agricultural and Resource Economics for their useful insights, encouragement, support, and superb administrative assistance.

Lastly, I would like to say thank you to my cohort and other peers who have made my experience at the Department of FARE exceptionally positive and memorable.
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CHAPTER 1: INTRODUCTION

1.1 Background

1.1.1 Wine consumption and market trends in Canada and Ontario

Wine is an important topic in Canada and consumption of wine is significant in the Canadian market. It was estimated from survey data in 2013 that almost 80% of the total Canadian population 15 years of age and older consumes alcohol (Canadian Public Health Officer 2015). Wine is Canada’s largest agricultural import by value, with imports of wine in containers holding less than 2 litres totaling over $2 billion in 2016 (Agriculture and Agri-Food Canada 2016). Additionally, a study by International Wines and Spirits Research based in the U.K. recently placed Canada as the 6th largest wine importer in the world (International Wine and Spirits Research Vinexpo Report 2015).

Wine consumption is a multi-billion dollar industry in Canada. In 2016, of the 22.1 billion in total domestic beverage alcohol sales, wine accounted for over 30% of that total (Statistics Canada 2017). Beer has historically occupied a larger percentage of the beverage alcohol market than wine, but has been declining in recent years. Between 2007 and 2016, beer sales as a proportion of all beverage alcohol sold in Canada decreased by over 5 percentage points to comprise 41.5% of total alcoholic beverage sales, losing most of its market share to wine which increased from 27% of all beverage alcohol sold to 31.7% (ibid 2017). Sales of Canadian wine in 2016 grew by 4.3 percentage points, slightly more than did sales of imported wine which grew by 4.1 percentage points (ibid 2017). In Ontario specifically, wine sales are
following the national trend and increasing at a greater rate than beer. Between 2015 and 2016, the rate of increase was 1.2 percentage points greater for wine than beer in Ontario (ibid 2017).

In several major markets in the world including Canada, the movement towards premium products, specifically alcoholic products of high quality with low alcoholic content, is forecasted to grow. In 2016 in Canada, the average unit price of wine showed a 2% growth in current value due to consumers trading up for high-quality and premium wines. At Liquor Control Board of Ontario (LCBO) stores, wines less than $8 per 750 ml bottle declined in sales towards the end of the review period, and bracket ranges higher than $8 per bottle mostly increased in sales (Euromonitor 2018).

An indicator of Canadian taste in foreign wine can be seen from import statistics. Canada is a net importer of wine and imported $2.3 billion worth of wine in 2014, against exports of $97.8 million (Agriculture and Agri-Food Canada 2016). Foreign imports dominate the domestic market, reaching 68% of total value in 2012, and are highly concentrated. Almost three quarters of foreign imports come from four countries: France, Italy, the United States and Australia, which made up 22%, 21%, 21% and 9% respectively of total import value in 2017 (Statistics Canada, Trade Data Online 2018). For the past decade, Canadians have demonstrated a growing taste for New World wines such as those from the United States, which exhibited a growth of 9.7 percentage points from 2008 to 2014 (Euromonitor 2018). As can be seen from Figure 1.1.1, France and Italy were recently the countries from which Canada imported the most wine in value (also in volume), and they have both been matched by the United States in both value and volume (Euromonitor 2018; Statistics Canada, Trade Data Online 2018). This may imply that
consumer preferences have changed and there is potential for producers to either increase market share for similar wine products or to change consumer preferences.

![Figure 1.1.1. Wine Import Value from Top Eight Importing Countries to Canada (2008-2017)](Source: Statistics Canada, Trade Data Online 2018)

**1.1.2 Recent policy initiatives to promote Ontario wines**

In recent years, there have been several governmental initiatives (both provincial and federal-provincial collaborations), to promote the Ontario wine industry, both in winery and vineyard investment, and through channels of marketing and promotion. In 2009, the provincial government launched the Ontario Wine and Grape Strategy to support growth in the Ontario wine sector with a specific focus on Vintners Quality Alliance (VQA) wines (Ontario Ministry of Agriculture, Food and Rural Affairs 2017). The strategy aims to increase Ontario wine sales,
increase volume and quality of wines, develop Ontario wine tourism, and create both direct and indirect jobs related to the sector. In 2013, this program was renewed for a five-year period with a total commitment of $73 million dollars.

For the 2017/18 to 2019/20 period, the provincial government is committing $22.5M for the VQA Wine Support Program and $22.5M for the Marketing and Vineyard Improvement Program. Objectives under the VQA Wine Support Program include encouraging the sale of premium Ontario VQA wines and assisting VQA wineries in taking advantage of newly-established modes of distribution and sale, such as in grocery stores. Objectives under the Marketing and Vineyard Improvement Program include strengthening Ontario’s VQA wine brand nationally and internationally, supporting and enhancing the marketing efforts of Ontario VQA wines, stimulating tourism in Ontario’s wine regions, and increasing consumer demand for Ontario VQA wine and grapes. Additional government measures include support to Ontario wineries through Growing Forward 2, a federal-provincial-territorial initiative (Ontario Ministry of Agriculture, Food and Rural Affairs 2018).

These initiatives are happening amidst changes to Ontario wine regulations. In 2016, the LCBO loosened point of sale restrictions. This gave rise to marketing efforts such as the “We Grow the Wines You Love” campaign in October 2016 where ten Metro retail store locations across the province gained support from the province’s Local Food Investment Fund, administered by the Greenbelt Fund.
1.1.3 The on-trade restaurant wine sector

Institutions and conduct in the wine market differs from other agricultural markets for many reasons. Wine import, distribution and retail in most provinces are centralized due to mandatory control through liquor boards (Importation of Intoxicating Liquors Act 1985). In most provinces, these boards also run liquor stores, which, depending on the province, may be the only alcohol retailers. The notable exception is Alberta, which privatized its beverage alcohol system in 1993 and imposes a fixed amount per litre mark-up on wine. The retail market for beverage alcohol is also known as the “off-trade” market. Each province has its own individual system for applying taxes, fees and mark-ups to wine.

Wine sales also occur in venues such as restaurants, pubs and bars, otherwise known as the “on-trade” market. The mechanisms relating to product assessment, selection, pricing, and consumer interaction differ greatly between these two different types of sale. In the on-trade model, establishments often obtain wine at licensee wholesale prices that are still impacted by governmental mark-ups (or duties if directly imported), and afterward impose their own individual mark-up schemes.

In the on-trade restaurant industry where wine is sold point-of-service (consumption upon purchase), pricing decisions are particularly important due to the industry custom of assigning a higher price than standard retail price in order to account for establishment costs (which include services rendered by intermediaries such as wine agents, wine managers, sommeliers and servers) and perceived value associated with offering the wine in a point-of-service setting. Typically, this mark-up is significant. Some studies have suggested that wines can cost between
two and five times more in restaurants than in retail stores or specialized Internet sites (Coqueret 2015).

In terms of volume, on-trade wine sales currently account for approximately 15% of wine sales in Canada, but in terms of value, on-trade sales account for approximately 28% of all wine sales (Euromonitor 2018). These figures demonstrate that some restaurants and other similar on-trade establishments in Canada are capable of charging consumers a much higher price for a much smaller volume of wine than in the off-trade retail sector. Both sectors have increased steadily over the past decade, retail sales reaching 484.7 million litres and $9.03 billion (retail sales price) and non-retail on-trade sales reaching 84.4 million litres and $3.52 billion (retail sales price) in 2016 (Euromonitor 2018).

Consumer Price Index (CPI) figures spanning from 1990 to 2013 (Figure 1.1.3) from provide an indication of how prices for wine purchased in licensed establishments and prices for wine purchased from stores have differed over time and taken different trajectories. Since the late 1990s, on-trade wine prices have increased at a much greater rate of growth than wine purchased from stores, which further demonstrates how sales of wine in the on-trade channel have a high potential for generating larger value per unit volume of wine.
Figure 1.1.2. CPI of On-Trade and Off-Trade Wine in Canada (1990-2013)  
(Source: Statistics Canada, CANSIM Table 183-0023 2018)

It is important to note that the custom of the mark-up reflects restaurant costs in procuring, maintaining, and serving the wine. Therefore, the entire amount of the mark-up may not directly accrue to either the on-trade establishment or the wine producer. Nevertheless, the higher value for volume of wine is translated into additional economic benefit for Canadian businesses and employees involved along the value chain of the wine.

There is also vital reputational, branding, and marketing benefit to promotion in on-trade restaurant channels, particularly in sophisticated or fine dining establishments. As will be discussed below, studies have stated that wine is a product for which customers are heavily influenced by reputational cues in assessing the wine’s economic value. Wines that are selected and served by top sommeliers, wine managers and chefs in reputable restaurants play a large part
in defining such reputational trends and increasing the value of certain wine attributes (such as appellation, region, producer or varietal or a combination of these factors) to customers.

### 1.2 Economic Problem

As demonstrated by import data in Figure 1.1.1 and price index data in Figure 1.1.3, there is evidence that suggests consumer demand of wine has been changing in recent years with respect to factors related to region of origin and consumption in restaurants. Several members of the Canadian wine industry have expressed the opinion that consumer tastes and preferences have changed significantly since the 1970s and are starting to exhibit a more flexible and complicated nature, with an increased willingness to try different wines from different regions (London Free Press 2017).

Although European wines, particularly French and Italian wines, have been very popular in previous decades, the Canadian market is showing increased demand in New World wines from regions such as the U.S., New Zealand, and Chile (International Wine and Spirits Research Vinexpo Report 2015). Wines from Ontario are also attracting consumer interest, and a 2013 survey of around one thousand consumers aged 18 to 31 found that wines from the region of Ontario scored better than other countries in terms of combined preferences for value and quality among consumers belonging to this age group living in Ontario (Abacus Data 2013).

Complicated relationships exist between the utility or value an Ontario consumer places on consuming a wine in a restaurant and certain attributes or factors such as region of origin and characteristics of the restaurant. With recent changes in the dynamic of these relationships,
information about these relationships would be very useful for Ontario restaurant owners and wine managers, especially those trying to attract customers by offering wines at appropriate prices that appeal to changing tastes. Such information could affect their choices on whether to include or exclude certain regions or varietals of wine on the menu, or on whether to list wines with higher prices due to certain characteristics of the wine or the restaurant. For example, in previous decades, Ontario wines have been valued less than French and Italian wines, but with recent changes in consumer preferences, a customer may be willing to pay as much or more money for an Ontario wine.

Ontario wine producers hoping to increase the demand for their product in the Ontario domestic market would also benefit from this information in several ways. Producers who want to increase sales can do so through increasing on-trade sales. Also producers may view the preferences of wine drinkers in Toronto restaurants as representative of wine drinkers purchasing wine through other channels such as through Toronto stores. The information would aid decisions about whether to tailor the viticultural and vinification processes to focus on certain varietals or regional styles when targeting the Toronto market or similar markets, or to adjust marketing strategies to target certain restaurants in Toronto or similar areas with certain characteristics.
1.3 Economic Research Problem

Information about wine pricing in restaurants in general, as well as information specific to Ontario restaurants, is limited. Which attributes of the wine and which attributes of the restaurant have an impact on restaurant wine pricing are unknown and the nature of their impact is unknown. As mentioned, such information would be very useful for members of the Ontario restaurant industry such as restaurateurs, wine managers, and wine agents, as well as wine producers looking to increase sales in the Ontario market and trying to focus resources to promote demand for specific wines in the Ontario market.

The relationship between off-trade retail wine pricing and certain wine characteristics like region of origin have been explored through an economic approach called hedonic analysis (Oczowski 1994; Combris et al. 1997 and 2000; Cardebat and Figuet 2004; Benfratello et al. 2009; Carew and Florkowski 2010; Brentari 2011; Kwong et al. 2011). These studies demonstrate that the hedonic approach is useful for assessing the value consumers place on a product such as wine by relating prices to different attributes of the commodity. The approach used in these studies allows for an economic model to be developed to aid in assessing the contributory value of each of the attributes to the pricing of the commodity. This same approach has also been used to examine the relationship between restaurant characteristics and average meal pricing (e.g. Falvey et al. 1992; Gunawardana and Havrila 1996; Gergaud et al. 2007; Fogarty 2012; Yim et al. 2014).

This study uses the hedonic approach to examine wine pricing in on-trade restaurant channels, which is an area that has been unaddressed by previous literature. No definitive
hedonic studies have been found that examine wine pricing in the restaurant sector with respect to wine level and restaurant level attributes, and no economic studies of restaurant wine pricing in Ontario were found. This research differs from other studies in that it employs hedonic analysis of wine pricing that incorporates both wine level and restaurant level attributes. The research also involves assembling a dataset of restaurant wine prices that provides useful descriptive statistics. For example, members of the restaurant industry and wine producers would all benefit from knowing the kind and the number of wines of particular varietals, vintages, and production regions that are being served in Ontario. The scope of this study focuses on 2017 by-the-glass (served in the amount of one glass) white wine pricing in Toronto restaurants with sophisticated wine lists (listing region, vintage, and varietal, and ranging between $7 to $27 CAD a glass) accessible on the internet. Some of these choices were due to availability of information, although some were imposed to define product class and to take into account price segmentation and conspicuous consumption, as will be discussed later.

1.4 Purpose

The purpose of this study is to assess the impact of restaurant characteristics, such as average meal price and cuisine type, and wine characteristics, such as region of origin and varietal, on by-the-glass white wine pricing in Toronto restaurants.
The objectives of this study are:

i) To document current wine menu prices and certain restaurant attributes of a sample of Ontario dining restaurants that have a sophisticated by-the-glass white wine list, using Alcohol and Gaming Commission of Ontario information and a process of online data collection.

ii) To develop a hedonic model of wine menu pricing in restaurants with sophisticated wine selections, identifying categories of restaurant, menu and wine attributes relevant to pricing.

iii) To use the hedonic model to assess the relationships between Toronto restaurant and wine menu attributes and wine pricing in order to aid restaurant owners and wine producers in their marketing and wine pricing strategies, and in adapting and targeting resources to better promote Ontario wine.

1.5 Thesis Outline

The following chapters will be presented as follows. Chapter 2 provides a review of prior literature on hedonic studies of off-trade retail wine price, followed by an outline of hedonic studies of average meal price in restaurants. Chapter 3 describes the theoretical framework of hedonic theory. Several notable studies in the history of the development of hedonic theory are outlined and the premise of Rosen’s 1974 formalization of hedonic regression upon which the methods of this paper are based is described, along with the assumptions underlying the hedonic framework. Chapter 4 describes the application of hedonic theory to the economic research problem and addresses the suitability of its underlying assumptions in the context of the on-trade
restaurant wine market. It explains the designation of wine-level and restaurant-level attributes, the process of data collection, the methods and quantitative tests involved in specification of the empirical model, and the use of cluster-robust regression methods. Chapter 5 explains the pairwise likelihood ratio tests used to determine significance of categorical variables, and presents the results and discusses the interpretation of the cluster-robust regression using continuous variables and dummy-coded categorical variables. The final chapter, Chapter 6, summarizes and discusses the implications of the findings of this study, limitations to the analysis, and the implications for future research.
CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents the findings of prior literature on the subject of restaurant wine purchasing/pricing and hedonic studies of both restaurant and retail wine pricing. There are several lines of studies relevant to the development of a hedonic model of restaurant wine pricing. First, studies that do not utilize the hedonic method but analyze factors that effect restaurant wine purchasing or pricing are useful in informing an appropriate framework. Second, there is a line of hedonic method studies of retail wine pricing studies originating in the 1990s, which describe findings on attributes that were found to be significant or insignificant to retail wine pricing. Finally, there is a small line of restaurant meal pricing studies that employ the hedonic method to analyze the effect of restaurant level factors on meal pricing, which may also be applicable to wine pricing.

2.2 Restaurant Wine Literature outside of Hedonic Models

Several consumer-focused studies have addressed the issue of wine purchase decisions in restaurant settings. Certain studies have concluded that the reputational aspects of a wine, such as the reputation of the region of origin or varietal, can play an important role in consumer decision-making and can reduce point-of-purchase anxiety, even where the price for the wine is higher than for another similar wine with a weaker reputation (Mitchell and Greatorex 1988; Tustin and Lockshin 2001; Preszler and Schmit 2009).
A study by Lacey et al. (2009) found the reputation of the restaurant itself reduces the level of perceived consumer risk when purchasing wine. Preszler and Schmit have argued that the different levels of wine product involvement of consumers explains them placing higher importance on extrinsic quality indicators rather than on “personal or quantifiable appraisals of specific product attributes” (2009:17). It was also found in this study that for upscale restaurants in New York City, offering variety was an important influential factor in wine purchase decisions (ibid 2009:29). Additionally, a study by Lockshin et al. (2011), which focused on wine lists in five-star Beijing restaurants found that differences emerged between small and large restaurants. It was found that, generally, wine managers and professionals working in restaurants with smaller capacities indicated that they prioritized focusing on popular wines and maximizing mark-ups, and in this way focused more on pricing than those in larger restaurants.

On the particular subject of by-the-glass wines, a recent study by Bruwer et al. (2017) frames consumption choices as the product of individual risk reduction strategies. Likert scores of perceived risk ratings were collected along with demographic data, revealing that consumers use the by-the-glass format as an opportunity to sample unknown products or relatively more expensive products than they normally would. Additionally, the findings reveal that by-the-glass sales do not detract from wine sales in other formats, such as full bottle.

In an analysis of restaurant wine pricing, a 2016 conference paper by Livat and Remaud used survey data from 267 sommeliers from around the world to assess determinants of wine mark-up in restaurants. The study used price segment characteristics, restaurant characteristics, wine menu characteristics, and sommelier characteristics. The method used was not framed as a hedonic method, and it was found that very few explanatory variables were significant; the
accuracy of the study may have suffered from using a sample frame that was geographically very broad. However, three interesting points arose in the study. It was found that 1) fine dining restaurants affiliated with a hotel tend to increase mark-up of wines, 2) the average cost of a meal positively impacts wine mark-ups, and 3) fine dining restaurants imposed on average a greater percentage mark-up than casual restaurants (2016: 277). Additionally, Coqueret (2015) posits a static model for optimizing wine pricing for restaurants using inputs of costs, stocks, and ratings of the bottles, but does not include an empirical hedonic analysis of wine pricing.

2.3 Hedonic Models of Retail (Off-Trade) Wine Price

2.3.1 Objective and sensory factors in hedonic price analyses of wine

There is a substantial history of economic studies of market or retail wine pricing using a hedonic pricing model. Prior studies have postulated that such off-trade pricing of wine is related to many categories of factors. One of the earliest studies, performed by Golan and Shalit in 1993, evaluated a grape price schedule by estimating hedonic qualities of different varieties of wine grapes by relating the contribution of wine grape characteristics to wine quality and then estimating the price of wine quality. The purpose of the paper was to develop “a pricing system that recognises quality in pricing an agricultural product” (1993: 311). The authors assumed for their hedonic model that the pricing was a function of consumer perception of wine quality, and that this quality could be attributed solely to wine grape characteristics before vinification in a winery.
Following this study, Oczowski published a study in 1994 that estimated a hedonic function relating the prices of Australian wine listed in an Australian consumer guide to several attributes described as ‘objective’. These attributes included grape varietal, region from which the grapes were sourced, vintage of harvest, and producer size. Two “subjective” attributes were also used, overall quality rating and cellaring potential. It was found that each of the attributes, both objective and subjective, were statistically relevant in explaining price deviations from average pricing.

Combris et al. (1997) created a hedonic model using prices of Bordeaux wines listed in a French consumer review in relation to ‘objective’ qualities similar to those in the Oczowski study, but the authors also introduced ‘sensory’ attributes which were assessed by jury groups consisting of professors of oenology, oenologists, and wine waiters. The sensory attributes included such factors as aromatic intensity, finesse and complexity, firmness, acidity, suppleness, flatness, fat, concentration, harmony, tannins, finish, alcohol, staleness, reduction, and development. In contrast to Oczowski’s study, the results of this analysis were that sensory attributes did not significantly determine market price for wine, while objective attributes played a significant role.

Since the 1997 study by Combris et al., several other studies have also included sensory factors. It is important to note the difference between sensory information from expert blind tastings not available to consumers and sensory information based on expert blind tastings from sources such as Wine Spectator and other catalogues and databases that are available to consumers. In 2000, Combris et al. repeated a similar study to the 1997 study for Burgundy wines with similar findings regarding the sensory and objective attributes. Cardebat and Figuet
(2004) at the University of Bordeaux created a hedonic model for Bordeaux vintages spanning 1996–1999 using sensory attributes (bouquet, taste, and finish) collected from blind tastings by six juries of five or six wine experts (oenologists, brokers, and wine waiters). The study also included ‘objective’ attributes (varietal, alcohol, vintage) and other attributes such as an overall jury score and an ageing score. The results indicated that the reputational influences of famous Bordeaux appellations and classifications were predominant in explaining pricing, while the sensory factors of bouquet and taste may have had some influence. A second study by Cardebat and Figuet (2009) applied a hedonic pricing model for French wines from the regions of Alsace, Beaujolais and Provence and found that sensory factors assessed by a panel of experts did not explain prices.

A study by Benfratello et al. (2009) analysed the pricing of wines from the Italian designations for Barolo and Barbaresco using prices from the producers’ estate wine shops. The study incorporated factors described as ‘objective’ such as vintage, cru and type (classification or appellation) while comparing the impacts of sensory characteristics (harmony, finish, tannins, and aromatic complexity, intensity, and finesse) and reputation variables relating to individual bottle and producer of the wine. The source of information for the sensory characteristics were the Wine Spectator magazine and the Duemila Vini guide edited by the Italian Association of Sommeliers (AIS). It was found that the hedonic model including objective and reputation variables had greater statistical significance in explaining pricing than the hedonic model with objective and sensory characteristics, suggesting that a greater amount of information on how the wine price is formed is contained in the reputation specification.
Brentari et al. (2011) analysed the pricing of Italian red wines using prices from an Italian consumer guide. A detailed hedonic model was constructed involving attributes described as ‘label’ attributes instead of objective attributes consisting of information a consumer would read from the bottle label (appellation level, appellation, superior/riserva, region, declared alcoholic content). Sensory attributes were measured by judges divided in three panels who evaluated sensorial characteristics of the wines. Laboratory data on chemical attributes of the wine was also available and incorporated (e.g. verified alcohol content, residual sugar, volatile acidity, total acidity, sulphur anhydrides, sulphur ratio). The results indicated that wine price mainly depends on the label characteristics of the wine sold.

Overall, the results of these prior studies imply that sensory factors obtained through a blind judging panel or chemical factors from laboratory data generally do not determine market wine pricing using hedonic analysis, or at least have far less impact when compared to ‘objective’ attributes, label attributes, or reputational factors.

2.3.2 **Reputational factors in hedonic price analyses of wine**

Many prior studies of wine pricing using a hedonic approach have demonstrated reputational influences in consumer purchasing. The reputational influence is often from a factor that studies define as ‘objective’, usually meaning information that all consumers can access equally from the label or some other form of communication, and that does not change between consumers. Notably, studies have shown that the effect of the region or appellation of origin is thought to have a strong reputational effect.
Landon and Smith (1997, 1998) used the term ‘individual’ reputation to mean the reputation of a single wine, and the term ‘collective’ reputation as the reputation effects from a group or categorical label (e.g. appellation) of wines. In the 1998 study, Landon and Smith applied the hedonic approach to study the combined effects of wine quality and reputation on Bordeaux wine prices. Quality measures were constructed from *Wine Spectator* catalogue ratings based on expert blind tasting of sensory wine characteristics, while reputation effects were based on Bordeaux regional appellations and industry-based quality indicators, such as the 1855 wine classification scheme (e.g., first growth, second growth, third growth). From their results, the authors found that collective reputation effects of geographic wine appellations and the Bordeaux wine quality growth classification regime serve as a good proxy for consumers to identify an individual firm’s reputation associated with past quality of their product. The findings indicated that reputation effects of the appellation had a larger impact on price premia than current quality as measured by the rankings of the *Wine Spectator* magazine.

The previously mentioned studies by Cardebat and Figuet (2004, 2009) concluded that reputational factors existing in the appellation of the wines explain prices. In the 2004 study on Bordeaux wines, the authors found that the reputation in the appellation was an indicator of expected quality and that the marginal impact of the expected quality on price was far greater than that of the quality rating given by the sensory panels.

Carew and Florkowski (2010) performed a hedonic analysis on Burgundy wines in the wine market in British Columbia, Canada. The study took into account the Burgundian village or appellation, vintage, alcohol, and quantity sold. The results confirmed collective reputation effects of Burgundian appellation with differences between white and red wines with village
designation. Additionally, vintages had a relatively larger effect on white wine prices than on red wine prices.

The findings for the importance of reputational influence from expert valuations or grading in catalogues is varied. The difference between scores from sensory blind tastings listed in a publication such as Wine Spectator and those expert blind tastings done for the purpose of a specific study is that the consumer may be aware of the scores before purchasing and the effect of the grading on the reputation of the wine may affect consumer preference. In a restaurant setting, consumers are unlikely to be exposed to such scoring, but the information is still informative in terms of the value consumers place on what they may consider to be an expert opinion or an indication of quality. Such indications may have similar effects to features in the restaurant setting, such as the rating of a restaurant or the effect of consumer perception of expert opinion in the wine menu selection.

As mentioned, Landon and Smith (1998) found reputation effects of the Bordeaux appellation had a larger impact on price premia than improvements in current quality as measured by the rankings of the Wine Spectator magazine. In 2000, Angulo et al., published a study of wine prices in a catalogue of Spanish red wines and found that attributes of region of production and vintage listed in the catalogue were significant determinants of pricing, while other attributes such as grape varietal and alcoholic content were not significantly correlated. The study did not include sensory attributes but incorporated expert valuations of wine listed in the catalogue, which were found to be positively correlated to catalogue price.
Benfratello et al. (2009), referencing Landon and Smith (1997, 1998), attempted to identify factors in individual reputation and producer reputation. For individual wine reputation, three widely known Italian guides were used to construct three bottle-specific dummy variables representing single wine reputation among consumers. For producer reputation, three producer-specific time-invariant variables were modeled based on catalogue ratings. As previously mentioned, the reputation model incorporating these variables was found to explain wine prices significantly better than the sensory model. It is interesting to note that the sensory data was based on Wine Spectator and AIS catalogue information that may have been available to consumers.

Of particular regional importance to the current research, a study by Kwong et al. (2011) analysed the LCBO retail pricing of wines produced in Ontario, Canada. The hedonic model included a discrete measure of wine quality based on rankings by a noted wine expert (Michael Vaughan), which appear to be available to the public via an online open-access database but may not be as widely known as publications such as Wine Spectator. Other attributes included were number of cases purchased by the LCBO, whether the wine label had the special designation of ‘Reserves’, ‘Single Vineyard’, or other special designation, whether the wine had been produced using environmentally sustainable methods (not necessarily a label characteristic), varietal, vintage, and LCBO vintage score. Separate models were created for wines priced below $18 CAD retail and for wines priced above. The results provided evidence of price segmentation in the market, supporting the finding that the term “Reserve” and the vintage year information are important for consumers of lower priced wines whereas these attributes are not important for consumers of higher priced wines. The expert score and number of cases purchased by the
LCBO was not important for lower priced wines whereas both had a significant impact for higher priced wines. Varietal appeared to have some importance for both price segments.

Price segmentation in the wine market has also been supported by the hedonic study conducted by Costanigro et al. (2007) on California and Washington red wines. In this study, it was found that better scores in the tasting review from Wine Spectator positively impacted wine prices. This effect was increasingly important for the commercial to semi-premium and premium market segments, and was largest for ultra-premium wines.

2.4 Hedonic Models of Restaurant (On-Trade) Pricing

There is a small line of studies that examine price of meals in restaurants. Notably, hedonic price functions analysing meal price have been applied by Falvey et al. to New Orleans restaurants (1992); Gunawardana and Havrila (1996) to restaurants in Melbourne, Australia; Gergaud et al. (2007) to restaurants in Paris, France, Fogarty (2012) to Australian restaurants, and Yim et al. (2014) to restaurants in Seoul, Korea. Attributes such as location, cuisine, capacity, and indicators of décor, food quality, service, ambience, and reputation are incorporated. Results vary greatly depending on study and region. These studies suggest that average meal price of a restaurant may be a significant indicator of some restaurant level attributes. They also support that a hedonic model may be useful for assessing restaurant pricing.

However, none of the above studies addressed wine pricing in particular. Only one study by Durham et al. (2004) was found that applied hedonic methods to restaurant wine purchase but did not include restaurant characteristics. The study used wine menu prices and purchase
quantity data from one restaurant of undisclosed location to study the attributes of a combined 
origin-varietal variable category, five sensory characteristics of both red and white wine, and 
fourteen sensory characteristics of red wine. The sensory characteristics were “derived from the 
wine list” (Durham et al. 2004: 117). The purchasing data had a large number of zero sales and a 
modified zero-inflated Poisson regression model was used. It was found that origin and varietal 
information is of interest to customers, and that some flavour and sensory characteristics 
appeared to influence wine selection while others did not. Overall, it was found that in some 
respects, the findings were consistent to that of studies by Combris et al. (1997, 2000), which 
found little responsiveness to sensory characteristics (Durham et al. 2004: 129).

The current research is the first of the author’s knowledge to develop a hedonic model 
using observations from many restaurants and incorporating restaurant level and wine level 
attributes specifically of restaurant wine pricing in Canada or any country.

2.5 Summary

Prior studies on restaurant wine purchasing and pricing support that reputational factors of the 
wine and the restaurant are influential on wine purchase decisions, which may include the size of 
the restaurant, and the offering variety of wine offered on a menu. Most hedonic method studies 
on retail wine pricing suggest that sensory attributes of the wine do not significantly impact 
restaurant wine pricing, but that ‘objective’ attributes such as origin, varietal, and vintage have a 
significant impact. Several of these hedonic studies also suggest that factors like region and 
expert ratings can have a strong reputational effect on consumers that impacts pricing. A small 
line of hedonic method studies that examines meal pricing in restaurants demonstrates that a
variety of restaurant level factors such as type of cuisine can have significant impact on
restaurant meal pricing. The current study is unprecedented in that it uses a hedonic analysis of
restaurant menu wine pricing from many restaurants using both restaurant level and wine level
attributes.
CHAPTER 3: THEORETICAL FRAMEWORK

3.1 Introduction

This chapter discusses the hedonic demand theory and the theoretical framework underlying the hedonic model developed in this study. It begins with an outline of the history of the development of the hedonic framework, and then explains the underlying demand theory of the hedonic method employed in this study, discussing the concept of revealed preference and Sherwin Rosen’s seminal formalization of a hedonic price function (1974).

3.2 Hedonic Demand Theory

3.2.1 Historical development of the hedonic approach

Hedonic demand theory was developed in order to estimate the value of or the demand for a good or service that can be represented as a function of utility-bearing attributes. The name of the method, deriving from the Greek word for pleasure, refers to its representation of the price of a good or service as a function of its ‘pleasurable’ or utility-giving attributes. Within this framework, the values of these attributes (termed hedonic prices) can be determined implicitly via the market price of a particular good or service, despite the lack of a market price for each attribute.

As an analytical framework, hedonic demand theory has enjoyed considerable success, with frequent applications within the field of agricultural economics. The first recognizable hedonic price studies date as far back as 1922 (Colwell and Dilmore 1999), with the first
application in an agricultural context occurring in 1928, in a study of the relationship between vegetable characteristics and vegetable price in a wholesale market in Boston (Parker et al. 1991). Notable (non-agricultural) early applications of the hedonic approach include Court (1939) and Griliches (1961), both of whom employed regression techniques to examine consumer preferences for optional inclusions on automobile purchases, allowing the construction of a quality-adjusted measure of automobile price changes over time. Formalization of the hedonic approach within a model of competitive equilibrium in a seminal paper by Rosen (1974) spurred further interest in the technique. Today, hedonic demand theory remains popular in applied economics, particularly in studies of commodity pricing, land economics, and quality-adjusted price indices. As demonstrated in the previous chapter, it has been widely used in studies analysing pricing of retail wine.

3.2.2 Theoretical framework underlying the hedonic approach

The hedonic method is based on the concept of revealed preference, or the premise that consumers’ preferences can be revealed through purchasing behaviours. The theory of revealed preference assumes that consumers make consumption decisions in order to maximize utility (Samuelson 1938). Revealed preference data are derived from choices on observed markets and are, in theory, relatively precise when direct observation is possible (Louviere et al. 2000).

The hedonic approach assumes that utility-maximizing consumers value goods as a ‘bundle’ of attributes. Viewed in this way, goods themselves are not the direct objects of consumer’s utility functions; rather, consumer’s utility is based upon the levels of each attribute present in the good consumed (Lancaster 1966). In a seminal paper, Rosen (1974) extended this
idea to treat market transactions as the co-location of optimal consumption and production
decisions in multidimensional product space. Formally, the approach describes any product in
terms of \( n \) attributes \( z_1 \ldots n \) (or ‘characteristics’, or ‘qualities’), which are assumed to be the full set
of characteristics over which consumers have preferences and which producers can produce.
Some space of dimension \( n \) may then be defined using the vector \((z_1, z_2, \ldots, z_n)\) as a basis. The
product market implicitly reveals a function relating prices and attributes as follows.

\[
p(z) = p(z_1, \ldots, z_n) \tag{1}
\]

The utility function is assumed to be strictly concave and is given as

\[
U = p(x, z_1, \ldots, z_n) \tag{2}
\]

where \( x \) is all other goods consumed. Rosen considered that the bid function representing the
amount a consumer would be willing to pay for a good \( z \) would then be \( \theta(z, u, y) \), where \( y \) is
income and \( U(y - \theta, z_1, \ldots, z_n) = u \). The relationship between bid functions and the price
function is shown in Figure 3.1.2 (from Rosen 1974: 39).
Within this framework the determined price, $p(z)$, of a given good is thus implicitly a function of its attributes, and price differences among goods are “equalizing differences for the alternative packages they embody” (ibid: 54). Rosen is careful to point out that the price of the product is in fact an envelope of possible prices that could be generated by given families of consumer value functions and producer offer functions. Empirically, the hedonic approach allows for obtaining observations of prices of a differentiated commodity and regressing the prices on the different product attributes or characteristics. This estimates the hedonic price function, the gradients of which are the implicit prices of the attributes, the ratios of which reflect consumers’ marginal rates of substitution among attributes (Nerlove 1995).

The hedonic price of an attribute is the implicit price for an additional unit of that attribute, or the amount the consumer is willing to pay to obtain one additional unit of that attribute, ceteris paribus. Formally, maximization of the utility function subject to the nonlinear
budget constraint requires consumers choosing \((z_1, \ldots, z_n)\) and \(x\) to satisfy the budget and the first order conditions:

\[
\frac{\partial P}{\partial z_i} = \frac{u_{z_i}}{u_x}, \quad i = 1, \ldots, n \tag{3}
\]

where the left-hand side of the equation is the marginal implicit value for \(z_i\).

### 3.3 Assumptions of Hedonic Models

The hedonic model makes a number of important assumptions. Most importantly, markets must be competitive for hedonic prices to serve as ‘equalizing differences’ in the manner intended by Rosen (1974). That is, neither monopolistic nor monopsonistic conditions may prevail, and firm entry and exist must be free. Oczkowski (1994) approaches this assumption via the analytically tractable features of entry and exit barriers, and the relative size of individual firms. The presence of entry or exit barriers precludes competitive conditions, while large firms will exercise some degree of monopolistic power. Oczkowski further emphasizes the standard competitive assumptions of perfect information in a hedonic context. In all cases violations of perfect competition will lead to hedonic prices that do not accurately reflect the utility associated with product attributes, producing biased estimates of the true hedonic price in empirical applications.

Further critical assumptions define the nature of goods analyzed within a hedonic demand framework, and the relationship between those goods and their consumers. In Rosen’s model, the goods under consideration are assumed to be indivisible. Practically, this assumption is supported by the argument that should a situation exist where a unit of some attribute could be
purchased separately, it is not considered identical with an additional unit of that attribute present as part of a good. In empirical applications, this requires that the divisibility of a good chosen for hedonic analysis be carefully considered. Furthermore, it is assumed that there is a continuous spectrum of products possible, such that incremental changes in price between products may reflect incremental changes in their underlying bundle of attributes (Rosen 1974). This implies that producers and consumers can co-locate anywhere in the product space without loss of fungibility between the goods; violation of this assumption will result in biased parameter estimates in empirical applications.

Lastly, goods must be ‘objectively measured’, that is, all consumers must be able to agree on the quantities of each attribute present in a given good, though they may differ as to their valuations of those quantities.

### 3.4 Summary

Many economists have used the hedonic model over the past century. Hedonic demand theory is based on the concept of revealed preference, and when applied to pricing treats pricing of a commodity as a function of the commodity’s attributes. The gradients of the estimates of the hedonic price function represent the implicit prices for an additional unit of the corresponding attribute. The hedonic model operates on the assumptions of competitive markets, a continuous spectrum of products, and goods that are indivisible and can be objectively measured.
CHAPTER 4: METHODS – EMPIRICAL MODEL & DATA

4.1 Introduction

This chapter outlines the method of model specification, beginning with consideration of how assumptions discussed in Subsection 3.2 are met. The specification of independent variables is discussed, as well as the choice of Toronto as the study area. The method of data collection, the treatment of categorical variables, and the use of Cronbach’s $\alpha$ testing to aid in the selection of ratings and average meal price data is then described. The reasons for designation of categorical levels is further explained with reference to descriptive statistics. Important questions and hypotheses addressed by the study are then laid out and the method of cluster-robust OLS regression discussed.

4.2 Model Specification

4.2.1 Consideration of assumptions

The approach taken in this thesis is to treat the consumption of a glass of wine in a restaurant setting as a single good, comprised of both physical and experiential elements. This is consistent with established hedonic theory. In fact, Lancaster (1966) used the example of a dinner party as a good that could be hedonically priced in a paper that remains highly influential in modern hedonic theory (Chine and Chau 2003). In this example, a dinner party is considered to possess “nutritional, aesthetic, and perhaps intellectual characteristics different from the
combination obtainable from a meal and a social gathering consumed separately” (Lancaster 1966: 133). The same approach is taken here, with the experiential elements of restaurant setting considered as inextricably bound to the physical characteristics of the wine being consumed from the point of view of price discovery. The empirical analysis thus includes both restaurant-level and wine-level variables to capture these different aspects of the consumption experience.

With the consumption good so defined, it is necessary to show a priori that the core assumptions of the hedonic framework are not violated. As discussed in Chapter 3, these assumptions are competitive markets, the non-separability of attributes, the existence of a continuum of products, the objective quality of priced attributes. It will be argued that these assumptions may safely be made. With regards to competition, it is noteworthy that the restaurant industry is notorious for free entry and exit, and is characterized by many small producers and consumers, thus meeting the practical conditions emphasized by Oczkowski (1994). It is difficult to imagine a case in a major metropolitan center like the study area (Toronto) where meaningful monopolistic power exists. Furthermore, each customer makes their purchasing decision more or less independently, and with as close to a free flow of information as could practically be desired. The latter point is supported by the popularity of online rating sites such as Yelp, Zomato or Trip Advisor, and the use of online restaurant menus to obtain wine prices used in this study.

The characteristics of a ‘wine consumption experience’ and their relationship to consumers similarly satisfy the assumptions of hedonic theory. First, the attributes are clearly non-separable. The same wines can often be purchased via retail sale in Ontario as in a restaurant, yet consumers are willing to pay a price premium to consume those wines in a
restaurant setting. Second, the differences between restaurants in the sample with regard to customer ratings, average meal price and the length and variety of their wine lists (an average of 6 wines per list, with 3 at minimum and 16 at most) with many varietals from many locations and vintages can reasonably be taken as constituting a continuum of products. Third, the attributes of the consumption experience are objectively measured in the sense used by Rosen (1974), in that the physical characteristics of by-the-glass wine and the atmosphere of each restaurant can be consistently observed by different individuals, although their preferences over these attributes are naturally expected to vary.

In this study, to take into account the potential for price segmentation or conspicuous consumption (purchasing for the purpose of displaying luxury or status; See Leibenstein 1950), the scope of product category was narrowed to by-the-glass wines. Because there is a potential for open bottles to spoil if not enough glasses are sold in time and the bottle is not left on the table for display, it is expected that wines chosen for by-the-glass menus will not be those in the same category of conspicuous consumption. It is also expected that for similar reasons, by-the-glass wines are limited to a narrower price range than full bottles of wine and the resulting data ranged from $7.50 to $27 a glass. Wines of interest were also limited to white wines, as white varietals account for a larger percentage of VQA wine production; for example in 2017, they accounted for over 58% of total VQA wine production (Vintners Quality Alliance Ontario 2017).

4.2.2 Specification of independent variables

After consideration of the results of prior studies of wine purchasing and pricing discussed in Chapter 2, independent variables were specified. ‘Objective’ variables evident on
the menu such as varietal, vintage, and region of origin were incorporated into the model. To take into account variety of offerings, the number of menu options for by-the-glass white wines was included as a factor. Prior studies also highlighted the relevance of reputational variables. Restaurant level variables representing reputational factors attaching to both physical and experiential elements of wine consumption in a restaurant were also incorporated. Average meal price was chosen as an indicator of restaurant reputation and quality, and median annual income per neighbourhood was chosen to capture information on the quality of restaurant location. Online consumer review rating scores were also included as a measure of restaurant reputation. Affiliation (ownership structure), type of cuisine, and total capacity were also included as variables that have an impact on the preferences of the consumer with possible reputational elements or cues that increase valuation of the wine. Deriving from equation (1) in Chapter 3, the hedonic function for pricing of by-the-glass white wines served in Toronto restaurants can be represented as follows.

\[
P(z) = P(\text{reg}, \text{var}, \text{vin}, \text{num}, \text{aff}, \text{amp}, \text{cap}, \text{cui}, \text{inc}, \text{rat})
\]

where \(\text{reg}\) denotes the wine’s region of origin, \(\text{var}\) denotes wine varietal, \(\text{vin}\) denotes wine vintage, \(\text{num}\) denotes the number of options, \(\text{aff}\) denotes the affiliation or ownership structure of the restaurant, \(\text{amp}\) denotes the average meal price, \(\text{cap}\) denotes the total restaurant capacity, \(\text{cui}\) denotes the type of cuisine, \(\text{inc}\) denotes the neighbourhood median income, and \(\text{rat}\) denotes the online rating score.
4.3 Sample Frame Selection and Data Collection

4.3.1 The study area: Toronto

Toronto was chosen as the area most suitable for this study for several reasons. Ontario is the largest beverage alcohol market in Canada totaling sales of $7.9 billion in 2016 (Statistics Canada 2017). Toronto is the largest metropolitan area in Ontario (as well as all of Canada) and contains the highest population density of consumers of drinking age in Ontario with a general population density of 1004 people per square kilometre in 2016, and the percentage of the population between 15 to 64 years of age representing 68.9% of the total distribution (Statistics Canada, Census Profile 2016).

Toronto is a significant tourist destination with 43.7 million visitors in 2018, a record high, and $8.8 billion estimated in tourist spending, which is $700 million more than was spent in 2016 (Tourism Toronto 2018). Toronto contains a high density of on-trade establishments that serve wine. The Alcohol and Gaming Commission of Ontario (AGCO) was established in 1998, by the Government of Ontario (Alcohol and Gaming Commission of Ontario 2017). The AGCO maintains a directory of all Ontario establishments that serve beverage alcohol, and records obtained on January 17, 2017 listed 3741 establishments in Toronto which served beverage alcohol.

4.3.2 Price data and attribute data collection

Between October and December 2017, the online crowd-sourced websites of Zomato, Yelp, and Trip Advisor were used to identify restaurants in the AGCO Toronto list that would
likely have wine lists available online. For each website, searches were made using the search terms “wine” and “wine restaurant” in the search bar under the category of restaurants in the location of Toronto, ON. The boundaries for the area of restaurants used was limited to the area defined by the AGCO liquor license list discussed below and did not include the Greater Toronto Area.

The address and venue name from the resulting search lists were used to search for the establishment’s official website. If the restaurant had an operational website, verification that the restaurant was still operational was achieved by crosschecking with other online sources (i.e., Zomato, Yelp, TripAdvisor, blogTO, Google Maps) or in some cases by phoning the establishment. If operational, the restaurant website was searched to see if they posted prices, region of origin, varietal for by-the-glass white wine selection. Only establishments that displayed all three variables and indicated they were current to the year 2017 were used. Number of by-the-glass white wines offered on menu was also recorded. For establishments that offered more than one pour size, the price for the standard glass size of 5 to 6 ounces was recorded. Prices were then converted to price per ounce.

The Zomato website sometimes had wine menus provided for establishments, often in the form of photographs taken of the menu, but many Zomato menus did not have any indication of date of the list and appeared outdated. Trip Advisor very occasionally listed wine menus, but the most accurate and recent lists were consistently provided by the official restaurant website and as a result, no Zomato or TripAdvisor menus were used.
A total of 66 restaurants providing a total of 396 by-the-glass white wine observations were retrieved using Zomato; a total of 74 restaurants providing a total of 432 wine observations were retrieved using Trip Advisor; and a total of 73 restaurants providing a total of 438 wine observations were retrieved using Yelp. The majority of these restaurants overlapped between website lists.

The ratings out of five stars for each restaurant was recorded on each of the three crowd-sourcing websites was recorded. Information from the three websites as well as other online sources, such as the restaurant website, review websites like blogto.com, and Google Maps, were compared and used to designate the type of cuisine under one of seven categories: Canadian or American, Steakhouse, French, Italian, Latin American or Spanish, Asian or Asian Fusion, and Other.

A list detailing information for all establishments licensed to sell alcohol in Ontario was acquired from the AGCO in January 2017. This list was later updated by AGCO information in January 2018. The list included the establishment’s operational business name, address, phone number, capacity and name of owner. This data was reformatted and filtered so that only entries for the area the AGCO defined as the city of “Toronto” were included. The affiliations, or ownership structure, of the restaurants was assigned by using the AGCO recorded owner of liquor license and researching online content regarding the owner. These were categorized under four labels: Chain or Franchise (where the restaurant operated under a branded/licensed name used for other members of the chain/franchise), Independent (where the restaurant was owned by independent individuals), Group (where the restaurant was owned by a business group that owned a variety of other restaurants and entertainment establishments; e.g. Oliver & Bonacini
Hospitality and the Liberty Entertainment Group), Hotel (where the restaurant was owned by a hotel), and Group & Hotel (where the restaurant was owned by a Group but operated in affiliation with a hotel).

To acquire restaurant characteristics related to the neighbourhood of the restaurant, the indicator of median annual income by neighbourhood from Canadian population census data for year 2016 was obtained from Statistics Canada (Statistics Canada, Data Products 2016). This data was obtained at the most disaggregated scale available (“dissemination area”, corresponding approximately to a range of 400-700 people, or about one city block in Toronto). The AGCO Toronto establishment list was geo-coded using the google maps API (automated programming interface) to return coordinates in WGS84 Web Mercator. The geo-coded points were loaded into the program Quantum GIS (QGIS), and re-projected as UTM (universal transverse mercator) zone 17N (WGS 84). Then a map of Canadian dissemination areas from the census data was re-projected in UTM using QGIS, and the unique dissemination area ID for each restaurant was extracted.

4.3.3 Descriptive Statistics

Tables 4.3.3a, 4.3.3b and 4.3.3c below list the descriptive statistics of the continuous and categorical variables, respectively, as defined for purposes of the hedonic model. Descriptive statistics for all labels of regions and varietals in the data are attached in the Appendix.
### Table 4.3.3a: Descriptive statistics of continuous variables

<table>
<thead>
<tr>
<th></th>
<th>min</th>
<th>mean</th>
<th>median</th>
<th>max</th>
<th>st. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wine Price - <em>P</em> (CAD per oz)</td>
<td>1.5</td>
<td>2.6</td>
<td>2.6</td>
<td>5.0</td>
<td>0.60</td>
</tr>
<tr>
<td>Average Meal Price - <em>AMP</em> (CAD)</td>
<td>30.0</td>
<td>90.7</td>
<td>85.0</td>
<td>150.0</td>
<td>27.71</td>
</tr>
<tr>
<td>Number of white by-the-glass options - <em>NUM</em></td>
<td>3.0</td>
<td>7.2</td>
<td>7.0</td>
<td>16.0</td>
<td>2.81</td>
</tr>
<tr>
<td>Total Capacity - <em>CAP</em> (Number of people)</td>
<td>30.0</td>
<td>254.0</td>
<td>220.0</td>
<td>692.0</td>
<td>169.82</td>
</tr>
<tr>
<td>Rating Score - <em>RAT</em> (points; out of a total of 5)</td>
<td>2.3</td>
<td>3.8</td>
<td>3.8</td>
<td>4.9</td>
<td>0.45</td>
</tr>
<tr>
<td>Median Income - <em>INC</em> (CAD)</td>
<td>46,592.0</td>
<td>107,541.0</td>
<td>110,080.0</td>
<td>202,240.0</td>
<td>25,911.78</td>
</tr>
</tbody>
</table>

### Table 4.3.3b: Descriptive statistics of restaurant-level categorical variables

<table>
<thead>
<tr>
<th></th>
<th>Frequency in sample</th>
<th>Percentage of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Affiliation - <em>AFF</em></strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent</td>
<td>214</td>
<td>54.04</td>
</tr>
<tr>
<td>Group</td>
<td>139</td>
<td>35.10</td>
</tr>
<tr>
<td>Hotel</td>
<td>25</td>
<td>6.31</td>
</tr>
<tr>
<td>Group &amp; Hotel</td>
<td>9</td>
<td>2.27</td>
</tr>
<tr>
<td>Chain or Franchise</td>
<td>9</td>
<td>2.27</td>
</tr>
<tr>
<td><strong>Cuisine - <em>CUI</em></strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian/American</td>
<td>123</td>
<td>31.06</td>
</tr>
<tr>
<td>French</td>
<td>69</td>
<td>17.42</td>
</tr>
<tr>
<td>Italian</td>
<td>50</td>
<td>12.63</td>
</tr>
<tr>
<td>Latin American/ Spanish</td>
<td>31</td>
<td>7.83</td>
</tr>
<tr>
<td>Asian/Asian Fusion</td>
<td>26</td>
<td>6.57</td>
</tr>
<tr>
<td>Steakhouse</td>
<td>25</td>
<td>6.31</td>
</tr>
<tr>
<td>Other</td>
<td>72</td>
<td>18.18</td>
</tr>
</tbody>
</table>
### Table 4.3.3c: Descriptive statistics of wine-level categorical variables

<table>
<thead>
<tr>
<th>Region - REG</th>
<th>Frequency in sample</th>
<th>Percentage of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>93</td>
<td>23.48</td>
</tr>
<tr>
<td>Ontario</td>
<td>87</td>
<td>21.97</td>
</tr>
<tr>
<td>France</td>
<td>81</td>
<td>20.45</td>
</tr>
<tr>
<td>California</td>
<td>33</td>
<td>8.33</td>
</tr>
<tr>
<td>Spain</td>
<td>24</td>
<td>6.06</td>
</tr>
<tr>
<td>Marlborough</td>
<td>21</td>
<td>5.30</td>
</tr>
<tr>
<td>Other</td>
<td>57</td>
<td>14.39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Varietal - VAR</th>
<th>Frequency in sample</th>
<th>Percentage of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chardonnay</td>
<td>95</td>
<td>23.99</td>
</tr>
<tr>
<td>Sauvignon Blanc</td>
<td>63</td>
<td>15.91</td>
</tr>
<tr>
<td>Pinot Grigio</td>
<td>43</td>
<td>10.86</td>
</tr>
<tr>
<td>Riesling</td>
<td>42</td>
<td>10.61</td>
</tr>
<tr>
<td>Other</td>
<td>153</td>
<td>38.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vintage - VIN</th>
<th>Frequency in sample</th>
<th>Percentage of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>148</td>
<td>37.37</td>
</tr>
<tr>
<td>2015</td>
<td>164</td>
<td>41.41</td>
</tr>
<tr>
<td>2014</td>
<td>58</td>
<td>14.65</td>
</tr>
<tr>
<td>2013</td>
<td>19</td>
<td>4.80</td>
</tr>
<tr>
<td>2012</td>
<td>4</td>
<td>1.01</td>
</tr>
<tr>
<td>2011</td>
<td>3</td>
<td>0.76</td>
</tr>
</tbody>
</table>

### 4.4 Treatment of variables

#### 4.4.1 Treatment of categorical variables

Five of the predictor variables included in this regression were categorical (region, vintage, varietal, affiliation, and type of cuisine). The default option in the regression software used in this analysis (R’s base package `lm()`) handles categorical variable by ‘dummy coding’, also referred to as ‘contrast coding’. For a categorical predictor with \( n \) possible values (or
‘levels’), \( n-1 \) binary variables are created. Each new variable is assigned a value of 1 if the predictor takes on that value for a given observation (and 0 otherwise). One variable must be selected as the reference level, which is the value of the predictor indicated if all \( n-1 \) binary variables equal 0. For example, the categorical variable \( VAR \), with five possible values (“Chardonnay”, “other”, “Pinot Grigio”, “Riesling”, “Sauvignon Blanc”) would be transformed into four binary dummy variables, with one of the five values designated as reference category.

Coding categorical variables in the linear regression context poses an important design question. Different reference levels will produce different results, including reversal of signs for estimated coefficients, and there may not be \textit{a priori} justification for selecting a particular reference level. When no \textit{a priori} reference level is implied by the hypotheses being tested and the design is unbalanced (as is the case here), recent work suggests that selecting the largest category (with the largest proportion of observations) as the reference is optimal in the sense that it maximizes the precision of resulting estimators (Peng and Mackenzie 2014). This approach was taken here, except for the variable of region of origin, where the second largest categorical level of Ontario (Italy being the largest at 93 observations, Ontario being at 87) was used for ease of interpretation with respect to differences of other regions in comparison to Ontario wines. The overall significance of the variable, in addition to the significance of the differences between categorical levels were tested using pairwise likelihood ratio tests.

\textbf{4.4.2 Pairwise Likelihood Ratio Tests}

‘Dummy coding’ is standard in most statistical packages, but results must be interpreted with care. Standard results (coefficients; \( p \)-values) do not refer to the effect of marginal increases in
the predictor variable or the significance of a single associated coefficient, as in the case of a continuous predictor. Instead, they refer to the marginal change in the response of moving from the reference level to the specific level of the categorical variable in question, and whether this specific change is important – not whether the original (pre-coding) categorical predictor is significant overall. For example, if the categories of varietals were dummy-coded using the category of “other” as the reference level, the resulting coefficients and $p$-values in standard output would refer to the change in the response variable occasioned by moving from the reference level to the level in question (e.g. from “Other” to “Chardonnay”), and the significance of this change.

The overall significance of the variable (e.g. varietal) included in this study are of interest, in addition to the significance of the differences between categorical levels (e.g. Chardonnay, Sauvignon Blanc, etc.). To test significance, pairwise likelihood ratio tests are used between different model specifications, using the \texttt{lrtest()} function from package \texttt{lmtest}. This standard test compares twice the difference in log-likelihoods between two models against a chi-squared distribution (Verbeek 2004). This approach has been used in the literature to test the significance of categorical predictors (e.g. region of origin) in a prior hedonic study of wine pricing (Benfratello et al. 2009). For each test, the null model, which includes all continuous and categorical variables, is taken to be

$$
P_i = \alpha + \beta_1 REG_i + \beta_2 VAR_i + \beta_3 VIN_i + \beta_4 NUM_i + \beta_5 AFF_i + \beta_6 AMP_i + \beta_7 CAP_i + \beta_8 CUI_i + \beta_9 INC_i + \beta_{10} RAT_i + \varepsilon \tag{5}
$$
where \( P_i \) denotes the restaurant price for wine \( i \), \( \alpha \) denotes the intercept term, the \( \beta \)s denote the coefficients to be estimated for the corresponding categorical variables (\( \text{REG}_i \) for region of observation \( i \), \( \text{VAR}_i \) for varietal of observation \( i \), \( \text{VIN}_i \) for vintage of observation \( i \), \( \text{AFF}_i \) for affiliation of observation \( i \), and \( \text{CUI}_i \) for cuisine of observation \( i \)) or continuous variables (\( \text{NUM}_i \) for number of options of observation \( i \), \( \text{AMP}_i \) for average meal price of observation \( i \), \( \text{CAP}_i \) for capacity of observation \( i \), \( \text{RAT}_i \) for rating score of observation \( i \), and \( \text{INC}_i \) for neighbourhood median income of observation \( i \)) and \( \varepsilon_i \) is the error term for observation \( i \) that represents independently distributed normal random variables with mean zero. The alternate model is identical save for the removal of one of the five categorical predictors. The results of these tests are presented in Table 5.1. It was found that the variables of vintage and cuisine were not significant at the 5\% level and therefore they were not retained in the model.

### Table 4.4.2. Results of Pairwise Likelihood Ratio Tests

<table>
<thead>
<tr>
<th>Categorical Variable added in alternate model</th>
<th># Degrees of freedom</th>
<th>( \chi^2 )</th>
<th>( Pr &gt; \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region – REG</td>
<td>6</td>
<td>25.96</td>
<td>0.0002</td>
</tr>
<tr>
<td>Varietal - VAR</td>
<td>4</td>
<td>27.68</td>
<td>0.0000</td>
</tr>
<tr>
<td>Vintage – VIN</td>
<td>5</td>
<td>8.10</td>
<td>0.1500</td>
</tr>
<tr>
<td>Affiliations – AFF</td>
<td>4</td>
<td>106.47</td>
<td>0.0000</td>
</tr>
<tr>
<td>Cuisine – CUI</td>
<td>6</td>
<td>12.09</td>
<td>0.0601</td>
</tr>
</tbody>
</table>
The results of the likelihood ratio test for the variables of Vintage and Cuisine might be explained by several factors. It was expected that by-the-glass wines have a custom of being in lower and narrower price brackets than full bottles, as explained in Subsection 4.2.1, and likely have relatively recent vintages (most were 2015 and 2016 vintages) since very old vintages tend to be higher in price (Robinson 2006: 752-3). The vintage year indicates the year in which the grapes were harvested which indicates weather conditions affecting viticulture and also how long the wine has been aging or maturing (ibid: 753). Certain vintages may have more value to consumers because they feel the climatic conditions for that year were favourable for the particular wine or because they feel that the age of the particular wine indicates desirable characteristics. The relationship of vintage to wine characteristics, as well as to consumer perceptions, is a complex one (ibid: 753). Many different climates may exist within the regional levels, particularly for the scale for which they are defined in this study. In addition, different varietals may respond differently to the same weather conditions. For some wines, a customer may feel that a certain amount of aging is desirable, but only up to a certain number of years, after which the wine may appear to be too aged. For other wines, the customer may prefer a recent vintage for a fresher quality.

Due to the complicated nature of vintage assessment which decreases the likelihood the consumer will either know or be concerned about differences between two very recent vintages (ibid: 752-3), it was not expected there would be significant differences in impact on pricing between recent vintages spanning a range of only five years.
Previous studies mentioned in Section 2.4 (e.g. Yim et al. 2014) that found that certain cuisines could have significant impact on restaurant meal pricing. As with wine, in previous decades, French and Italian cuisine may have been considered to be of higher quality than other styles such as American or Canadian (Freedman 2016). However, tastes have been changing recently. Freedman, a professor of history at Yale University, has stated that globalization and innovation have become much more important factors of restaurant quality, and mentions that restaurants ranging in cuisine styles from American to Asian to Spanish to Nordic have been considered to be top quality restaurants serving top quality food and drink in recent years (ibid 2016). This supports that, currently, no one type of cuisine would significantly impact customer valuation of food or drink served at a restaurant more than another kind of cuisine. Therefore, it is understandable that no category level of cuisine would have a significant effect on restaurant wine pricing.

4.4.3 Categorization of wine-level characteristics

For countries of origin with where most of the wines were from one specific region within the country, the regional level (as opposed to the country level) was used as the region name. For example, all the wines from New Zealand were from Marlborough except one that was from Nelson, so they were initially labeled either Marlborough or Nelson. The same treatment was applied to two New World countries: Canada (where almost all of the wines were from Ontario), and the USA (where almost all of the wines were from California). For all other countries that had multiple regions listed, the country name was used as the region of origin. The frequency of each region is demonstrated in Figure 4.4.3a. For purposes of the regression, the
Region variable was divided into seven categorical levels: Italy, Ontario, France, California, Spain, Marlborough and Other.

A total of 41 grape varietals appear in the data, but four of the varietals account for 61.2% of the 396 observations: Chardonnay, Sauvignon Blanc, Pinot Grigio, and Riesling. Therefore, the varietals were categorized under these four names with all other varietals being labeled as “Other” to give a total of five categorical levels. Figure 4.4.3b displays the percentages of the total sample for each of these levels. It should be noted that for the purposes of this study, wines with menu information listing their varietal as Pinot Grigio were considered to have a different varietal than wines labeled as Pinot Gris.
4.4.4 Choosing rating score and average meal price data: Cronbach’s α test

Crowd-sourced restaurant ratings were available from three independent websites (Trip Advisor, Yelp, and Zomato). A visual inspection of ratings per restaurant (Figure 4.4.4) appears to show systematic bias, with ratings from Trip Advisor consistently high, ratings from Yelp consistently low, and ratings from Zomato showing the most variation (standard deviation of 0.46, versus 0.41 for Yelp and 0.36 for Trip Advisor).

Figure 4.4.3b. Percentages of wine varietal in sample

- Chardonnay (23.9%)
- Sauvignon Blanc (15.9%)
- Pinot Grigio (10.8%)
- Riesling (10.6%)
- Other (38.8%)
Figure 4.4.4. Comparison of crowd-sourced rating scores for sample restaurants

To evaluate the likelihood of multicollinearity and assist in the selection of a rating for inclusion in further analysis, a missing-values robust version of Cronbach’s $\alpha$ (Zhang and Yuan 2015) was used to evaluate the internal consistency of the three ratings scores. This metric is not a statistical test, but rather a description of the degree to which separate ratings (or test score results, or measurements) agree across a sample population; a score above 0.7 is generally considered ‘acceptable’ or ‘consistent’ in the social science literature (Santos 1999; Tavakol and Dennick 2011). For the three ratings websites considered here, $\alpha = 0.723$. Intuitively, therefore, the measure of one restaurant’s quality relative to the others provided by any one rating platform is consistent with that provided by any other.

The three platforms use different methods of scoring. The methods used by Trip Advisor and Yelp result in scores rounded to the nearest integer and Zomato’s algorithm results in scores with decimal places. As a result, the three scores were not averaged in order to avoid a loss of
precision. Only the scores from Zomato were retained for inclusion in further analysis and only the corresponding Zomato average meal price data was used. This selection was also motivated by the availability of continuous average meal price data from Zomato, which avoids the subjectivity present in categorical measurements of meal price systems employed by Yelp and Trip Advisor. While Zomato records dollar value cost per meals, the latter websites require users to grade the cost of the restaurant using a categorical system.

According to the Zomato website, Zomato ratings utilize a 5-point grading model and the distribution of scores is normalized at the city level; therefore, ratings in each city are distributed over a normal curve. Zomato uses an algorithm to calculate user credibility based on user activity which affects the weighting of their rating on overall restaurant rating (Goyal 2015). The Zomato website describes meal price as being the cost for two and claims that the standard for measurement of this cost is based on an average of 2 mid-ranged appetizers, 2 mains, 2 beverages, and one dessert. Half of the cost for two value was recorded as the value for Zomato average meal price. Descriptive statistics of the Zomato average meal price and Zomato rating are detailed in Table 2, along with descriptive statistics for all other continuous variables. Because the use of Zomato information was chosen, there were 396 observations of wine prices for which all characteristics were known.

4.5 Cluster-Robust Ordinary Least Squares Regression

When estimating hedonic demand equations via an Ordinary Least Squares (OLS) regression framework, care is required to achieve accuracy in both estimated regression parameters and in statistical inference. Because there are observations on multiple wines per
restaurant, the collected data exhibits a clustered structure. To obtain accurate parameters for hypothesis testing this study employs current best-practice methods to estimate cluster-robust standard errors.

Frequentist hypothesis testing in a regression framework is distinguished from the purely algebraic exercise of determining a line of best fit by the application of what are termed the Gauss-Markov assumptions. As formulated by Verbeek (2004: 16), these are $E\{\varepsilon\} = 0$ (expected value of the error term is zero), $V\{\varepsilon\} = \sigma^2 I_N$ (error terms have constant variance and the covariance between errors is zero; $I_N$ is the N x N identify matrix), and the independence of observations and errors terms (which implies $E\{\varepsilon | X\} = E\{\varepsilon\} = 0$). Given the regression model $Y = XB + \varepsilon$ under these conditions, the OLS estimator $(X'X)^{-1}X'Y$ will be the best linear unbiased estimator of the coefficients $B$. In this study, however, error terms are expected to have non-constant variance and be correlated between some observations (i.e. $V\{\varepsilon\} = \sigma^2 I_N$ does not hold). As a result, the standard error of the estimated coefficients $B$, $(se(\hat{B}))$, is expected to be biased downwards (Cameron and Miller 2015). Since parametric hypothesis testing in this instance is based upon comparing the Wald ‘t-statistic’ to an expected distribution, and $se(\hat{B})$ constitutes the denominator of t, the probability of a type I error (rejection of a true null hypothesis) is consequently increased.

A two-step process is employed here to overcome bias in $se(\hat{B})$ and achieve meaningful inference. First, OLS, is used to estimate the regression model (5). Second, a ‘cluster-robust’ method is used to obtain standard errors that are accurate despite $V\{\varepsilon\} \neq \sigma^2 I_N$. Thus OLS provide accurate coefficient estimates, and cluster-robust error terms allow meaningful inference.
This approach is preferred to the prior practice of proceeding via the feasible generalized least squares estimator because the need to specify a model for within-cluster error covariance is removed (Cameron and Miller 2015), and the potential for mis-specification is also removed.

The cluster-robust estimator used here is the default option provided by the `cluster.vcov` function in the R package `multiwayvcov` (Graham et al. 2016). This function implements the clustering method suggested by Cameron et al. (2011), with an additional degrees of freedom correction applied. In the one-way clustering case with $G$ clusters encountered here, this results in the ‘sandwich estimator’ $\sqrt{\{\hat{\beta}\}} = (X'X)^{-1}\hat{\beta}(X'X)^{-1}$, where $\hat{\beta} = \sum_{g=1}^{G} X'g e_g e'_g X_g$, which was first derived for the balanced-cluster case by White (1984; Cameron et al. 2011).

The validity of this method relies on correct specification of clusters, the number of clusters being relatively large, and the independence of observations that have no clusters in common (ibid 2011). The presence of natural clusters (restaurants) in this study means the first concern is satisfied, while the number of restaurants (66) in the collected sample is not small. Furthermore, while some restaurants may have identical values for some variables, such as neighbourhood median income due to being co-located in Canadian Census Designated Units, the expected value for wine-level variables can safely be assumed to be independent of the conditions in other restaurants. Once calculated, cluster-robust standard errors calculated by `cluster.vcov` were then passed to the R function `coeftest` from package `limtest` (Hothorn et al. 2018) for convenient calculation of $t$-statistics and $p$-values.
4.6 Specification of Functional Form

It has been emphasized that economic theory does not specify an appropriate functional form for hedonic regression and that the choice of the functional form should be based on the nature of empirical data (Rosen 1974; Freeman 1979; Hallvorsen and Pollakowski 1981). In this study, the testing of different model specifications was restricted to linear and log-linear functions to allow for an unambiguous interpretation of the estimated parameters.

The assessment of functional form was achieved through assessment of normalcy through visual analysis of residual plots (Figure 4.6a) and quantile-quantile plots (Figure 4.6b), an approach that may be preferred to formal statistical testing (Ghasemi and Zahediasl 2012). As can be seen from Figure 4.4a, the residuals for the log-linear model show better conformance with the underlying assumption of normality than the linear model and do not appear to systematically vary with fitted values. Inspection of Figure 4.4b further supports that the log-linear model is more appropriate. These plots compare residuals from the fitted model against residuals from a theoretical normal distribution; perfect alignment along the line \( y = x \) would indicate complete normality of \( Y|X \). In practice this concordance is generally not perfect (Wang and Bushman 1998). Whereas the linear model shows some deviations from normality in the tails, the log-linear model shows almost no deviation from normality. Both the residual plots and the quantile-quantile plots were generated by base R diagnostics accessed via the base function `plot()` applied to base `lm()` output.
On the basis of these diagnostics, a log-linear form was adopted as being better suited to the underlying regression assumptions. Many other hedonic studies of wine have similarly employed a log-linear form (Oczkowski 1994; Nerlove 1995; Combris et al 1997; Schamel and Anderson 2003). The final regression model can be represented as follows.
\[ Ln(P) = \alpha + \beta_1 REG + \beta_2 VAR + \beta_3 NUM + \beta_4 AFF + \beta_5 AMP + \beta_6 CAP + \beta_7 INC + \beta_8 RAT + \varepsilon \]  

(6)

where \( P \) denotes the vector of restaurant price of wine,

\( REG \) denotes the region dummy variables (reference level - Ontario),

\( VAR \) denotes the varietal dummy variables (reference level - Other),

\( NUM \) denotes the vector for number of options,

\( AFF \) denotes the affiliation dummy variables (reference level - Independent),

\( AMP \) denotes the vector for restaurant average meal price,

\( CAP \) denotes the vector for restaurant capacity,

\( INC \) denotes the vector of restaurant neighbourhood median income,

\( RAT \) denotes the vector of restaurant rating,

\( \alpha \) denotes the intercept term,

\( \beta \) denotes the estimated coefficients (will be a vector for categorical dummy variables), and \( \varepsilon \) is the vector of the error term.

### 4.7 Questions and Hypotheses

The results of this study are expected to address the question of which regions, varietals, and vintages impact restaurant wine prices in Toronto. As mentioned in Section 1.2, little information is available regarding this question. According to previous literature on off-trade hedonic models (discussed in Subsection 2.3.1), ‘objective’ characteristics of region, varietal,
and vintage can have significant impacts on retail wine pricing, and therefore it is probable that a similar situation exists for restaurant pricing.

As previously mentioned in Subsection 1.1.1, Canada and Ontario are net importers of wine, particularly from the United States, Italy, France, and Australia. This trade imbalance could indicate that wines from these countries are valued more highly than wines from Ontario on average. However, as mentioned in Section 1.2, there has been sentiment expressed in the Canadian wine community that consumer tastes are starting to expand. Additionally, the import data does not mention percentages of varietals or percentages of white wine and red wine per country. Therefore the import information is not sufficient to inform expectations on how different regions and white varietals affect pricing.

With respect to white varietals, some general information is known about consumer preferences. In 2013, Chardonnay and Sauvignon Blanc were the most popular white varietals in Canada with Pinot Grigio on the rise (Agriculture and Agri-Food Canada 2013), which is consistent with the frequencies in the sample data. However, more precise data concerning which varietals are more valued by consumers or relating varietals to regional data is not readily available. It can be argued that certain New World regions such as California, USA and Australia are more appreciated in Canada for their red varietals than their white varietals, and that the region of Marlborough, New Zealand is more appreciated for its Sauvignon Blanc, which would explain why New Zealand has more frequency than Australia in the studied sample. Therefore, current information is inadequate to address questions of consumer preferences on region and white varietals in Toronto restaurants and the results of the study are expected to contribute to remedying this lack of information.
Previous studies discussed in Section 2.2 (Bruwer et al. 2017; Preszler and Schmit 2009) indicated that a greater amount of offerings affected purchasing behaviours and encouraged consumers to try more expensive wines than they normally would, particularly in by-the-glass scenarios. Therefore, the number of menu options was expected to have a positive impact on wine menu pricing.

With respect to affiliation or ownership structure, it was expected that hotels and restaurant groups would have a positive effect on restaurant wine pricing in comparison to independently owned restaurants, due to the culture of high quality reputation that is customary in their business strategies and also the ability of the hotel to capture the business of their clients. This hypothesis was supported by findings by Livat and Remaud (2016) as discussed in Section 2.2.

As discussed in Subsection 2.3.2, ratings of wine and factors that have strong reputational force on consumers positively impact wine pricing. Therefore, ratings of restaurants is expected to have a positive impact on wine pricing, which would also be consistent with findings by Lacey et al. (2009) discussed in Section 2.2. In accordance with findings by Livat and Remaud (2016) discussed in Section 2.2, it was hypothesized that average meal price would have a strong reputational force on consumers and significantly positively impact wine pricing. As also discussed in Section 2.2, Lockshin et al. (2011) found that smaller restaurants focused more on pricing than larger restaurants. This may indicate that consumers are willing to pay higher prices at smaller restaurants. Therefore it was hypothesized that capacity would have a negative effect on restaurant wine price.
As supported by Gergaud et al. (2007) discussed in Section 2.4, location can be an important factor in defining restaurant reputation. With respect to the indicator of neighbourhood median income, consumers might feel restaurants that are located in wealthier neighbourhoods are reputable. Thus, the value of the wine they serve would be increased in the eye of the consumer as being reputable, and as discussed in Chapter 2, there is precedence supporting that indicators of reputation affect purchasing decisions and wine pricing.

4.8 Summary

The scenario of for restaurant by-the-glass white wine pricing in Toronto was found to meet the assumptions required for appropriate use of the hedonic method. After consideration of prior literature, the following independent variables were identified: region of origin, varietal, vintage, affiliation, average meal price, capacity, type of cuisine, neighbourhood income, and rating. Data was collected on these variables for Toronto restaurants mostly using information from the AGCO and online sources. The results of the likelihood ratio test indicated the hedonic model that included all categorical variables except for vintage and cuisine better explained the data than alternative models tested. A Cronbach’s α test was utilized to determine internal consistency between online ratings from crowd-sourcing websites, data from Zomato was found to be most useful for this study.

After an analysis of descriptive statistics, the categorical variables were designated categorical levels and the method of ‘dummy coding’ was used, setting the reference level at the level with the greatest number of observations (second greatest in the case of region of origin).
On the basis of a visual analysis of residual plots (Figure 4.6a) and quantile-quantile plots (Figure 4.6b), a log-linear form was specified.

The results of this study are expected to address the lack of information regarding the issue of which regions, varietals, and vintages impact restaurant wine prices in Toronto. It was hypothesized that number of options would positively affect pricing. It was also hypothesized that affiliation with hotels and restaurant groups would have a positive effect on restaurant wine pricing in comparison to independently owned restaurants. Furthermore, restaurant ratings, average meal price, and neighbourhood median income were all hypothesized to have significant positive impact on pricing. Cluster-robust ordinary least squares regression was found to be an appropriate method of regression due to the clustered structure resulting from observations on multiple wines per restaurant.
CHAPTER 5: EMPIRICAL RESULTS

5.1 Hedonic Price Equation Regression Results

OLS estimates and corresponding statistics for the hedonic price equation (5) using cluster-robust standard errors are displayed in Table 5.2. The regression was based on a total of 396 observations and returned an R-squared value of 0.4233. Thirteen of the estimated coefficients are significant at the 5% level.

### Table 5.3. Regression Results on Price per Ounce of White By-the-Glass Wines

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|----------|
| Intercept      | 0.6287   | 0.1253     | 5.0166  | 0.0000   | ***    |
| Region         |          |            |         |          |        |
| Italy          | 0.0606   | 0.0546     | 1.1100  | 0.2677   |        |
| France         | 0.1744   | 0.0399     | 4.3718  | 0.0000   | ***    |
| California     | 0.0837   | 0.0539     | 1.5524  | 0.1214   |        |
| Spain          | 0.1694   | 0.0504     | 3.3600  | 0.0009   | ***    |
| Marlborough    | 0.1196   | 0.0487     | 2.4574  | 0.0144   | *      |
| Other          | 0.1098   | 0.0410     | 2.6790  | 0.0077   | **     |
| Varietal       |          |            |         |          |        |
| Chardonnay     | 0.1197   | 0.0347     | 3.4527  | 0.0006   | ***    |
| Sauvignon Blanc| 0.0355   | 0.0334     | 1.0630  | 0.2884   |        |
| Pinot Grigio   | -0.0736  | 0.0310     | -2.3724 | 0.0182   | *      |
| Riesling       | -0.0001  | 0.0398     | -0.0028 | 0.9978   |        |
| Number of Options | 0.0055  | 0.0030     | 1.8076  | 0.0715   | .      |
| Average Meal Price | -0.0001 | 0.0006     | -0.2027 | 0.8395   |        |
### 5.2 Interpretation of Results

#### 5.2.1 Interpretation of estimated coefficients

The functional specification of the model resulted in a log-linear OLS regression. Therefore, the estimated coefficients (the $\beta$s) of the continuous predictor variables can be interpreted as meaning that one unit increase in the predictor variable increases restaurant wine price (CAD per ounce) on average by $100 \times \beta$ percent, holding all else constant. For the categorical predictor variables coded as dummy variables, the movement of the dummy variable from 0 (no) to 1 (yes) can be interpreted as causing a $100 \times \beta$ percent change in wine price (CAD per ounce) on average, holding all else constant.
5.2.2 Interpretation of results of wine-level characteristics

The results of the pair-wise likelihood ratio tests indicate that the categorical variables of Region and Varietal have significant impact on Toronto restaurant by-the-glass white wine pricing. From the regression using Ontario as reference for dummy-coded categorical levels of region, significant estimates at the 5% level were found for the following regions (in descending order of estimated coefficients): France (17.4% premium over Ontario), Spain (16.9%), Marlborough (11.9%), and Other (11.0%). This implies that all categorized regions except for Italy and California (France, Spain, Marlborough, and Other) have positive effects on restaurant wine pricing as compared to Ontario wine. Italy and California have no significant difference in impact in comparison to Ontario wine. This supports that consumers place greater value on white wines served by-the-glass in Toronto restaurants from France, Spain, and Marlborough (and possibly certain other regions), above their preference for that for Ontario.

The results of the hedonic regression indicate differences in effect on wine pricing in the case of Chardonnay and Pinot Grigio when compared to the ‘Other’ category of varietals other than the top four most frequent varietal levels (Chardonnay, Sauvignon, Pinot Grigio and Riesling). In comparison to ‘Other’ varietals, the Chardonnay level has a positive effect on restaurant wine pricing (with a $\beta$ of 0.120), the Pinot Grigio level has a negative effect (with a $\beta$ of -0.073), and the Sauvignon Blanc and Riesling levels appear to have no significant differences in effect. Chardonnay, as mentioned before, is one of the most popular white varietals for consumption in Canada. In addition to being popular, Chardonnay may be able to generate higher value from consumers than many other varietals, as supported by the results. Pinot Grigio
is also a popular varietal for consumption in Canada, but the results indicate that consumers place lower value on the varietal of Pinot Grigio.

The fact that all Pinot Grigio wines are produced in Italy raises the possibility of multicollinearity between these two dummy variables, which would be expected to result in inaccurate coefficient estimates. Such inaccuracy would produce large standard errors; however, in this analysis, the standard errors on the estimated coefficients are similar to the errors on other terms (i.e. not unusually large), indicating that collinearity between these two dummy variables does not pose a challenge to the analysis.

5.2.3 Interpretation of results of restaurant-level characteristics

The estimate for the variable for number of options was found to be statistically insignificant at the 5% level. This contradicts the hypothesis that an increased variety of offerings increases the value to the consumer of trying a more expensive wine. This suggests that in Toronto restaurants, the number of wine options for by-the-glass white wines does not impact wine pricing.

The pairwise likelihood ratio tests indicated that all the categorical variables are significant explanatory variables except for Vintage and Cuisine. All categorical levels in the dummy-coded Affiliations variable displayed significant estimates at the 5% level using the Independent level as reference. The categorical levels in descending order of estimated coefficients are as follows: Hotel (34.2% price premium over independent restaurants), Group & Hotel (35.1%), Group (9.8%), and Chain or Franchise (-19.1%). This implies Group, Hotel, and Group & Hotel structures have a positive effect on restaurant wine pricing compared to the
Independent structure, and Chain or Franchise structures have negative effect compared to the Independent structure. This is consistent with the hypotheses that predicted that Hotel and Group structures have a positive effect on restaurant pricing, due to a reputational effect on the consumer valuation of the wine. The results suggest that establishments in the Chain or Franchise level have negative reputational effect on wine price.

In accordance with the hypotheses, the continuous variable of rating score appears to have a significant positive effect. This suggests that higher ratings are related to reputational elements that increase consumer utility in restaurant wine. Total capacity, also in accordance with the initial hypothesis, has a negative effect on wine pricing with an estimated coefficient of -0.0004. The results support the hedonic analysis interpretation that consumers obtain increased utility from wines at restaurants with lower capacities. This may be because such restaurants have more intimate settings that are desirable to consumers in the context of a fine wine dining experience.

Unexpectedly, the results indicated that continuous variable of Average Meal Price is not a significant explanatory variable. It was hypothesized that price of the food at restaurants represents a reputational element that creates a higher value of the restaurant wine for the consumer as supported by. However, the actual result, which is inconsistent with this hypothesis, may be explained by recent trends in restaurants. Many new kinds of casual restaurants have become increasingly popular (The Conversation 2016), such as trendy and deconstructed concept restaurants with what is sometimes termed a “hipster aesthetic” (The Economist 2018), that charge lower meal prices than classic ‘white linen’ fine dining restaurants. Many of these newer aesthetic restaurant focus on sophisticated elements of wine, and some even place more
importance on the wine than on the food (Henderson 2018). The emergence of sophisticated wine menus at such restaurants may mean that higher prices for wine can be charged at restaurants that have lower meal prices, and therefore restaurant meal prices do not have a consistent effect on restaurant wine prices.

Finally neighbourhood median income has a significant negative effect on restaurant wine price. The initial hypothesis intuitively related neighbourhoods with higher median incomes as having a nicer atmosphere and therefore a better reputational effect on the wine in restaurants in the neighbourhood. The results of the regression bring to light a possible flaw in this logic. In Toronto, many reputable dining and entertainment establishments occur in commercial or downtown locations where residential accommodations are not valued highly or people from lower income brackets reside, but commercial spaces are valued highly. Since the 2016 census data used in this analysis is based on household surveys and does not include commercial data, neighbourhoods with lower median incomes may very well relate to restaurants with high reputational elements that influence consumer valuation of wine. To identify this relationship more clearly, further research of Toronto geography and demography is necessary.

5.3 Summary

The results of the regression suggest that all regions except for Italy and California have a positive effect on pricing in comparison to Ontario. The varietal of Chardonnay is found to have a positive effect on pricing and Pinot Grigio a negative effect in comparison to the reference level encompassing other varietals.
The number of menu options are not found to have a significant positive effect on pricing, whereas online ratings appear to have significant positive effect. Capacity and medium income are found to have a significant negative effect. Group, Hotel, and Group & Hotel structures appear to have a significant positive effect on restaurant wine pricing compared to the Independent structure, and Chain or Franchise structures that appear to have negative effect. Unexpectedly, Average Meal Price demonstrated no significant impact on pricing.
CHAPTER 6: CONCLUSION

6.1 Conclusion and Implications

The results indicate that the hedonic price equation for Toronto restaurant by-the-glass wine pricing is determined by both wine-level characteristics and restaurant-level characteristics. The information from the results of the study is useful for restaurateurs, wine managers and agents, and wine producers aiming to affect domestic wine demand, and its usefulness may extend to decisions regarding wine in general as well as white wines served by the glass. The information is also likely applicable to other urban centres in Canada that may exhibit similar wine consumer behaviour.

Restaurant owners and managers who want to be able to promote higher value wine in their by-the-glass portfolio (or wine agents who want to promote wines to these restaurants) may want to focus more on Chardonnay and less on Pinot Grigio. Selections of Riesling and Sauvignon Blanc could be seen as interchangeable in terms of how they effect pricing. Restaurateurs do not necessarily need to increase the number of options available on the by-the-glass menu to encourage consumers to try higher priced wines. These considerations must be balanced with any additional costs of having a longer list. With regards to vintage, the aggregate analysis level in this study does not capture the value of vintage that may exist for expert consumers, and the findings did not provide evidence of discrimination between vintages in by-the-glass white wines.
When deciding on pricing strategies, restaurateurs should take note of the affiliation or ownership structure of restaurants they are comparing prices with. Independent restaurants appear likely to be able to charge more for wine than chains and franchises with similar wine products, but less than restaurant groups, hotels, and groups partnering with hotels. Also, restaurants with lower meal prices or smaller capacities or located in neighbourhoods with lower median residential income should not necessarily refrain from offering a selection of higher priced wines based on those factors alone. Nor should restaurateurs feel that the serving of Canadian or American cuisine, or that the type of cuisine in general, creates assumptions by the consumer in valuing wine. It may be that restaurants serving Latin-American or Spanish cuisine can increase wine pricing. Finally, restaurateurs may want to take into account website rating scores when deciding what price levels to charge for wines.

The results suggest that Ontario white wines in the domestic restaurant market are still not valued as highly by consumers as white wines from other regions such as France, Spain and Marlborough, New Zealand, although it is promising to note that the results indicate they are on par with white wines from California and Italy. Ontario white wine value might be increased further if wine producers adjusted their strategies to promote Ontario wines in accordance with the findings of this study. For example, it may be beneficial for Ontario white wine producers seeking to sell wine at higher prices to focus on increasing production or increasing the quality of their Chardonnay varietal wines. It may also be useful for producers to observe the cultural and stylistic elements of wine from certain regions like France, Spain and Marlborough and try to deduce what elements of these wines cause them to be valued more highly in Ontario and
attempt to incorporate these elements into the viticultural, vinicultural and marketing strategies of the winery.

The results also suggest that Ontario white wine producers do not have to focus on promoting their wines in restaurants with high meal prices or with large capacities or in high income neighbourhoods in order to find markets willing to pay higher prices for by-the-glass wines. Nor do they need to restrict themselves to focusing on any restaurants that serve specific kinds of cuisines. Also, producers interested in generating a higher price for their product should focus less on marketing to chains and franchised restaurants, and more on restaurants with higher online rating scores.

6.2 Limitations and Future Research

Several areas of future research would be useful in addressing limitations of this study. Data availability was limited to online data from crowd-sourced websites and restaurant websites. It was assumed that the online restaurant menu would reflect the menu that consumers would see inside the restaurant. In sampling restaurants, there was no way to ensure that a precisely random sampling of restaurants belonging to a distinct category of wine restaurants was achieved. However, only restaurants with a similar sophistication and nature of wine selection and displaying online menus that displayed region, varietal, and vintage of wine were chosen as a way to create a class of comparable samples. This sampling method employed a form of cluster sampling, and as a result cluster-robust methods were employed in the regression model. This method was considered better than alternative of employing anonymous surveys to restaurants which likely would have resulted in much more limited information and fewer observations.
With additional funding, future research could involve gathering more information on the sample frame of restaurants (perhaps using geographic analysis using an extension of GIS methods employed in this study) in order to more accurately sample wines and restaurants of a more defined class. Also, future research could involve physically collecting in person wine menu information and information on restaurant attributes from the restaurants, which could increase accuracy and may also result in more observations.

Another point for future study would be whether the class of product, white wines by-the-glass, can be narrowed further. Because the wine was a class of product and not the exact same product in every case, it is impossible to tell exactly what percentage or portion of the higher price would accrue to the restaurant if the wine were a more expensive wine for the restaurant to purchase. A future study with additional funding might obtain data on licensee price of wine, which may allow for calculation of the mark-up price. It might also be useful to explore whether LCBO monopolistic pricing is significant in relation to mark-ups.

However, it is important to note the above point does not change the validity of this study’s hedonic analysis since the hedonic model works on the basis of revealed preference of the consumer, and the attributes’ relationships to the price of the wine is still established in this model. It should be noted as well that all previously mentioned hedonic studies of off-trade retail market wine pricing did not use a specific wine, but a class of wine and none except for two (Nerlove 1995; Brentari 2011), took into account the effects of different stores or channels of retail from which the wine prices could have resulted from.
Finally, more information is needed with respect to several design features of the model. Further study of the market and a larger sample size may help with increasing accurate categorization of regions or varietal, or additional funding and cooperation with restaurants may allow for the product class to be narrowed to a particular combination (or several combinations) of region, varietal and vintage as mentioned above. There are complex relationships between these three variables and consumer perception of these variables. For example, in this study, Pinot Grigio and Pinot Gris were categorized as two different varietals because they are listed on the menus with different names, but scientifically, they are the same varietal, and it is uncertain whether the consumer would be aware of this at the time of purchase or whether they would be aware of differences in style between Italian Pinot Grigio and Pinot Gris from another country. Sufficient information to allow for a narrowing of product class or access or observation of consumer purchase settings would be required to develop a model that accounts for these factors. For the purpose of this study, insufficient resources were available.

Also, further study is required on the means and mechanisms by which several of the attributes or indicators chosen in this model relate to reputational effects, experiential effects or customer valuation of wine in restaurants in order to properly assess whether certain important variables have been omitted or certain variables included are inappropriate.
REFERENCES


**APPENDIX**

**Table A1. Summary of Notable Hedonic Studies of Off-Trade Wine over the last 25 years**

<table>
<thead>
<tr>
<th>Year</th>
<th>Authors</th>
<th>Sample</th>
<th>Model Specification</th>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Golan and Shalit,</td>
<td>Red and white wine grapes grown in Israel (7 types, 18-187 observations per type)</td>
<td>Non-linear (not specified)</td>
<td>Price</td>
<td>Hedonic Quality as perceived by consumers as dependent on characteristics of wine grapes: Brix, total acid, tartaric acid, malic acid, date of harvest, grape weight, pH</td>
<td>Importance of sugar content, total acidity, and harvest date. The last variable indicates the advantage of processing grapes with a high sugar content at an earlier date. Results showed that pricing system paid little premium for a better quality product</td>
</tr>
<tr>
<td>1994</td>
<td>Oczkowski</td>
<td>Australian table wines (not specified)</td>
<td>Linear and Log-Linear (OLS)</td>
<td>Price, recommended retail</td>
<td>Objective – Grape variety, region, vintage, producer size Subjective – overall quality rating, cellaring potential Additional – year of marketing</td>
<td>The six broad attribute groupings were found to be statistically important in explaining price deviations from average prices; interaction terms between these groups were also found to be important</td>
</tr>
<tr>
<td>1995</td>
<td>Nerlove</td>
<td>Imported wines in the Swedish market (239 wines)</td>
<td>Log-Linear (OLS)</td>
<td>Quantity</td>
<td>Price and quality attributes which characterise the variety</td>
<td>Argues that standard hedonic regression model is not appropriate; Regressed quantity sold on price and quality attributes on the assumption that prices and attributes are exogenous to the Swedish consumer</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Region</td>
<td>Method</td>
<td>Price</td>
<td>Jury Grade</td>
<td>Sensory – Characteristics</td>
</tr>
<tr>
<td>------</td>
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<td>------------------</td>
<td>--------------------</td>
<td>-------------</td>
<td>-------------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>1997</td>
<td>Combris et al.</td>
<td>Bordeaux wines</td>
<td>Log-Linear (OLS)</td>
<td>Price</td>
<td>Jury Grade</td>
<td>Aromatic intensity, finesse and complexity; firmness, acidity, suppleness, flatness, fat, concentration, harmony, tannins, finish, alcohol, staleness, reduction, development</td>
</tr>
<tr>
<td>2000</td>
<td>Combris et al.</td>
<td>Burgundy wines</td>
<td>Log-linear (OLS)</td>
<td>Price</td>
<td>Jury Grade (present and future)</td>
<td>Aromatic intensity, finesse and complexity; firmness, acidity, suppleness, flatness, fat, concentration, harmony, tannins, finish, alcohol, staleness, reduction, development</td>
</tr>
<tr>
<td>2000</td>
<td>Angulo et al.</td>
<td>Spanish red wines</td>
<td>Multinomial Logit (Maximum Likelihood)</td>
<td>Price, categorical</td>
<td>Region of production, vintage, grape variety, alcoholic content and expert quality ratings</td>
<td>Region of production and vintage are the main market price determinants while grape variety and the alcoholic contents are not significantly correlated with red wine prices; Expert valuation found in catalogue is positively correlated to price</td>
</tr>
<tr>
<td>2004</td>
<td>Cardebat and Figuet</td>
<td>Bordeaux wines</td>
<td>Log-Linear (OLS)</td>
<td>Price</td>
<td>Sensory (bouquet, taste, finish) and objective (variety, alcohol, vintage) characteristics</td>
<td>Overall jury score</td>
</tr>
<tr>
<td>Year</td>
<td>Authors et al.</td>
<td>Region of production</td>
<td>Model</td>
<td>Price</td>
<td>Quality Attributes</td>
<td>Analysis</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>----------------------</td>
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<td>-------</td>
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<td>----------</td>
</tr>
<tr>
<td>2007</td>
<td>Costanigro et al.</td>
<td>California and Washington red wines (13,024 wines)</td>
<td>Partially Linear (OLS)</td>
<td>Price, categorical</td>
<td>Ageing score, Classification, Appellation, Colour (red or white)</td>
<td>Empirical evidence that the wine market is differentiated into multiple segments or wine classes</td>
</tr>
<tr>
<td>2009</td>
<td>Cardebat and Figuet</td>
<td>Alsace, Beaujolais, and Provence wines (140 wines)</td>
<td>Log-Linear (OLS)</td>
<td>Price</td>
<td>Expert Quality Note, Sensory (Bouquet, Taste, Final Impression), Appellation, Vintage</td>
<td>Relationship between quality and price of the Alsace, Beaujolais and Provence wine areas is poor; Reputational factors existing in the appellation of the wines appeared to significantly explain prices whereas sensory factors assessed by a panel of experts did not (even less than for Bordeaux wines)</td>
</tr>
</tbody>
</table>
| 2009 | Benfratello et al. | Barolo and Barbaresco wines (227 wines) | Various (Maximum Likelihood) | Price | General quality – overall judgement, alcoholic gradation, quantity produced, Sensorial – harmony, finish, tannins, and aromatic complexity, intensity, and finesse | Reputation model significantly outperforms the taste one (model including objective and reputation variables had greater statistical significance than the hedonic model with objective and sensorial characteristics) suggesting that a greater amount of information on how the wine price is
<table>
<thead>
<tr>
<th>Year</th>
<th>Authors</th>
<th>Wine Type</th>
<th>Model</th>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Carew and Florkowski</td>
<td>Burgundy wines (not specified)</td>
<td>Log-Linear (OLS)</td>
<td>Price</td>
<td>Village or Appellation Vintage Alcohol Quantity Sold</td>
</tr>
<tr>
<td>2011</td>
<td>Brentari et al.</td>
<td>Italian red wines (434 wines)</td>
<td>Linear and Log-Linear (not specified)</td>
<td>Price</td>
<td>Label – appellation level, appellation, superior/riserva, region, declared alcoholic content Chemical – verified alcoholic content, residual sugar, volatile acidity, total acidity, sulphur anhydrides, sulphur ratio 3 indicators used to summarize 18 Sensory variables – 1 overall, 3 colour, 4 bouquet, 10 flavour Vintage Channel (supermarket, wine shop, or both)</td>
</tr>
</tbody>
</table>

Objective – type (Barbaresco or Barolo), cru, vintage Reputational – 3 bottle-specific and 3 producer specific

Results confirm collective reputation effects of Burgundy; implicit values differ between white and red wines with village designation and vintage having a relatively larger effect on white wine prices than in the case of red wines; Premier or Grand Cru designation command a premium for most wines, while their average prices were not necessarily the highest in the sample; BC consumers are discriminating among vintages and are willing to pay a premium for some, but not according to the rule “the older, the better”

Price mainly depends on the label characteristics of the wine sold; other indicators, even when statistically significant, are quite irrelevant; producer seems to have a limited market power especially in the large distribution where label characteristics explain about 90% of price formation
<table>
<thead>
<tr>
<th>Year</th>
<th>Authors</th>
<th>Region</th>
<th>Methodology</th>
<th>Price</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Kwong et al.</td>
<td>Ontario dry red wines (337 wines)</td>
<td>Semiparametric / partially linear (not specified)</td>
<td>Price</td>
<td>Ln of number of cases, Expert score, Special label attributes, Environmentally sustainable, Grape variety, Vintage, Vintage score</td>
</tr>
</tbody>
</table>

Evidence of price segmentation; Quality and environmental variables to be highly significant in explaining variations in wine prices
Table A2. Frequency of varietals in sample

<table>
<thead>
<tr>
<th>Varietal</th>
<th>Frequency</th>
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</thead>
<tbody>
<tr>
<td>Albarino</td>
<td>5</td>
</tr>
<tr>
<td>Assyrtiko</td>
<td>2</td>
</tr>
<tr>
<td>Bellone</td>
<td>1</td>
</tr>
<tr>
<td>Blend</td>
<td>37</td>
</tr>
<tr>
<td>Chardonnay</td>
<td>95</td>
</tr>
<tr>
<td>Chenin Blanc</td>
<td>10</td>
</tr>
<tr>
<td>Falanghina</td>
<td>5</td>
</tr>
<tr>
<td>Fiano di Avellino</td>
<td>1</td>
</tr>
<tr>
<td>Folle Blanche</td>
<td>1</td>
</tr>
<tr>
<td>Frico Bianco</td>
<td>1</td>
</tr>
<tr>
<td>Friulano</td>
<td>1</td>
</tr>
<tr>
<td>Furmint</td>
<td>1</td>
</tr>
<tr>
<td>Garganega</td>
<td>3</td>
</tr>
<tr>
<td>Gavi</td>
<td>6</td>
</tr>
<tr>
<td>Gewurztraminer</td>
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<td>Godello</td>
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<tr>
<td>Greco</td>
<td>1</td>
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<tr>
<td>Guner Veltliner</td>
<td>9</td>
</tr>
<tr>
<td>Loureiro</td>
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</tr>
<tr>
<td>Macabeo</td>
<td>2</td>
</tr>
<tr>
<td>Macabeu</td>
<td>1</td>
</tr>
<tr>
<td>Malvasia</td>
<td>1</td>
</tr>
<tr>
<td>Wine Type</td>
<td>Quantity</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Marsanne</td>
<td>2</td>
</tr>
<tr>
<td>Melon de Bourgogne</td>
<td>2</td>
</tr>
<tr>
<td>Moscatel</td>
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</tr>
<tr>
<td>Moschofilero</td>
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</tr>
<tr>
<td>Muscadet</td>
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</tr>
<tr>
<td>Nascetta</td>
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<tr>
<td>Nero d'Avola</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>Palomino</td>
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</tr>
<tr>
<td>Pecorino</td>
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</tr>
<tr>
<td>Pinot Nero</td>
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</tr>
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<td>Pinot Bianco</td>
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<td>Pinot Blanc</td>
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</tr>
<tr>
<td>Pinot Grigio</td>
<td>43</td>
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<td>Pinot Gris</td>
<td>6</td>
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<td>Pinot Nero</td>
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<tr>
<td>Riesling</td>
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<td>Sauvignon Blanc</td>
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<td>Savatiano</td>
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</tr>
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<td>Torrontes</td>
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</tr>
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<td>Trebbiano</td>
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</tr>
<tr>
<td>Velenosi</td>
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</tr>
<tr>
<td>Verdejo</td>
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<tr>
<td>Grape</td>
<td>Quantity</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Verdicchio</td>
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<td>Vermentino</td>
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<td>Vernaccia</td>
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<tr>
<td>Vidiano</td>
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<tr>
<td>Viognier</td>
<td>6</td>
</tr>
<tr>
<td>Welschriesling</td>
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</tr>
<tr>
<td>Xarel Lo</td>
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</tr>
<tr>
<td>Zinfandel</td>
<td>1</td>
</tr>
</tbody>
</table>
Table A3. Frequency of varieties in sample

<table>
<thead>
<tr>
<th>Region</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>5</td>
</tr>
<tr>
<td>Australia</td>
<td>2</td>
</tr>
<tr>
<td>Austria</td>
<td>10</td>
</tr>
<tr>
<td>British Columbia</td>
<td>4</td>
</tr>
<tr>
<td>California</td>
<td>33</td>
</tr>
<tr>
<td>Chile</td>
<td>4</td>
</tr>
<tr>
<td>France</td>
<td>81</td>
</tr>
<tr>
<td>Germany</td>
<td>4</td>
</tr>
<tr>
<td>Greece</td>
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<td>Hungary</td>
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<td>Italy</td>
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<tr>
<td>Marlborough</td>
<td>21</td>
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<td>Nelson</td>
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<td>Ontario</td>
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<td>Portugal</td>
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<td>South Africa</td>
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</tr>
<tr>
<td>Spain</td>
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<td>Washington</td>
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</table>