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Hedonic wine price functions with different prices*

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This study examines the impact that recommended retail prices, actual market prices and the release of a prominent wine guide have on Australian wine hedonic price estimates, for attributes such as sensory quality, winery reputation and grape region. In general, hedonic price estimates appear to be independent of prices employed. The main identified differences in estimates relate to the size of the producer and some regional impacts. For market prices only, increases in producer size are estimated to reduce prices. This implies the existence of supply chain quantity discounting price practices. The impact of an authoritative wine guide appears to have a negligible influence on prices in Australia. In the absence of market transaction prices, the common practice of employing recommended prices for hedonic wine price estimation is defendable.

Key words: hedonic estimation, retail prices, wine prices, wine quality.

1. Introduction

The estimation of the relationship between the price of a bottle of wine and its attributes continues to maintain considerable interest worldwide. Hedonic wine price functions typically relate a wine's price to characteristics such as its sensory quality rating, the reputation of the wine, producer reputation, and individual sensory and chemical attributes. If the sample design requires, other characteristics specified in price functions include the wine's vintage, grape variety and the region from which the grapes were sourced. Recent examples of hedonic wine price function estimation include the following: Roma *et al*. (2013), Menival and Charters (2014) and Levaggi and Brentari (2014). A summary of hedonic wine price models can be found in Estrella Orrego *et al*. (2012) and Oczkowski and Doucouliagos (2015).

An inadequately addressed issue is what impact do different prices for the same wine have on the estimation of marginal wine price estimates. In most previous studies, the recommended (suggested or listed) retail price (RRP) has been used for analysis (Estrella Orrego *et al*. 2012; Oczkowski and Doucouliagos 2015). Highly cited of studies which employ RRPs include Oczkowski (2001) and Schamel and Anderson (2003). In contrast, a minority

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of studies employ some form of market retail prices: for example, Jaeger and Storchmann (2011) use online retail prices, and Cuellar and Claps (2013) employ prices from scanner data.

Any cursory examination of prices in wine shops suggests wine prices often vary from their listed prices and in some cases to a large extent. A natural question arises, do these differences between market and listed prices influence the marginal impacts of wine characteristics on prices? Estimating accurate marginal attribute wine prices is important for a number of reasons including better informing production and marketing decisions of producers, and allowing consumers to identify potential bargains and over-priced wines (Oczkowski 1994; Roma *et al*. 2013).

An examination of the comparison of RRPs versus market prices is also important from a theoretical perspective. The Rosen (1974) hedonic framework implies that RRPs, being set by wineries, are more like producers' offer prices expressing the prices they wish to receive for their products. In contrast, market prices represent equilibrium outcomes. To this extent, market prices may better reflect both demand and supply conditions than RRPs (Estrella Orrego *et al*. 2012).

Another potential price difference issue relates to the time release of important information about a wine's quality. There exists some evidence suggesting that expert wine critics and their wine reviews may have an impact on wine prices and therefore the marginal price attribute estimates (Ali *et al*. 2008). No analysis of the impact of specific wine guides has been undertaken in the Australian context.

In summary, this research addresses the broad question, do different prices matter when estimating a hedonic wine price function? We will address the following specific research questions: are marginal wine price impacts different between RRPs suggested by wine producers and market-transacted prices; and does the release of a prominent wine guide and its wine ratings impact on marginal wine price estimates? In the next section of the paper, we outline some theoretical considerations and discuss previous empirical literature. Section three discusses the data employed for analysis, while section four presents and discusses the estimates of hedonic wine price functions for the different prices. Finally, section five provides a conclusion.

2. Theoretical considerations and previous literature

Most previous wine price studies cite Rosen (1974) hedonic model as their theoretical foundation. For any particular wine attribute or characteristic, the tangents between individual producers' offer and consumers' bid functions trace out a market equilibrium price function. The derivative of the price function represents the marginal price of that attribute. Thus theoretically, the preferred set of prices for hedonic price estimation is market-transacted prices. In this context, the estimation of a hedonic function using RRPs is more likely to reflect the marginal prices preferred by producers rather than

by consumers. This comment, however, implies that producers may have little regard to demand conditions when recommending prices. Most wine producers, however, are able to adjust prices based on previous demand conditions for their particular products.

2.1. Wine attributes and pricing

It may prove instructive to comment on some particular wine attributes and their relation to RRPs and market prices. One of the predominant wine attributes considered by studies is the wine's sensory quality (Oczkowski and Doucouliagos 2015). In a general commodity context, Caves and Greene (1996) argue the strength of the relation between the price of a product and its quality depends on the information available about its quality. In the full information case, the correlation between price and quality should be near unity; that is, higher quality goods should command a higher price. Reductions from a unit price–quality correlation may occur in cases where buyers lack complete quality information and find the costs of attaining additional information uneconomic. Since wine is an experience, good consumers cannot accurately assess its quality before purchase; this lack of information about quality weakens the relation between price and quality. However, over time as a wine is consumed, the information about the wine's quality improves and the price–quality relationship strengthens if market prices rather than RRPs are used in estimation.

Relatedly, it is suggested the publication of wine guides and their rating scores improve information on wine quality for consumers (Johnson and Bruwer 2004). As a consequence, there is an expectation the release of prominent wine guides may strengthen the price–quality relationship. The impact of wine guides will be better captured by market prices than by RRPs, as RRPs are typically determined before the release of expert review ratings (Landon and Smith 1998; Benfratello *et al*. 2009).

Arguments about incomplete information may also be important for other subjective attributes such as a wine's cellaring potential and quality rating for a wine producer. Again, for such attributes, the marginal impacts may be stronger for market prices than for RRPs. These arguments do not necessarily downplay the importance of fully informed 'objective' attributes such as the variety and region of the grapes employed in the wine's production, in explaining deviations between RRPs and market prices. Over time, there may be unexpected demand shifts and/or supply shocks for particular varieties and/or regions, which are not foreseen by wine producers when recommending prices but are subsequently captured by market prices.

2.2. Recommended retail pricing theoretical models

Some recent literature has been developed to examine theoretically the setting of RRPs and the relation between manufacturers and retailers (Puppe

and Rosenkranz 2011; Buehler and Gartner 2013). Puppe and Rosenkranz (2011) model emphasises the behavioural motive for setting RRPs and suggests that a monopolistic retailer may set its price to the manufacturer's recommended price to avoid a significant drop in the marginal propensity to consume if the market price is set above the RRP. Buehler and Gartner (2013) model emphasises the importance of setting RRPs as a communication device in vertical supply relations but also considers the case of 'moon pricing' where RRPs are set 'fictitiously' high to fool customers into buying more at market 'bargain' prices. Theoretically, it is demonstrated that if the charged market price is less than the posted RRP, then supply chain surplus is optimised.

Other theoretical models examine the role of quantity price discounting in the supply chain relationship between a manufacturer and retailer (*e.g.,* Chen *et al.* 2001; Wang and Wang 2005). These theoretical models suggest that if demand is responsive to price, then price discounts (from listed prices) from the supplier to the retailer for trading larger quantities may be financially attractive for the entire supply chain (Wang and Wang 2005) and may also improve supply chain efficiency by better coordinating the distribution system (Chen *et al.* 2001).

2.3. Previous empirical literature

There appears to be only limited empirical literature on how different price types (RRPs or market prices) impact on modelling outcomes. Caves and Greene (1996) examined the list and market prices of a range of consumer goods in the United States to explore the relation between price and quality. In general, the models explaining the rank correlations between quality scores and list or market prices produced similar results for various hypotheses. For example, conclusions about hypotheses relating to the impact of the number of brands and product innovations on the price–quality relation were identical for both list and market prices.

There appears to be no wine study that has made a direct comparison of hedonic estimates between RRPs and market prices for the same wines. Some studies, however, have used correlations between list and transaction prices to justify a preferred price set. For example, Delmas and Grant (2014) for a subsample of analysed wines identify a correlation of 0.91 between the logs of list and transaction prices, and this motivates the use of list prices only in a larger sample set.

Indirectly, the comparison of RRPs and market prices has been examined in the wine price–quality meta-analysis study of Oczkowski and Doucouliagos (2015). In explaining the observed heterogeneity of partial correlation estimates between wine price and quality across 180 models, the use of the RRPs in studies was found to result in a decrease of 0.207 in the partial correlation. The lower correlation suggests the strength of the price–quality relationship is weaker when RRPs are employed. The point estimate,

however, was found to be statistically insignificant when employing appropriate bootstrap standard errors. In part, its insignificance results from the small number of studies that do not employ RRPs. At best, these results suggest that a stronger price–quality relation may exist when employing market rather than retail prices and that specific studies examining this suggestion are warranted.

The empirical literature on estimating the impact of wine critics on prices uses various techniques, but none appear to directly compare hedonic estimates for the same wines before and after the release of wine reviews. For example, Ali *et al*. (2008) analyse the impact of Robert Parker's ratings on young Bordeaux reds by making use of an unusual time release of wine ratings for a particular vintage (ratings released after setting prices, when normally ratings are released before the setting of prices in Bordeaux).[1] This allowed for the identification, by comparing prices and qualities over time, of the Parker effect equating to 2.80 euros for *en primeur* prices. Hilger *et al*. (2011) conduct a retail field experiment to find a significant positive response to expert opinion labels. Friberg and Gronqvist (2012) show how significant demand increases for Swedish wines do occur after the release of favourable national newspaper reviews.

3. Data description

Our focus is on Australian premium table wines. Australia is becoming an increasingly important wine producer and currently is the fourth largest wine exporter in the world (OIV 2012). Even though many book publications, newspaper, magazine and online reviews are available for Australian wines, the most authoritative and highest-selling wine guide in Australia is James Halliday's *Australian Wine Companion*. This guide provides the basis of our data set and has been used previously in hedonic wine price estimation by Oczkowski (2001) and Schamel and Anderson (2003). Each year the *Australian Wine Companion* provides a review (for most wines), quality rating, cellaring potential and the RRPs for over 6000 wines. Subjective quality scores and reviews are embargoed from publication until the book's release in late July.

While the listed prices are easily accessible through the wine guide, the choice of information for identifying market prices is more complex. Approximately 6000 liquor retailer establishments exist in Australia, ranging from small local hotel bottle shops to large Australia-wine supermarkets (IBISWorld 2014). Estimates of market share differ, but some (Centaurus Partners 2013) suggest the largest two retailers Woolworths and Wesfarmers command over 75% of the wine market. Without detailed price and quantity data for individual wines for all retailers, to construct an appropriate weighed

[1] Typically wine guides and their wine ratings are released after recommended prices are set. This is not the case for the Parker ratings and Bordeaux reds.

average market price, our choice is limited to information from the major retailers.[2] We employ data from the retailer Dan Murphy who is part of the largest Woolworths group (50% market share). Dan Murphy has over 175 stores Australian-wide, claims to have the biggest range of wines and maintains a lowest-price guarantee. There is a theoretical expectation and some empirical evidence to suggest that price guarantees, in general, may reduce the price variability between major retailers through their signalling role (e.g., Manez 2006). Dan Murphy has a high profile online presence with anywhere up to 4000 Australian wines available for online purchase (www.danmurphys.com.au). Our price data come from the online website, labelled as the 'national price', which is also typically charged in stores.[3]

We collated market price data at two time points: 1) approximately 2 weeks before the release of the wine guide (*Preprice*); and 2) approximately 12 weeks after the release of the guide (*Postprice*). The data collection period relates to wines available during the second half of 2013, and given the relative stability of retail wine prices over time is expected to be representative of previous recent years.[4] The *Postprice* time collation date allows sufficient time for any potential impact of the wine guide to work its way through the market. There is some literature to suggest that the impact of wine reviews on sales occurs predominately during the first week after a positive review and for annual guides is potentially important for up to 12 weeks (Friberg and Gronqvist 2012). To facilitate appropriate analysis of the research questions, wines that are simultaneously listed in the wine guide and are available at both points in time need to be identified. For each individual wine, only the vintage reviewed in the guide and available in the market is employed. These requirements identify 786 Australian table wines. The relatively small sample size compared with the number of wines listed in the wine guide and online reflects the dominance of many relatively cheap wines available online, which are not assessed in the wine guide.

Summary statistics for the differences in the three sets of prices (measured in Australian dollars $A) are provided in Table 1. Significant differences exist in the comparisons between RRPs and market prices.[5] On average, market prices are $4.10 (or 13%) less than RRPs, with approximately 75% of market prices being cheaper than RRPs. It appears the practice of 'moon pricing' is

[2] The absence of comprehensive Australian data on wine sales for various outlets and locations prohibits an examination of the influence of retailer attributes on prices such as sales channels, see Brentari *et al*. (2011).

[3] We employ the per bottle price that excludes discounts for bulk purchases and special offers. The website (www.danmurphys.com.au/help/price-guarantee-content) claims that some slight variations may exist between the national and local store prices, but no variations were identified for our sample.

[4] For the previous 10 years (2004–2013), retail wine prices have risen by an average of 1.1% p.a., with a standard deviation of 1.2% (ABS 2013). This stability of retail prices also exists across states, with 10 years averages varying from 0.8% for Brisbane to 1.8% for Adelaide.

[5] The *Wine Companion* quotes RRPs as dollar integers, for comparisons with market prices; no price changes relate to absolute price differences of 0.01 or less.

Table 1 Summary price difference statistics

	Mean	Std Dev	Mean logs	Std Dev logs	Negative Change	No Change	Positive Change
Preprice *less* RRP	−4.18 (−13.7)	8.59	−0.131 (−23.7)	0.155	595 [75.7%]	90 [11.5%]	101 [12.8%]
Postprice *less* RRP	−4.10 (−13.9)	8.30	−0.129 (−24.2)	0.149	594 [75.6%]	88 [11.2%]	104 [13.2%]
Postprice *less* Preprice	0.086 (1.01)	2.39	0.002 (0.68)	0.068	55 [7.0%]	661 [84.1%]	70 [8.9%]

Paired *t*-statistics for mean differences are provided in parentheses.

common for wines sold in Australia. Interestingly, approximately 13% of wines have market prices that exceed those recommended by the winemakers. There is no statistical difference between the pre- and postwine guide release prices, with approximately 84% of wines not changing prices, and roughly an equal number of wines experiencing price rises (9%) and price falls (7%). The simple correlation between market prices (irrespective of whether pre- or postprices are used) and RRPs is 0.99, and when the logs of the data are used, the correlation is 0.97. While the correlation between pre- and postwine guide release prices is 0.998 and 0.994 when using logs. In general, these correlations are particularly high and may imply the use of different prices has little impact on marginal attribute price estimates.

4. Hedonic wine price estimates

The broad specification employed for hedonic price estimation is as follows:

$$\ln(\text{Price}) = \text{f}(\text{quality rating, winery reputation, cellaring potential, vintage, variety, region, producer size}). \quad (1)$$

This specification reflects most characteristics previously found to be important (Oczkowski 1994; Schamel and Anderson 2003; Estrella Orrego *et al.* 2012). The quality rating provides an overall subjective sensory evaluation score for the wine. Winery reputation attempts to measure the reputation a winery has gained over time for producing high-quality wines.[6] Cellaring potential and vintage capture the time value of the wine. Location

[6] Menival and Charters (2014) untap various aspects of winery reputation in examining prices for Champagne. They focus on measures of winery reputation such as geographic and the status of the negociants. In Champagne, it is argued the quality of individual non-vintage wines does not significantly vary over time and hence, measures of winery reputation adequately capture quality aspects. These arguments have less relevance to our analysis, which focuses on vintage wines and hence requires a measure of individual quality, in addition to a measure of winery reputation.

Table 2 Descriptive statistics

	Mean	Std Dev	Min	Max
Preprice (logs)	34.25 (3.29)	40.94 (0.62)	4.90 (1.59)	668.99 (6.51)
Postprice (logs)	34.34 (3.29)	41.41 (0.62)	4.90 (1.59)	668.99 (6.51)
Recommended Retail Price (logs)	38.44 (3.42)	47.23 (0.58)	7.00 (1.95)	785.00 (6.67)
Quality Rating	92.6	2.44	87	98
Cellaring Potential	2021.0	6.77	2012	2060
Winery Reputation	5.16	0.57	3	5.5
Vintage	2010.7	1.12	2003	2012
Producer Size	under 5	12.3%	50.1–100	13.7%
(1000 cases)	5.1–20	28.5%	100.1–500	10.6%
	20.1–50	20.7%	over 500	14.1%
Variety	20 varieties			
Region	26 regions			

and wine type characteristics are captured by the wine regional and varietal variables. While producer size captures both possible supply-side economy-of-scale and demand-side 'exclusiveness' effects.

Descriptive statistics for the data are provided in Table 2 with data definitions provided in the online appendix. The Z values of the skewness and kurtosis coefficients for all three prices are approximately 100 and 600, respectively. This indicates significant positive skewness and a very sharp peak. This is the typical distribution of prices listed in wine guides and motivates our choice of the log-linear form for estimation and explains the dominant log-linear form in hedonic wine studies (Estrella Orrego *et al.* 2012; Oczkowski and Doucouliagos 2015). Both the RESET specification test and goodness-of-fit measures point to the superiority of the log-linear over the linear form for our data. For the three estimated price models, the RESET $F_{3,729}$ test statistics average 11.1 for the log-linear form and over 840 for the linear model. The squared correlations between raw prices and predictions average 0.42 for the log-linear model and 0.32 for the linear form.

Interval variables for all regressors are used except for producer size (given the approximate range nature of available data) and the region and variety variables. For the nominal variables coded as dummy variables, we estimate coefficients without the need to omit a control, (see Oczkowski 1994, p100). That is, the estimated coefficients for producer size, region and variety dummy variables reflect deviations from the average of the dependent variable, evaluated at the means of the other nondummy variable regressors.

Hedonic wine price estimates for Equation (1) are provided in columns (1) to (3) of Tables 3 and 4 for the three alternative price measures. In general, the goodness of fit of these models, explaining about 60% of the price variation, is slightly higher than is encountered for other Australian hedonic price models (Oczkowski 2001; Schamel and Anderson 2003). For all three

Table 3 Hedonic wine price function parameter estimates

	RRP (1)	Preprice (2)	Postprice (3)	Preprice less RRP (4)	Postprice less RRP (5)	Postprice less Preprice (6)
Constant	115.6*** (2.61)	118.8*** (2.65)	120.1*** (2.71)	3.245 (0.26)	4.539 (0.38)	1.293 (0.24)
Wine Quality (0–100)	0.081*** (8.34)	0.084*** (8.35)	0.085*** (8.42)	0.003 (1.20)	0.005 (1.61)	0.001 (0.91)
Cellar (Drink to)	0.027*** (5.38)	0.029*** (5.76)	0.028*** (5.45)	0.002* (1.79)	0.001 (0.54)	−0.001** (−2.40)
Vintage	−0.087*** (−4.05)	−0.091*** (−4.18)	−0.090*** (−4.19)	−0.004 (−0.67)	−0.003 (−0.57)	0.001 (0.26)
Winery Rating (0–5.5)	0.097*** (3.29)	0.113*** (3.63)	0.115*** (3.70)	0.015 (1.36)	0.017 (1.54)	0.002 (0.40)
Size (1,000 Cases)						
0–5	0.061 (1.24)	0.154*** (3.04)	0.154*** (3.00)	0.093*** (7.23)	0.094*** (6.77)	0.0003 (0.06)
5.1–20	0.010 (0.45)	0.062*** (2.66)	0.056** (2.38)	0.051*** (7.35)	0.046*** (6.45)	−0.005 (−1.51)
20.1–50	−0.043 (−1.51)	−0.036 (−1.29)	−0.036 (−1.26)	0.007 (0.72)	0.008 (0.81)	0.0009 (0.25)
50.1–100	0.049 (1.23)	0.044 (1.06)	0.043 (1.04)	−0.005 (−0.41)	−0.006 (−0.48)	−0.0008 (−0.16)
100.1–500	−0.033 (−0.74)	−0.110** (−2.34)	−0.117** (−2.47)	−0.077*** (−4.65)	−0.084*** (−4.82)	−0.007 (−0.78)
Over 500	−0.033 (−0.72)	−0.165*** (−3.43)	−0.150*** (−3.23)	−0.133*** (−8.05)	−0.117*** (−7.98)	0.015 (1.28)
R^2	0.580	0.602	0.603			

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. $N = 786$. T-ratios are in parentheses and employ robust standard errors. T-ratios in columns (4)–(6) employ cluster robust standard errors based on wine identification.

Table 4 Hedonic wine price function variety and region parameter estimates

	RRP (1)	Preprice (2)	Postprice (3)	Preprice less RRP (4)	Postprice less RRP (5)	Postprice less Preprice (6)
Variety						
Cabernet/Merlot	−0.173** (−2.45)	−0.204*** (−2.60)	−0.201** (−2.57)			
Chardonnay	0.117*** (3.08)	0.127*** (3.09)	0.121*** (2.99)			
Grenache Blend	−0.106 (−0.93)	−0.045 (−0.41)	−0.050 (−0.47)	0.062* (1.85)	0.056* (1.70)	
Other Red Blends	−0.184* (−1.69)	−0.171* (−1.73)	−0.173* (−1.79)			
Other White Varietals	−0.013 (−0.20)	0.020 (0.29)	0.001 (0.02)	0.033* (1.94)		−0.018* (−1.78)
Pinot Gris	0.118* (1.73)	0.147** (2.25)	0.137** (2.09)			−0.010** (−2.10)
Pinot Noir	0.239*** (4.63)	0.228*** (4.07)	0.220*** (3.85)			
Riesling	−0.319*** (−5.74)	−0.320*** (−5.55)	−0.318*** (−5.57)			
Rose	−0.163*** (−2.58)	−0.130* (−1.71)	−0.136* (−1.77)			
Sauvignon Blanc	0.031 (0.58)	0.044 (0.79)	0.011 (0.20)			−0.033** (−2.42)
Semillon	−0.329*** (−3.81)	−0.285*** (−3.08)	−0.301*** (−3.31)			
Shiraz	−0.0004 (−0.01)	−0.009 (−0.25)	0.004 (0.10)			0.012** (2.47)
Shiraz/Cabernet	−0.201* (−1.78)	−0.238* (−1.94)	−0.231* (−1.87)			
Region						
Adelaide Hills	−0.122** (−2.43)	−0.066 (−1.15)	−0.063 (−1.20)	0.055*** (2.63)	0.059*** (3.32)	
Barossa Valley	0.108** (2.02)	0.136** (2.48)	0.141*** (2.61)	0.028* (1.88)	0.033** (2.27)	
Canberra	0.0002 (0.001)	0.060 (0.76)	0.062 (0.77)	0.060*** (2.66)	0.061*** (2.73)	
Clare Valley	0.076 (1.30)	0.073 (1.12)	0.096 (1.54)			0.023* (1.67)
Coonawarra	−0.012 (−0.20)	0.017 (0.28)	−0.004 (−0.07)			−0.022* (−1.94)
Eden Valley	0.034 (0.40)	0.015 (0.18)	−0.011 (−0.13)		−0.046** (−2.11)	−0.026** (−1.98)
Great Southern	−0.170** (−2.29)	−0.241*** (−2.65)	−0.212** (−2.55)	−0.071* (−1.84)		
Hunter Valley	0.004 (0.06)	−0.084 (−1.10)	−0.071 (−0.94)	−0.089*** (−2.77)	−0.076*** (−2.67)	
King Valley	0.180** (2.36)	0.225*** (3.03)	0.226*** (3.01)			
Langhorne Creek	0.091 (0.93)	0.150* (1.68)	0.145 (1.61)	0.058** (2.08)	0.054** (2.05)	
Margaret River	−0.010 (−0.25)	−0.019 (−0.46)	−0.030 (−0.74)			−0.012* (−1.66)
Mornington Peninsula	0.146** (2.42)	0.109* (1.70)	0.111* (1.71)	−0.036* (−1.76)	−0.035* (−1.76)	
Murray Darling	−0.295*** (−3.46)	−0.280*** (−2.58)	−0.302*** (−2.84)			
Other NSW	−0.026 (−0.26)	0.030 (0.28)	0.032 (0.30)	0.056** (2.44)	0.059** (2.37)	
Other Qld	0.481*** (3.80)	0.431*** (3.51)	0.434*** (3.57)			
Other WA	−0.098 (−0.59)	−0.178 (−0.88)	−0.161 (−0.80)	−0.080* (−1.85)		
Riverina	−0.473*** (−4.23)	−0.550*** (−5.87)	−0.615*** (−6.23)		−0.142** (−2.40)	−0.065** (−2.02)
Swan Valley	−0.096 (−0.99)	−0.253 (−1.44)	−0.140 (−1.05)	−0.157* (−1.75)		0.111** (2.37)

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. $N = 786$. T-ratios are in parentheses and employ robust standard errors. T-ratios in columns (4)–(6) employ cluster robust standard errors based on wine identification. Only statistically significant estimates are presented for parameter differences.

prices, wine quality, cellaring potential, vintage and winery ratings are statistically significant. As expected, a wine's higher quality, longer cellaring potential, older vintage and higher winery rating lead to a higher wine price. None of the producer size dummies are significant for RRP, but a number are significant for the pre- and post wine guide release market prices. For market prices, this implies the larger the producer size, the lower the wine price.

Table 4 identities the statistically significant variety and regional effects for the alternative prices.[7] In general, the estimated impacts are broadly consistent across the three prices, but some differences exist. For varieties, consistently significant premiums are identified for Pinot Noir, Chardonnay and Pinot Gris, and discounts for Riesling, Rose, Cabernet Merlot, Semillon and Shiraz/Cabernet. A number of regions consistently command a premium including Barossa Valley, King Valley, Mornington Peninsula and Other Queensland, while discounts are associated with Great Southern, Murray Darling and Riverina. It is important to recognise that these discounts and premiums arise even after controlling for the other factors including quality, winery reputation, cellaring potential and vintage. The number of identified additional regional effects is comparable to that identified in Schamel and Anderson (2003) who use similar-sized samples.

Columns (4) to (6) in Tables 3 and 4 provide estimates and tests for the differences between the parameters for the different prices models. The tests for parameter differences employ the dummy-variable version of the Chow test (Gujarati 1970). Effectively, the three price models are pooled into a single model that includes the following: the explanatory variables from Equation (1); dummy variables that define the price groups: and interactions between these dummy variables and explanatory variables. Given that the three prices relate to the same wines, then the observations in the pooled model are dependent and so the use of robust standard errors clustered by wine identification is required for accurate testing. The average interclass correlation (Cameron and Miller 2010) between the three prices is 0.987, and ignoring this correlation results in substantially higher standard errors if the standard robust estimator is employed.[8] The same estimates and test statistics for differences between parameters can be derived from three models, which use the differences between prices as dependent variables and robust standard errors. This latter method may be empirically simpler to implement as it does not require the cluster robust estimator and dummy variables for different prices.

The comparison of estimates suggests for wine quality, cellaring potential, vintage and winery rating, the estimated marginal impacts are statistically equivalent across prices. Columns (4) and (5) indicate that only the cellaring

[7] Table 4 suppresses the insignificant estimates for the region and variety variables; these are available on request from the author.

[8] The finding of lower standard errors for the cluster estimator compared with the robust estimator contrasts to the normal expectation that cluster standard errors produce higher standard errors, see Cameron and Miller (2010).

potential variable has a statistically significant impact at a 10% level for the difference between prewine guide release prices and RRPs. In practical economic terms, the point estimate differences are unimportant; for example, for a wine's quality, the marginal impact of a one-point increase in the quality rating implies an approximate 8.1% increase in price for RRPs and a 8.5% increase in price for postwine guide release prices. Even though this increase is consistent with our theoretical expectations, at sample average RRPs, this difference results only in a 15 cents increase in prices per quality point. Possibly the most notable change in marginal impacts relates to the winery rating, where a one-point increase in the winery rating leads to an additional 1.8% increase for post prices over RRPs, which at average prices translates to an approximate 70 cents increase in prices per winery rating point.

In contrast, the producer size variable does identify some statistically significant marginal impact differences between prices. Columns (4) and (5) in Table 3 clearly indicate that in reference to 'average prices', for small producers marginal impacts are higher for market prices than for RRPs, while for large producers, marginal impacts are lower for market prices than for RRPs. For example, for the smallest producer size (less than 5,000 cases), the marginal impact is approximately 15% points when using market prices, while it is about 6% points when using RRPs (a 9% difference, see columns (4) and (5)). This suggests for market prices, the 'exclusiveness' of buying wines from small producers commands a premium above average prices.

The results for large producers are consistent with the theoretical models, which suggest that quantity price discounting may occur along a supply chain. Price discounting with large volumes improves supply chain surpluses and better coordinates the distribution channel. For wine products, the nature of price discounting possibly relates to the product lines of large producers. Even though very high-quality wines are produced in small quantities, the trade of large volumes for lower quality wines dictates the nature of the relation between the retailer and producer. Because of the total volume of wine traded between a producer and retailer, price discounts translate across a range of quality wines. The theoretical quantity discounting models suggest that market prices are lower than RRPs when larger quantities are traded along the supply chain. Clearly, large trades and therefore quantity price discounting are only possible for large producers. Our statistically significant negative marginal estimates for producer size suggest that such quantity discounting practices may be occurring with large wineries that produce over 100,000 cases.

As expected, given that over 80% of market prices did not change after the release of the wine guide, very little difference exists between the pre- and postprice estimates for the continuously measured variables, see Table 3 and column (6). Only a statistically significant difference for cellaring potential is identified. In practical terms, the difference appears to be unimportant, implying that even an additional 10 years cellaring potential results only in a 1% point fall in postprice compared with the preprice.

A few differences between estimates emerge for the variety and region variables. Columns (4)–(5) in Table 4 indicate only the estimates for Grenache Blends and other white varietals differ between RRPs and market prices. For region, many differences emerge between RRPs and market prices. The impacts are statistically significant and increase prices by more than 5% points as we move from RRPs to market prices for Adelaide Hills, Canberra, Langhorne Creek and Other NSW. In these cases, winemakers appear to underestimate their relative regional importance compared with consumers. In contrast, some significant falls in regional marginal impacts between market prices and RRPs are estimated for Hunter Valley, Riverina and Swan Valley. Here, winemakers appear to overestimate their regional importance compared with consumers.

Finally, there appear to be some minor impacts resulting from the release of the wine guide on variety and region market price estimates, see Table 4, column (6). The most noticeable variety impact occurs for sauvignon blanc with a 3.3% point fall in its market premium after wine guide release. For regions, the most important changes occur for Swan Valley and Riverina. The discount reduces by 11% points, from 25.3% to 14.0%, for the Swan Valley, while the market discount increases by 6.5% for the Riverina (from 55% to 61.5%) after the release of the wine guide.

5. Conclusion

This study has examined the relation between market and recommended retail prices and the impact that these different prices for the same wine may have on marginal hedonic prices. Even though we have identified that on average market prices are approximately 13% lower than RRPs, the key marginal hedonic prices are largely independent of whether market prices or RRPs are used for analysis. This implies that depending upon data availability, either RRPs or market prices can be used to accurately estimate marginal prices for wine quality, cellaring potential, vintage, winery rating and variety. To some extent, this general finding establishes market accuracy for the majority of previously published hedonic wine price estimates, as they have employed RRPs.

Our analysis, however, did identify some important differences between prices for the impact of producer size and some regional variables. The differences in regional marginal prices possibly point to inaccurate expected regional impacts held by wine producers for some regions. The major impact of different prices on hedonic estimates occurs with the producer size variable. Producer size is found to have no statistically significant impact when using RRPs, but increases in producer size do significantly reduce prices when employing market prices. Identifying lower marginal price estimates for large producers for market prices appears to be consistent with the predictions of theoretical models of quantity discounting. It is important to note the possibility of quantity discounting is not (and cannot be) identified by models

that only employ RRPs. This finding implies that researchers who use market prices for analysis may need to account for producer size effects in hedonic functions, while the consideration of producer size effects may be less pressing for models that employ RRPs.

The only noticeable impact of the release of wine quality information through the *Australian Wine Companion* occurs for a small number variety and region variables. In contrast to previous studies, which have identified important price impacts resulting from the reviews of wine critics, our research design does have some limitations in assessing this impact. Even though we have employed the best-selling guide and used prices from a leading retailer, only a sample of wines from both the wine guide and those available in the market place have been assessed. Further, a significant amount of 'other noise' clearly exists in the market place, with other wine guides and reviews in newspapers and magazines published. To this extent, it may be difficult to disentangle the individual effect of any one piece of information on prices by comparing prices at various points in time. Potentially, direct consumer surveys may better assess the impact of the *Australian Wine Companion* on prices (Mueller *et al*. 2009; Hilger *et al*. 2011).[9]

In conclusion, it appears the common practice of employing recommended, listed or suggested prices for hedonic wine price estimation is defendable. Clearly more studies that explicitly consider different prices for the same wines are needed to further establish the generalisability of this finding for other countries. The importance of producer size for market prices only possibly reflects the ability of large producers to better forge relationships with retailers to offer significantly lower prices than those recommended by producers. Given the market dominance of some Australian wine retailers, it would also be interesting to examine whether this result generalises to other countries with different levels of retail market concentration.

References

Ali, H.H., Lecocq, S. and Visser, M. (2008). The impact of gurus: Parker grades and en primeur wine prices, *The Economic Journal* 118, F158–F173.

Australian Bureau of Statistics (ABS). (2013) *Consumer Price Index*, Cat no. 6401.0, ABS, Canberra.

Australian and New Zealand Wine Industry Directory (ANZWID). (2013). Winetitles, Adelaide.

Benfratello, L., Piacenza, M. and Sacchetto, S. (2009). Taste or reputation: what drives market prices in the wine industry? Estimation of a hedonic model for Italian premium wines, *Applied Economics* 41, 2197–2209.

Brentari, E., Levaggi, R. and Zuccolotto, P. (2011). Pricing strategies for Italian red wine, *Food Quality and Preference* 22 (8), 725–732.

[9] Our finding of an negligible impact of the *Australian Wine Companion* on prices is, however, consistent with some commentary. Mueller *et al*. (2009) suggest that unlike Robert Parker in the United States, no single critic has an important influence on wine prices in the Australian market given the availability of numerous wine reviews.

Buehler, S. and Gartner, D.L. (2013). Making sense of nonbinding retail-price recommendations, *American Economic Review* 103 (1), 335–359.
Cameron, A.C. and Miller, D.L. (2010). Robust inference with clustered data, in Ullah, A. and Giles, D. (eds), *Handbook of Empirical Economics and Finance*. Chapman and Hall, Boca Raton FL, pp. 1–25.
Caves, R.E. and Greene, D.P. (1996). Brands' quality levels, prices, and advertising outlays: empirical evidence on signals and information costs, *International Journal of Industrial Organization* 14, 29–52.
Chen, F., Federgruen, A. and Zheng, Y.S. (2001). Coordination mechanisms for a distribution system with one supplier and multiple retailers, *Management Science* 5, 693–708.
Cuellar, S.S. and Claps, M. (2013). Differential effects of brand, ratings and region on willingness to pay: a hedonic price approach, *Journal of Wine Research* 24 (2), 138–155.
Delmas, M.A. and Grant, L.E. (2014). Eco-labeling strategies and price-premium: the wine industry puzzle, *Business and Society* 53 (1), 6–44.
Estrella Orrego, M.J., De Francesco, E. and Gennari, A. (2012). The wine hedonic price models in the 'old and new world': state of the art, *Revista de la Facultad de Ciencias Agrarias* 44 (1), 205–220.
Friberg, R. and Gronqvist, E. (2012). Do expert reviews affect demand for wine?, *American Economic Journal – Applied Economics* 4 (1), 193–211.
Gujarati, D. (1970). Use of dummy variables in testing for equality of coefficients in linear regression: a generalization, *The American Statistician* 24 (5), 18–22.
Halliday, J. (2013). *Australian Wine Companion*, 2014 edn. Hardie Grant Books, Richmond.
Hilger, J., Rafert, G. and Villas-Boas, S. (2011). Expert opinion and the demand for experience goods: an experimental approach in the retail wine market, *Review of Economics and Statistics* 93, 1289–1296.
IBISWorld. (2014). *Industry Report G4123: Liquor Retailing in Australia*, July edn. IBISWorld Pty Ltd., Sydney.
International Organisation of Vine and Wine (OIV). (2012). *Statistical Report on World Vitiviniculture 2012*. OIV, Paris.
Jaeger, D.A. and Storchmann, K. (2011). Wine retail price dispersion in the United States: searching for expensive wines, *American Economic Review: Papers and Proceedings* 101 (3), 136–141.
Johnson, T. and Bruwer, J. (2004). Generic consumer risk-reduction strategies (RRS) in wine-related lifestyle segments of the Australian wine market, *International Journal of Wine Marketing* 16 (1), 5–35.
Landon, S. and Smith, C.E. (1998). Quality expectations, reputation, and price, *Southern Economic Journal* 64 (3), 628–647.
Levaggi, R. and Brentari, E. (2014). The hedonic price for Italian red wine: do chemical and sensory characters tics matter?, *Agribusiness* 30 (4), 385–397.
Manez, J.A. (2006). Unbeatable value low-price guarantee: collusive mechanism or advertising strategy, *Journal of Economics and Management Strategy* 15 (1), 143–166.
Menival, D. and Charters, S. (2014). The impact of geographic reputation on the value created in Champagne, *Australian Journal of Agricultural and Resource Economics* 58, 171–184.
Mueller, S., Lockshin, L., Louviere, J., Francis, L. and Osidacz, P. (2009). How does shelf information influence consumers' wine choice?, *Australian and New Zealand Wine Industry Journal* 24 (3), 50–56.
Oczkowski, E. (1994). A hedonic wine price function for Australian premium table wine, *Australian Journal of Agricultural Economics* 38 (1), 93–110.
Oczkowski, E. (2001). Hedonic wine price functions and measurement error, *Economic Record* 77 (239), 374–382.
Oczkowski, E. and Doucouliagos, H. (2015). Wine prices and quality ratings: a meta-regression analysis, *American Journal of Agricultural Economics* 97 (1), 103–121.

Partners, Centaurus (2013). *Wine Industry Report: Expert Report on the Profitability and Dynamic of the Australian Wine Industry*. Prepared for Winemakers Federation of Australia, Sydney.

Puppe, C. and Rosenkranz, S. (2011). Why suggest non-binding prices?, *Economica* 78 (310), 317–325.

Roma, P., Di Martino, G. and Perrone, G. (2013). What to show on the wine labels: a hedonic analysis of price drivers of Sicilian wines, *Applied Economics* 45 (19), 2765–2778.

Rosen, S. (1974). Hedonic prices and implicit markets: product differentiation in pure competition, *Journal of Political Economy* 82, 34–55.

Schamel, G. and Anderson, K. (2003). Wine quality and varietal, regional and winery reputations: hedonic prices for Australia and New Zealand, *Economic Record* 79 (246), 357–369.

Wang, Q. and Wang, R. (2005). Quantity discount pricing policies for heterogeneous retailers with price sensitive demand, *Naval Research Logistics* 52, 645–658.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

AJARE.do STATA estimation commands

AJARE_Stacked.do STATA commands for testing differences between prices.

Data.dta STATA data file for AJARE.do

Data_Stacked.dta STATA data file for AJARE_Stacked.do

Appendix.