

Price Volatility, Competitiveness, and Innovation in the South African Wine Industry

By

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Dedication

I dedicate this thesis to my lovely children, beautiful souls- Machelyn Muchende and Clive Muchende, who inspired me to lead the way and demonstrate that indeed,

"life is what you make it."

Abstract

The South African wine industry is the eighth largest producer of wine in the world. Despite its progress since the 1990s, the industry has come under increased competition from other wine producers. The wine industry grew rapidly from 1994 until 2005 when it started to face major challenges that led to only a quarter of wine farmers producing at financially sustainable levels, reductions in the number of grape farmers and the area of vineyard under cultivation, and job cuts, low pay, and low prices. The most immediate constraints to the competitiveness of the wine industry are global competition, inadequate innovation, and volatile input costs of production. Therefore, this thesis contributes to the debate on these issues by (i) examining South Africa's wine competitiveness against other Southern Hemisphere New World (SHNW) producers; and (ii) investigating wine consumers' perceptions of and willingness to pay for product innovation by the South African wine industry; and (iii) investigating the impact of energy price volatility on South African wine prices. The main research questions/contributions are addressed in Chapters 3, 4, 5 and 6 as follows:

Chapter 3 investigates the competitiveness of South African wines against rivals in the SHNW, and the determinants of their performance in the global wine market. The aim is to identify priority areas to focus on to enhance South Africa's competitiveness and sustain the industry. Global competition, especially among the SHNW producers, has been cited as one of the causes of the poor performance by the South African wine industry (Esterhuizen and Van Rooyen, 2006; Van Rooyen et al., 2011; Van Rooyen and Boonzaaier, 2018). The export market is critical for South African wines considering that half of its annual production is sold abroad (SAWIS, 2020). Also that exports attract higher earnings for the industry. Therefore, comparing the degree of South African wine competitiveness with other SHNW producers and investigating factors influencing specialisation will help identify priority areas to focus on to enhance South Africa's competitiveness and sustain the industry. The 1990 to 2018 panel data from Global Wine Markets is used for the analysis. Trade specialisation and their determinants are determined through (i) the computation of the Revealed Comparative Advantage, (ii) estimation of the Galtonian regression model and (iii) estimation of the panel regression model. The findings reveal that all countries migrated to higher price points with variable degrees of success. As a result, South African wines were relatively less competitive than their rivals. The study reveals the relative position of the South African wine industry and draws inferences on priority areas for enhancing competitiveness.

Chapter 4 investigates wine consumers' perceptions of and willingness to pay for product innovation by the South African wine industry. The aim is to elicit information on whether consumers are ready to pay for wines made with natural preservatives (*Rooibos & Honeybush*), organic production, and a higher quality score. Determining whether consumers choose such wines is crucial as it would reveal whether wine players can exploit this source of avenue to save the struggling industry. It contributes to knowledge by being the first study to estimate the premium price for not having added SO₂ in wine by substituting the conventional wine preservative with Rooibos and honeybush — a natural preservatives. The Discrete Choice Experiment (DCE) approach elicited willingness to pay for the innovative alternative. Consumers' preferences for organic wine, wine quality, and cost were also examined. Results from the mixed logit model indicate that consumers are willing to pay additionally *R60.40* per bottle of wine with natural preservatives, while they are ready to pay *R19.45* more for organic wine and *R1.55* for each point on quality score.

Chapter 5 investigates the robustness of the empirical estimates obtained in chapter 4. Identified as a potential methodological issue in the DCE literature, the chapter contributes to knowledge by examining the influence of 'price framing' on empirical estimates in environmental valuations. The tests are performed using data from a choice experiment on preferences for natural preservatives in wine. The same respondents completed a nearly identical DCE survey, one with a *real price* and another with a *percentage price change*. 611 respondents completed the survey, and a panel mixed logit model was used for the analysis. Results demonstrate that 'price framing' significantly influenced respondents Willingness To Pay for wine attributes. The study sheds light on the establishment of guidelines for developing valid cost attributes in DCE.

Chapter 6 investigates whether energy price volatility influences South African wine prices. The aim is to establish the extent to which energy price volatility affects wine prices. The implication of the findings is that a formula of dependence and risk between energy and wine markets could be established and used to protect the wine industry from spillovers and foster wine market stability. The study contributes to knowledge by thoroughly examining the volatility behaviours of energy (fuel and electricity) and wine prices. Using a Multivariate Generalized Autoregressive Conditional Heteroscedasticity (MGARCH) model, the chapter estimates own- and cross-volatility

spillovers and persistence between the South African energy and wine markets using monthly Consumer Price Index data from 2002 to 2018. Results from the analysis indicate positive and significant volatility effects, with a substantial spillover from the energy market to the wine market. The results also indicate that only fuel and wine prices move together in the long run.

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List of Acronyms

AAWE	American Association of Wine Economists
ABARE	Australian Bureau of Agricultural and Resource Economics
ADF	Augmented Dickey Fuller
CPI	Consumer Price Index
CVC	Cape Vintner Classification
DAFF	Department of Agriculture
DCE	Discrete Choice Experiment
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
FAO	Food for Agriculture Organisation
FDI	Foreign Direct Investment
FGLS	Feasible Generalized Least Squares
GARCH	Generalised Autoregressive Correlation Heteroscedasticity
GDP	Gross Domestic Product
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGWS	Institute for Grape and Wine Sciences
IICA	Inter-American Institute for Cooperation on Agriculture
IMF	International Monetary Fund
IPW	Integrated Production of Wine
KWV	Koöperatieve Wijnbouwers Vereniging
MGARCH	Multivariate General Autoregressive Conditional Heteroscedasticity
MXL	Mixed Logit
NBNZ	National Bank of New Zealand
NERSA	National Energy Regulator of South Africa
NZTE	New Zealand Trade and Enterprise
OECD	Organisation for Economic Cooperation and Development
OIV	International Organisation of Vine and Wine
OLS	Ordinary Least Square
PCSE	Panel-Corrected Standard Errors
PWC	Price Water House Coopers
RCA	Revealed Comparative Advantage

RGDP	Real Gross Domestic Product
RSCA	Revealed Symmetric Comparative Advantage
RTA	Relative Trade Advantage
SA	South Africa
SWSA	Sustainable Wine South Africa
SALBA	South Africa Liquor Brand Owners Association
SASEV	South Africa Society for Ecology and Viticulture
SAWB	South Africa Wine and Brandy Company
SAWIT	South African Wine Industry Trust
SAWIC	South Africa Wine Industry Council
SAWIS	South Africa Wine Industry Information and Systems
SHNW	Southern Hemisphere New world
UNCTAD	United Nations Conference on Trade and Development
WISE	Wine Industry Strategic Exercise
WineTech	Wine Industry Network for Expertise and Technology
WOSA	Wines of South Africa
WTO	World Trade Organisation
WTP	Willingness To Pay
ZAR	South Africa Rand

1 Introduction

1.1 The importance of wine to the South African Economy

The South African (SA) wine industry has different stakeholders: producers (grape growers), producer cellars (co-op winemakers), private cellars (independent winemakers), wholesalers, and retailers. SA wines are progressively competitive internationally, with a good and positive pattern since 1994. The industry contributes R54.96 billion annually to the South African economy. This represents 1.2% of GDP in 2019, and the industry creates approximately 300,000 jobs for the country. For the Western Cape Province, the wine industry's contribution to GDP was determined to be R19.2 billion in 2019, equating to a contribution of 4.6% to provincial GDP (WOSA, 2020). In addition, the wine business contributes around R7.17 billion in taxes to the South African government per annum, and farmers' incomes are worth R6.16 billion every year (WOSA, 2020). More importantly, the wine industry is connected to the rest of the economy in various ways, directly through producers' purchases of goods such as fertilizer, pesticides, and herbicides, and indirectly through financial searches, insurance, research and development, and advisory services. Wine, South Africa's second-largest agricultural export product, generates close to R7,500 million in foreign revenue yearly, with around half of total output exported and the other half sold locally. Wine tourism additionally contributes a significant amount of forex to the South African economy through wine tasting and purchases by tourists (Vink, 2019).

1.2 Research Problem

Despite its success, the South African wine industry is under threat. After initial rapid growth, the industry has faced major challenges since 2005. These include volatile input production costs; the unreliable supply of, and high costs for, energy; climate change and associated drought; fragmented wine players; labour costs; poor wine quality and low prices; poor technological adaption; lack of innovation and development; and global competition.

The negative trends started around 2005 after a positive trend in the competition that began post-apartheid in 1994. During 2006-2016, only a quarter of wine farmers were producing at financially sustainable levels. Many farmers shut down, leading to a reduction in the number of grape farmers from 4,185 in 2006 to 3,145 in 2016 (VinPro, 2018). This number dropped further to 2,778 in 2019. During the same period, 2006-2016, the total area cultivated as vineyards reduced from 102,146 ha to 95,775 ha. This number reduced further to 92,067 ha in 2019. Growing grapes was no longer sustainable, and farmers diversified to grow fruits and other economically viable crops.

The reduction in wine production led to job losses, low pay, and the casualization of farmworkers. To reduce costs, some wine players shifted to lower-risk and less productive technologies. As a result, investment in the sector was meagre, with foreign direct investment (FDI) concentrated in wine countries with viable returns, i.e., China, Hong Kong, United States, France, Germany, Russia, Australia, Bulgaria, and Mexico. Globally, South African wines are among the cheapest on the international market (OIV, 2016). Industrial experts have expressed concern about the poor wine quality and low value and have suggested a strategic shift from selling cheap bulk wines to selling packaged bottles that attract premium prices (between €5- €7 (R80 — R105) per bottle).

While most of the challenges facing wine producers have been well documented and discussed within the industry, global competition, innovation, and volatile input production costs stand out as three things necessary to enhance competitiveness and, subsequently, the sustainability of the wine industry. These three challenges will be elaborated on in Chapter 2. With the goal of enhancing the industry's competitiveness, the study focuses on four areas. First, it investigates the degree of SA's competitiveness against rivals in the Southern Hemisphere New World. Competition can be mitigated through (i) innovation that potentially improves wine quality and attracts higher profits and (ii) reducing production input costs. Second, the study then demonstrates how innovation and costs could be covered in the industry. Third, it tests the robustness of empirical estimates obtained. Finally, using one input cost, i.e. energy, the study demonstrates how such costs negatively affects productivity in the wine industry.

1.3 Research Questions and Objectives

The following research questions are addressed:

1. *What is the degree of South Africa's competitiveness against rivals in the Southern Hemisphere New World (Australia, Chile, Argentina and New Zealand) and what factors determine specialization in these economies?*
2. *Are wine consumers (local & international) willing to pay a premium for natural preservatives in wine?*
3. *Does 'price framing' influence empirical estimates in Discrete Choice Experiments?*
4. *To what extent does energy price volatility influence wine prices?*

The broad research aims to understand the degree of South Africa's competitiveness against rivals in the New World, identify innovative strategies that will help alleviate the challenges, and provide new insights on the linkages between energy and wine prices in South Africa. Specifically, the objectives for chapters 3, 4, 5 and 6 are as follows:

Chapter 3 investigates the degree of South African competitiveness against rivals in SHNW and determines the factors influencing specialization. The aim is to identify priority areas to focus on to enhance South Africa's competitiveness and, subsequently, the sustainability of the wine industry. The 1990 to 2018 panel data from Global Wine Markets is used for the analysis. Trade specialization and its determinants are determined through (i) the computation of the Revealed Comparative Advantage, (ii) estimation of the Galtonian regression model and (iii) estimation of the panel regression model.

Chapter 4 investigates wine consumers' perception of, and willingness to pay for, product innovation by the South African wine industry. The aim is to elicit information on whether consumers are ready to pay for wines made with natural preservatives (*Rooibos & Honeybush*), organic production, and a higher quality score. Determining whether consumers choose such wines is important as it would reveal whether wine players can exploit this source of avenue to save the struggling industry. Indeed, key evidence informing wine players is how valuable 'no sulphite added' wine is to consumers and what share of consumers would consider such a trait necessary in their buying decisions. The stated preference approach and Discrete Choice Experiment (DCE) are

used to understand consumers' perceptions and, in particular, how consumers would value a wine produced using *Rooibos & Honeybush* as a preservative for conventional and organic production.

Chapter 5 investigates the robustness of DCE estimates obtained in chapter 4. In a stated preference study, the method and survey used to assess non-market value can have an impact on the results, as well as the validity and reliability of value estimates. To answer the research question "Does 'price framing' influence empirical estimates in Discrete Choice Experiments?" the study explores the effects of 'price framing' on DCE measurements using data from a choice experiment on preferences for natural preservatives in wine. The same respondents completed a nearly identical DCE survey, one with a *real price* and another with a *percentage price change*. 611 respondents completed the survey, and a panel mixed logit model was used for the analysis.

Chapter 6 investigates the nature of the relationship between fuel, electricity, and wine prices. The aim is to establish the extent to which energy price volatility affects wine prices in the South African wine industry. The implication of the findings is that a formula of dependence and risk between energy and wine markets could be established and used to protect the wine industry from spillovers and foster wine market stability. The study uses the MGARCH approach to derive own- and cross-volatility spillovers and persistence between markets using monthly CPI prices for 2002-2018.

1.4 Study Structure

The following seven chapters constitute the main body of the thesis:

Chapter 1 establishes the nature of the study, briefly highlights the significance of the wine industry to the South African economy, and introduces the research problem, questions, and objectives of the thesis.

Chapter 2 gives a brief history of the South African wine industry as a background for the study. The study area and structures, major challenges, and efforts to transform the industry are discussed.

Chapter 3 compares the South African wine trade's competitiveness with rivals in the Southern Hemisphere New World, namely, Australia, Chile, Argentina, and New Zealand. Trade specialization and its determinants are determined through (i) the computation of the Revealed Comparative Advantage, (ii) estimation of the Galtonian regression model and (iii) estimation of the panel regression model. The 1990 to 2018 panel data from Global Wine Markets is used for the analysis.

Chapter 4 examines wine consumers' perception of and willingness to pay for natural preservatives in wine. The stated preference approach and Discrete Choice Experiment (DCE) are employed to elicit information on how consumers value a wine produced using *Rooibos & Honeybush* as a preservative for conventional and organic production. The study provides the industry with the first evidence on consumers' acceptance of a new natural wine preservative and, more specifically, how consumers might respond should the industry decide to scale up.

Chapter 5 investigates the robustness of DCE estimates and explores the effect of 'price framing' on environmental valuations using data from a choice experiment on preferences for natural preservatives in wine. The study sheds light on the establishment of guidelines for developing valid cost attributes in Discrete Choice Experiments.

Chapter 6 investigates whether energy price volatility influences South African wine prices using monthly Consumer Price Index (CPI) for 2002-2018 and a Multivariate GARCH approach. Finally, chapter 7 concludes the study and discusses policy implications.

2 The South African wine industry

2.1 Historical Synopsis

Jan Van Riebeeck, the then governor of South Africa, planted the first vine in the Cape in 1655 and, three years later, the first Cape wine was produced (Vink et al., 2004). In 1680, Governor Simon Van der Stel planted over 100,000 vines in the Constantia valley. This was followed in 1688 by French Huguenots settling principally in the Franschhoek valley and bringing expertise in winemaking. According to Vink et al. (2004), the wine industry did not flourish until the Cape came under British rule. Between 1810 and 1820 the Cape exported 90% of its wine to Great Britain.¹ By 1825 the export levels to Britain dropped significantly owing to a treaty between Britain and France that favoured French wines. Local demand alone could not absorb the excess supply of wine. Consequently, farmers formed cooperatives to protect their interests and welfare. This successively led to the formation of KWV (Ko-operatiewe Wijnmakers Vereeniging Van Zuid-Afrika) in 1923 (Vink, Williams, and Kirsten, 2004). Members of KWV were required to sell their produce to the cooperative, which applied a mandatory 10% levy for each sale. Even though most wine farmers joined the cooperative, a few farmers from Constantia and Stellenbosch refrained. They argued that their produce was of superior quality and therefore preferred not to join the cooperative (Vink, Williams, and Kirsten, 2004). This was contested by KWV, who petitioned the government to sanction compulsory cooperation, which was awarded in 1924. KWV monopolised and managed all the affairs of the wine industry for close to 72 years. For example, the industry was highly characterised by fixed prices and control of market supply, large-scale manufacturing of poorer quality (modest) wines for the home-grown market, planting quotas, vineyards of cooperatives' cellars that operated on trust, high-yielding cultivars, the ensuring of the lowest costs for grapes delivered, isolation from the global wine trade, and the removal of surplus wine without compensation. The greater part of this surplus wine was used for the production of brandy and spirits. Brandy was a critical part of the South African wine industry, especially after export sanctions were imposed. This meant that a large part of the production of

1. The Cape Colony was under British rule at the time and imperial preference policies crucially decreased the taxes payable on Cape wines. These schemes were formally ended in 1825, which led to a significant export drop, thereby plunging the industry into a depression.

wine grapes, both in terms of cultivar assortments planted and yields, was determined by the needs of the brandy sector (Heijbroek, 2004). Therefore, the South African wine industry is still attempting to align its varietal structure and yields with the quality requests of the worldwide market. Even though there has been an increase in cultivar upgrades, the industry still lags behind some New World² wine producers (Heijbroek, 2004). Other important elements of the history of the wine industry (such as governance issues, the fragmentation of wine players, cooperatives, institutions, leadership vacuum and price dilemma), which relate to the current challenges faced by the industry, are discussed in Appendix 2.

2.2 Study Area and Structure

2.2.1 Wine Area

The South African wine lands are mainly located in the Western Cape and to a lesser extent in the Northern Cape and the Free State (see Figure 2.1). The Western Cape, which has 95% of South Africa's vineyards, is partitioned into many regions, such as the Overberg, the Klein Karoo, the Breede River Region, the Olifants River Region, and the Coastal Region. The Coastal Region includes Paarl, Constantia, Durbanville, Swartland, and the Stellenbosch district. The Overberg contains viticulture territories like Elgin and Walker Bay. The Breede River Region is composed of Worcester, Robertson, and Swellendam. Finally, the Klein Karoo area includes the towns of Montague, Ladysmith, and Calitzdorp, which are wine districts, and the Cape South Coast (see Table 2.1). In 2019, the total area under vine, producing wine grapes, was 92 066 hectares.

Of the total number of grapevines in South Africa in 2019, Stellenbosch accounts for 16.36%, Paarl for 15.87%, Robertson for 13.83%, Swartland for 13.50%, Bredekloof for 13.68%, Olifants River for 10.26%, Worcester for 7.18%, the Northern Cape for 4.02%, the Klein Karoo for 2.42%, and the Cape South Coast for 2.88% (see Table 2.1). Table 2.1 shows that the vineyards area is reasonably distributed between five wine regions (Stellenbosch, Paarl, Robertson, Swartland and

2. New World wine producers are those outside the traditional wine growing areas of Europe and the Middle East, for example France, Italy and Spain. They comprise South Africa, Argentina, Australia, Canada, Chile, Mexico, and the USA.

Breedekloof). These areas cover about 70% of the total area planted during 2019. The two most productive areas, Stellenbosch and Paarl, are dominated by independent growers and cellars.

Figure 2.1: Wine Growing areas of South Africa



Source: WOSA, 2020

Table 2.1: Geographic distribution of SA vineyards per wine region, 2020

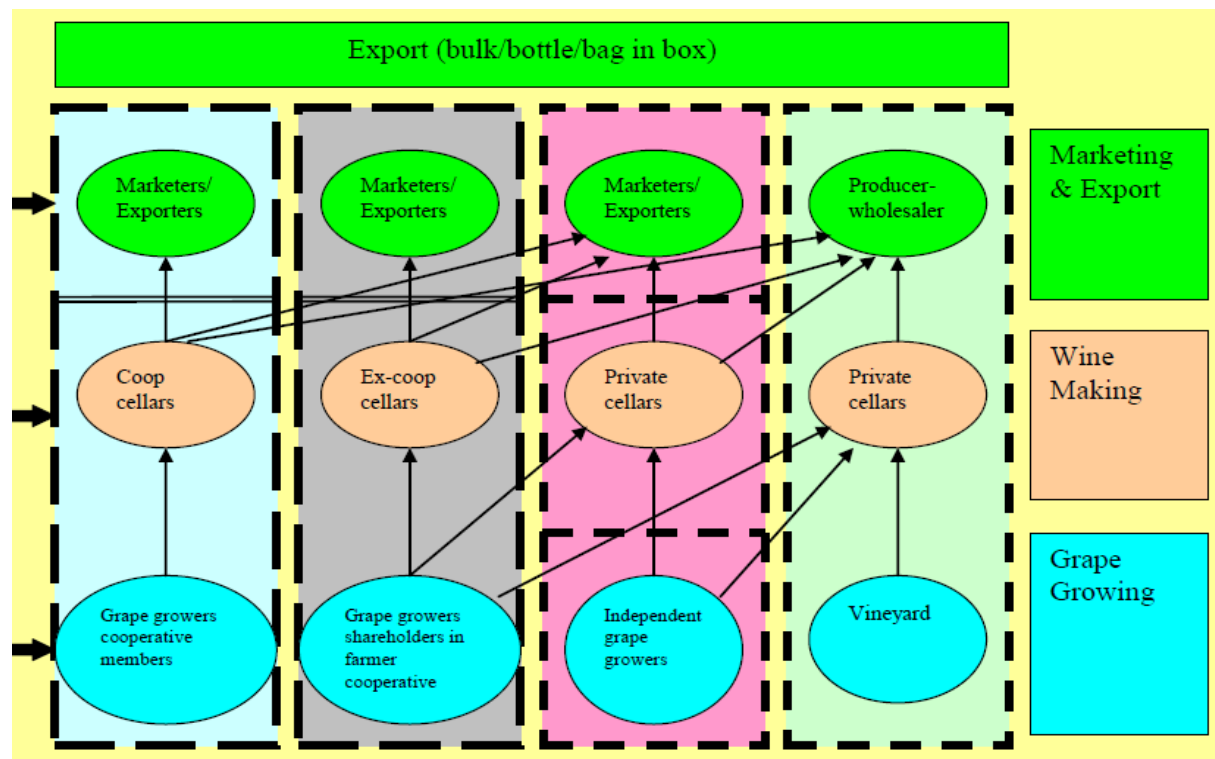
Wine Regions	Independent cellars	C-operative cellars	Area Hectares	% of total hectares
Stellenbosch	162	2	15 066	16.36
Paarl	108	7	14 607	15.87
Robertson	36	8	12 731	13.83
Swartland	29	1	12 432	13.50
Breedekloof	17	10	12 593	13.68
Olifants River	12	3	9 450	10.26
Worcester	10	8	6 606	7.18
Northern Cape	11	2	3 701	4.02
Klein Karoo	18	4	2 224	2.42
Cape South Coast	57	0	2 656	2.88
	460	45	92 067	100

Source: Authors compilation, 2020

2.2.2 Wine Industry Structure

The South African wine industry has many different stakeholders, divided into producers (grape growers), producer cellars (co-op winemakers), private cellars (independent winemakers), wholesalers, and retailers (see Figure 2.2). According to SAWIS (2020), there were 2,778 primary wine producers in 2019 and a total of 533 wine cellars crushing grapes. The wine cellars are divided between private wine cellars, which are larger (about 460), smaller operations, considered boutique winemakers, and producer wine cellars, consisting of cooperatives and ex-cooperatives, generally general, of cooperatives and ex-cooperatives large operators (SAWIS, 2020). The ex-cooperatives (Ex-coop) are former cooperatives that have registered as private companies (figure 2.2).

Figure 2.2: The structure of the South African Wine Industry



Source: SAWIS, 2020

By 2019 a total of 45 producer wine cellars were recorded. The cooperative sector has generally been the most significant part of the South African wine industry. They account for 80% of South Africa's total wine crop (SAWIS, 2020). Wholesalers can be partitioned into export only, general wholesalers, and producer wholesalers. Wine is purchased in bulk from producers and private wine cellars by general wholesalers, who subsequently brand, promote, distribute, or export the wine in packaged or bulk. Producer wholesalers (sometimes known as estates) are distinguished because they own a vineyard, process and label their wine. There were 220 confirmed estates in 2019, and this group is responsible for most of South Africa's exports. Retailers, the last link in the wine value chain, are the marketing agents and retail outlets from which customers can buy wine. In South Africa, supermarkets handle between 35% and 39% of all off-trade wine consumption (by value). Massmart and Metcash, for example, manage around 41% of the market. Distributions at restaurants, B&Bs, motels, and the hospitality industry, in general, would be considered on-licence consumption. The remaining sales are made through bottle shops, skilled professionals, and direct sales, which include sales at the cellar door (SAWIS, 2020).

The South African wine industry's area, structure, and size had evolved from when the first vines were planted. In 2019, the total area under vines was 92 067 hectares, showing a reduction from 102 146 hectares in 2006 (SAWIS, 2020). In terms of varietal distribution of the hectareage under cultivation, Sauvignon Blanc, Chenin Blanc, and Colombard hold the top positions for the white wines, while Pinotage, Cabernet Sauvignon, and Shiraz are the most widely planted red varieties (see Table 2.2). White wine types account for 55.5% of wine plantings, according to SAWIS (2020), with Chenin Blanc accounting for 18.6% of the total. Red wine types account for 44.5% of all vineyards in the United States. Cabernet Sauvignon is the most extensively planted red variety, accounting for 11% of all plantings. Shiraz makes up 10% of the blend, with Merlot accounting for 5.8% and Pinotage, a South African grape, accounting for 7.2%. The Pinotage red varietal is viewed as a uniquely South African grape variety (a combination of Pinot Noir and Cinsault), although this variety is currently found in different countries across the world.

Table 2.2: Wine Grape Variety and % hectareage per region, 2019

White variety	Total Hectares%	Red variety	Total % Hectares
Chenin Blanc	18.6	Cabernet Sauvignon	11
Colombar(d)	11.5	Shiraz	10
Sauvignon Blanc	10.5	Pinotage	7.2
Chardonnay	7.3	Merlot	5.8
Muscat d'Alexandrie	1.7	Ruby Cabernet	2.2
Semillion	1.1	Cinsaut	1.8
Other white varieties	4.8	other red varieties	6.5
	55.5		44.5

Source: SAWIS, 2020

2.3 Major Challenges

As highlighted above, the South African wine industry faces many challenges, such as global competition, volatile input production costs, an unreliable energy source and associated high costs, the effects of climate change, particularly drought, fragmentation within the industry, labour costs, and the problems of an unskilled labour force, poor wine quality and consequent low prices, poor

technological adaption, and a lack of innovation and development. Therefore, this study focuses on three elements: competition, innovation, and input costs.

2.3.1 Global competitiveness

The South African wine industry's economic viability is determined to be largely dependent on its competitiveness. The wine industry has come under increased competition from other wine producers across the world. Global competition, especially competition from other SHNW producers, has been cited as one of the causes of the underperformance of the South African wine industry (Esterhuizen and Van Rooyen, 2006; Van Rooyen et al., 2011; Van Rooyen and Boonzaaier, 2018). Specifically, the industry faces a wide range of difficulties in marketing its product. These include worldwide over-supply, sensitivity to external economic shocks such as exchange rate fluctuations; highly subsidised competitors; tax increments; volatile costs for production input and surplus removal (DAFF, 2015). These challenges, coupled with the increased fragmentation of wine players, pose a threat to the sustainability of the South African wine industry. The South African market is predominantly a bulk exporter of wine, with 58% exported in bulk, in contrast to 42% traded as packaged wines in 2015 (SAWIS, 2020). Industry specialists argue that South African wine needs to sell more packaged wine at prices greater than R80 (€5) to become more competitive (VinPro, 2018). The price range between R80-R105 is the fastest growing (worldwide), and the margins are healthier, but the industry lacks the serious investment needed to exploit this category due to small margins. However, it is feasible if wine players integrate and coordinate efforts and resources to produce strong brands and the volumes necessary to compete successfully in the international wine market (more on competitiveness in chapter 3 of the study). In the process, they could also find innovative ways to boost competition.

2.3.2 Innovation to enhance competition

Competition can be enhanced through technological development and innovation. Agriculture's development is commonly acknowledged to be fuelled by innovation. Scientists and extension workers are increasingly recognizing the critical role of innovative farmers and the value of their trials and inventions for agricultural development (Chambers and Thrupp, 1994; Klerkx and Leeuwis, 2008; Reij and Waters-Bayer, 2014). The South African wine industry, for example, may

investigate an alternate wine preservative to SO₂ as a potential revenue stream to help the struggling industry.

As health issues (e.g. hang-over and headaches) are linked to SO₂ in wine, winemakers worldwide have been encouraged to find alternative ways to preserve wine. In 2014, the South African industry launched the world's first wine made using natural preservatives (Rooibos and Honeybush). Rooibos (*Aspalathus linearis*) and honeybush (*Cyclopia*) are indigenous to the Western and Eastern Cape Provinces of South Africa (Du Toit, Joubert and Britz, 1998; Small and Catling, 2009) and have been harvested and processed mainly to produce herbal teas (Du Toit et al., 1998). The Department of Oenology has conducted research on their antioxidant capacity at the University of Stellenbosch in collaboration with two wineries (Audacia and KWV) with the view to using this indigenous plant for wine preservation (Burgstahler and Robinson, 1997; Du Toit, Joubert and Britz, 1998; Rankine, 2004; Rudd, 2016). The thesis investigates the potential niche market in-depth (see chapter 4) to gauge consumers' perceptions on the importance of 'no sulphite added' wines. Wine producers could experiment with the potential of this new preservative to generate much-needed revenue for the industry.

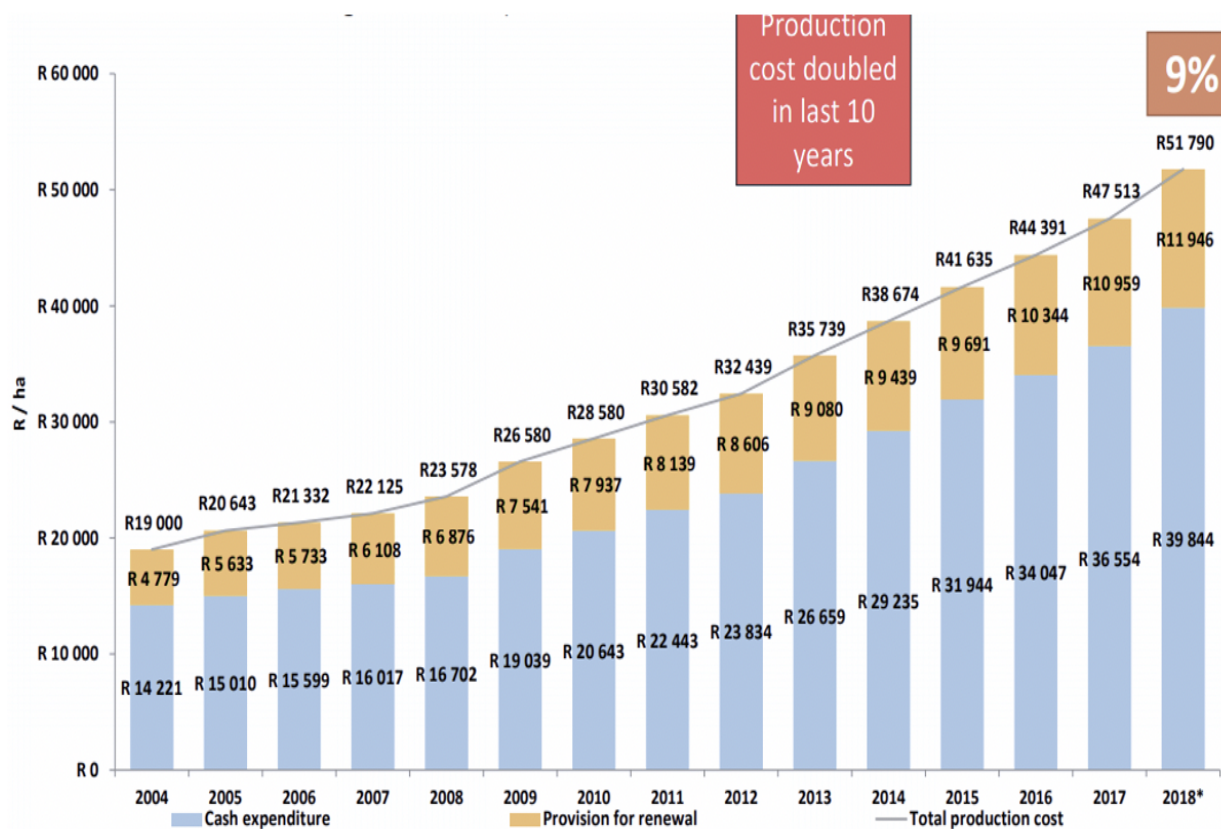
2.3.3 Cost of production

The volatile input production costs render the wine industry progressively marginal, a "price taker", and financially unstable. The thesis takes a closer look at the costs of wine production across the industry's value chain, including grape production costs, cellar costs, and energy costs.

Grape production costs are made up of cash expenditure and the provision for renewal. The challenge for wine producers is that the costs of wine grapes are increasing year on year at a higher rate than reported inflation (Figure 2.3). In the 2015 farming season, the costs incurred consisted of cash expenditure which relates to direct costs (i.e. fertiliser, pesticides, and herbicides), labour (i.e. permanent, seasonal, and supervisory), mechanisation (i.e. fuel, repairs, and maintenance), fixed improvements, and general expenses (i.e. electricity, water tax, and administration). From 2013, the industrial average total production cost increased by 8% to R38 674/ha in 2014 (VinPro, 2018). The total cash expenditure increased by 10% from 2013 to 2014, reaching R29 235/ha in 2014. The costs were primarily driven by an increase in the statutory minimum wage and by energy

costs. Similarly, cash expenditure increased by 9% from 2017 to 2018, to R39 844/ha. The provision for renewal relates to capital items such as cultivar replacement, tractors, tools, and buildings, which help maintain the business's sustainability (VinPro, 2018).

Figure 2.3: Industrial average input cost of grape production - r/ha

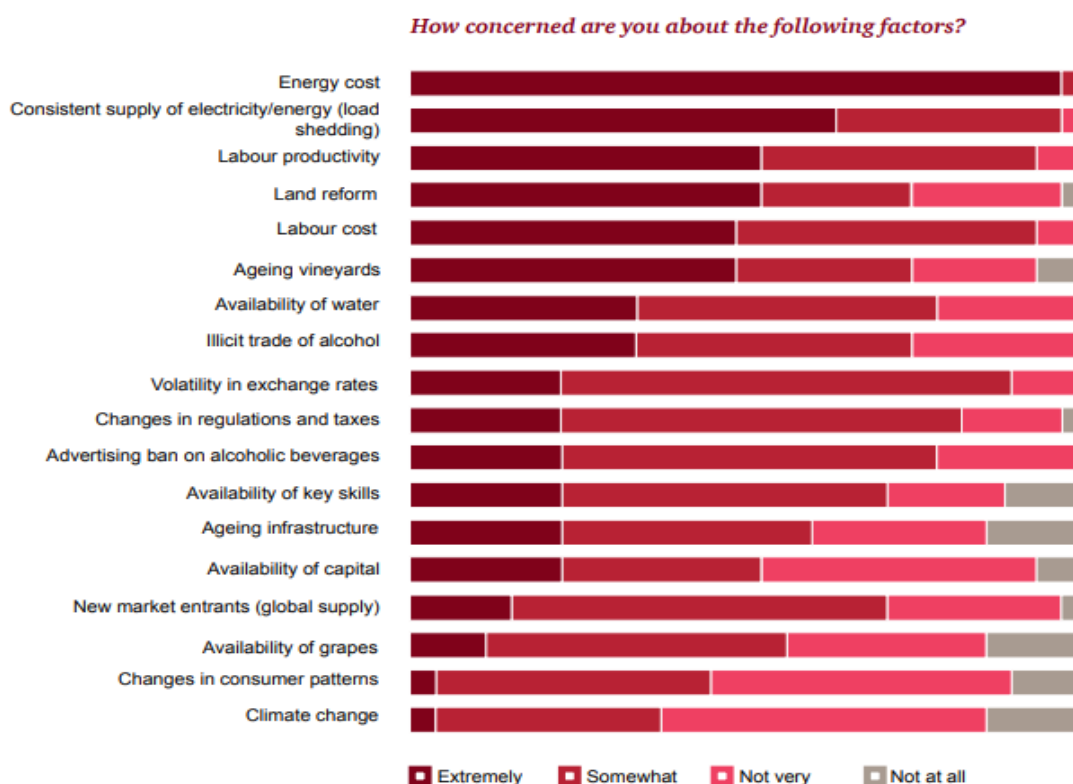


Source: VinPro, 2019

On the other hand, **cellar costs** relate to the costs required to make, store, package, market, sell, and distribute the wine (VinPro, 2018). The production costs vary significantly, depending on whether the produced wine is marketed in bulk or packaged. Cellar costs include labour, fuel and electricity, chemicals, maintenance and cellar consumables, water, insurance, marketing and sales, bottling and packaging, distribution, administration, taxes, depreciation, and administration. These costs vary depending on the model of the winery, such as estate, producer winery, ex-coop producer winery, and private winery. On average, 75% of the cost goes towards grape production, and 25% goes towards cellar costs.

The South African wine industry is highly mechanised and relies heavily on energy sources for the wine production process across the entire production value chain, from farming to winemaking, storage, bottling, and distribution to retailers. **Energy costs** (the focus of chapter 6 of this thesis) have been a concern for a while. Annual surveys conducted by Price Waterhouse Coopers (see Figure 2.4) include a question to chief executive officers on how concerned they were about energy costs (PwC, 2016). Energy includes traditional forms of electricity generated by burning fossil fuels such as coal and diesel and renewable sources like solar and wind. In my further discussions on energy, it is important to remember that the two are intensively used (fuel and electricity) across all stages in the sectors' value chain.

Figure 2.4: PwC Wine Industrial Survey 2015

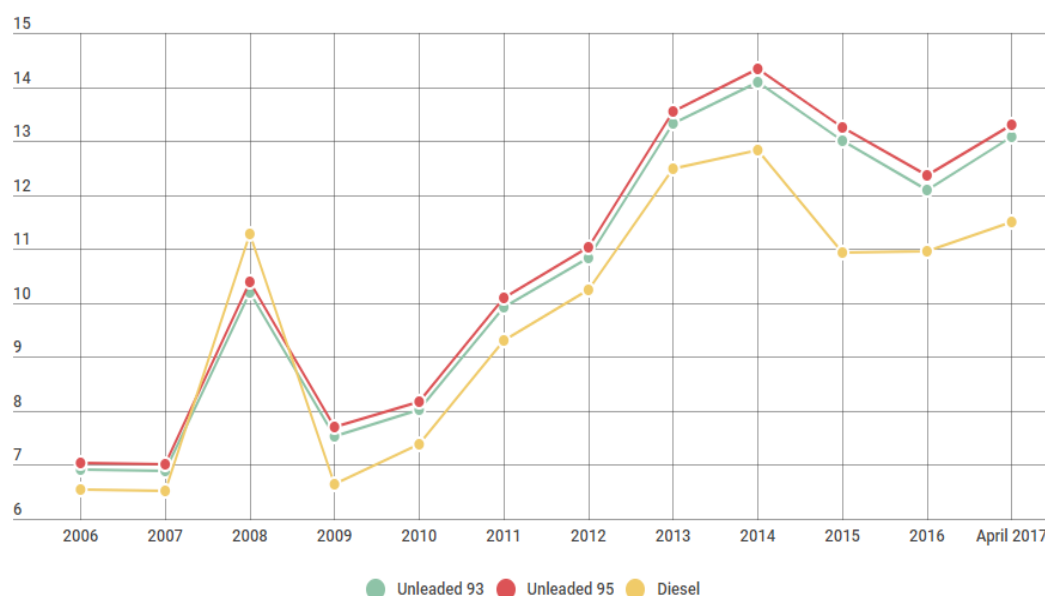


Source: PwC (2016)

The South African government imports approximately 96% of its crude oil requirements from Saudi Arabia, Iran, and Nigeria (DAFF, 2015). The agricultural sector uses 3% of the total imports comprising about 69% fuel and 30% of electricity (DAFF, 2015). Unrefined petroleum costs, combined with the Rand/Dollar exchange rate, significantly affect fuel costs. Over the years, the

department of energy has linked the domestic fuel price to the imported cost³ (Eskom, 2018). This was achieved using the import parity price concept based on the in-bond landed cost (IBLC)⁴ formula (Competition Tribunal, 2006). This approach was used from the 1950s until 2003 when it was replaced with the basic fuel price (BFP) that gives more accurate estimates by incorporating domestic and international factors. The domestic fuel pump price is then calculated by adding to the import costs, including transportation costs, fuel taxes, levies, and margins. Figure 2.5 depicts the movements of fuel prices in South Africa for the period 2006 – 2017. (Figure 6.1, in chapter 6, demonstrates the volatility clustering for fuel and electricity).

Figure 2.5: Movement of fuel price in Rands/litre 2006-2017



Source: Authors' calculation using the South African department of energy Statistics

Three broad observations can be made from Figure 2.5. Firstly, petrol prices for unleaded 93 and 95 track each other's movements quite closely throughout the observed period. During the global economic crisis of 2008-2009, diesel prices were higher than those of petrol, but prices dropped to their normal levels after recovery. Since 2009 fuel prices rose rapidly and reached their highest peak in 2014 before dropping and then rising again.

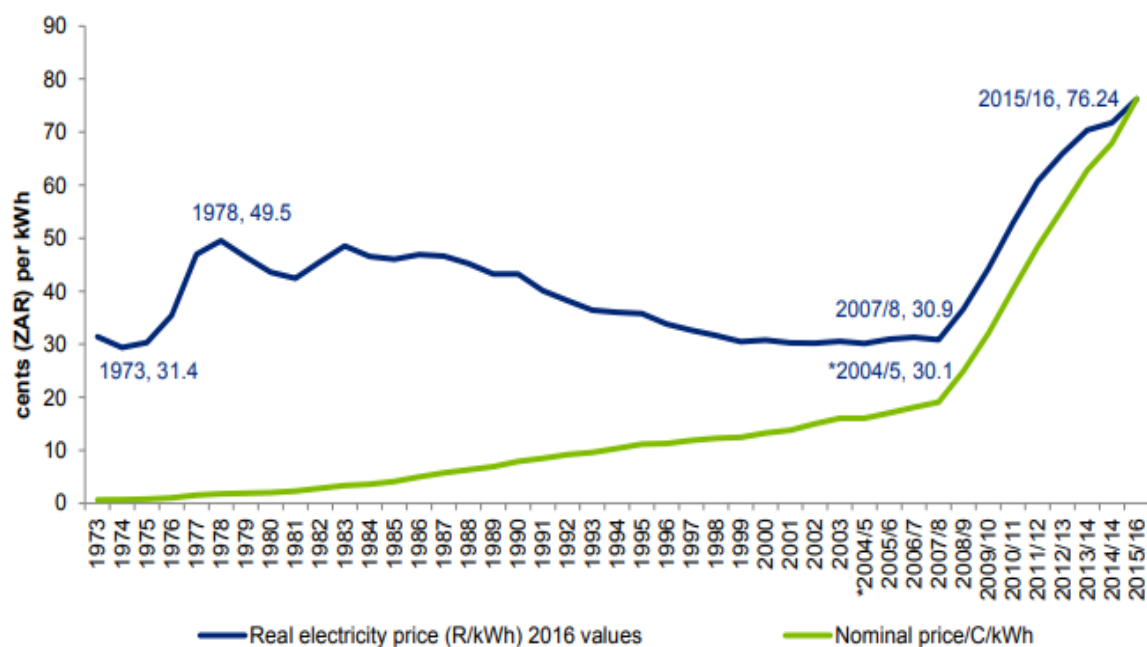
3. The price of imported unrefined petroleum is pegged to one of three primary benchmarks: Brent, WTI, and Dubai.

4. The IBLC formula used prices obtained at specific refineries, as opposed to daily spot prices quoted in the international energy market.

South Africa's electricity business is dominated by a single state-owned company (Eskom), which controls generation, transmission, and distribution (Eskom, 2018). Eskom divides the electricity tariff structure into various categories (Rural, Residential, and Urban) with different implications for the cost of electricity. For example, the agricultural sector, which the wine industry falls, is classified as rural for tariff purposes. On average, electricity costs make up approximately 8% of producing grapes and about 2% of cellar costs (VinPro, 2018). Although electricity is mainly used for irrigation and winemaking (seasonally), this use is at the peak times (between January and April) when the grapes and ultimately the wines produced are at the highest risk of spoilage, thus increasing the risk of higher associated costs. These costs are further exacerbated by the high level of load-shedding and power outages experienced in the industry.

The electricity price trend has never shown the true economic cost of supply because of government interventions. Figure 2.6 reflects the average real and nominal electricity prices over 45 years.

Figure 2.6: Trend in Average Electricity Prices realised by Eskom per kWh



Source: adapted from (Deloitte, 2016) analysis.

The graph shows that real electricity prices only increased in the 1970s and 2008 when Eskom undertook a massive capacity development program. The National Energy Regulator of South Africa (NERSA) approved significant hikes in the annual electricity. As a result of this ambitious project, between 2008 and 2013, electricity prices dramatically increased in real terms (inflation-adjusted), rising by 114%, while nominal prices increased by 191% over a similar period (Eskom, 2018). This thesis studies (chapter 6) the impact of these changes on wine price for the period 2002-2020. It is assumed that rising energy costs will put pressure on winemakers.

2.4 Efforts to transform the industry

Over time, the South African wine industry has enacted strategies and action plans that map out the short-term and long-term aspirations for the sector. The study focuses on these strategies relevant to the thesis. However, it is important to recognise that structures and processes that could build on the findings of this research already exist.

In 1999, WineTech unveiled the Vision 2020 plan, which outlined new goals for the wine industry's growth and global competitiveness based on industry-wide consultations (SAWB, 2003). The strategy was a notable indicator that the industry was shifting from a production-oriented to a market-oriented mindset (Ponte and Ewert, 2007). On a fundamental level, the Vision 2020 strategy aimed to achieve the following goals (SAWIS, 2020):"

- Be internationally competitive;
- Change from being production- and commodity-driven to market-driven;
- Develop "Brand South Africa";
- Handle wine, brandy, distillate, and grape juice concentrate as specialised production entities and end all forms of cross-subsidisation;
- Exploit South Africa's wine ecology by developing terroir-based wine production;
- Develop total value chain management;
- Integrate total logistics and total quality management systems into industry practices;
- Develop world-best business intelligence systems for the industry;

- Invest in market-focused innovation, and link innovation with programmes of human development in the wine industry;
- Institute ethical trade practices and meaningful social responsibility programmes throughout the industry;
- Be a "good citizen" and support the development of a prosperous and fair South Africa by implementing strategies for affirmative action."

The goal of Vision 2020 was to develop specialized procedures for each of three sub-ventures: drinking wine, wine distillates and liquor, and grape juice products (SAWB, 2003). Unfortunately, the execution of the vision has not been successful on numerous fronts, as it requires an incorporated construction that provides initiative and addresses all partners - a design that is currently missing.

The Wine Industry Strategic Exercise (WISE) 2025 strategy, on the other hand, was developed and launched in 2015 by the South African Wine and Brandy industry (SAWB). The aim was to implement a thorough industry-wide strategic exercise to assist the industry in becoming more competitive globally and assisting in the wine industry's transformation by 2025. With representatives from VinPro, SALBA, SAWIS, WOSA, WineTech, and a range of stakeholders within the value chain, it aspires to achieve its aims based on the following six key pillars for growth:

1. Economic empowerment and development that will stimulate growth and transformation;
2. Market development and promotion by working more collectively;
3. Social development and upliftment by improving livelihoods;
4. Knowledge and information development that is more business-orientated;
5. Human Resource development and training by being more open and looking more globally;
6. Technology innovation and transfer by increasing efficiency.

These six pillars are also used in the Agricultural Policy Action Plan (APAP) for the wine industry. This study aligns with pillars 4 and 6, "Knowledge and information development" and "Technological innovation and transfer". Knowledge and information development deals with matters to do with market research and data analysis to best inform the industry on its strengths

and weakness. Chapters 3, 4, 5 and 6 of this study contribute to this theme. For example, understanding the extent of SA wines competitiveness will help with identifying areas to focus on for the growth of the industry; the findings from the experiment will inform wine players on how valuable 'no sulphite added' wine is to consumers and what share of consumers would consider such a trait necessary in their buying decisions. Furthermore, the understanding of the effects of 'price framing' on DCE measurements (chapter 5) will guide the development of valid measurement tools that reflect the true value and impacts policy decision and implementation and lastly, the understanding of the link between energy and wine prices will help formulate hedging mechanisms that prevents spillover and foster wine market stability (chapter 6). Similarly, "Technological innovation and transfer" is relevant and is addressed in all chapters more with chapter 4 of this study. For example, discovering natural preservatives for winemaking could boost the industry if stakeholders can exploit the potential niche market to generate revenue. Extensive work has already been done to develop strategies for each theme, and the following table highlights the targets sets and how far (see table 2.3).

Table 2.3: WISE targets (VinPro, SALBA, SAWIS, WOSA, WineTech, 2020)

2015	Target	2025	2016	2019
2%	Producer return on investment	CPI +5%	<1%	<2%
80,000-ton surplus	Business model	Equilibrium	Possible shortages	short supply
1.5%	Black-owned land and water	20%	2%	3%
330 million litres	Local wine sales	430 million litres	400 million litres	387.6 million litres
60:40	Exports bulk: packaged	40:60	61:39	55:45
20%	Ethically accredited volume	100%	48%	61%
10% volume	New markets USA: China: Africa	25% volume	11% volume(20% value)	11%
ZAR 6 billion	Wine tourism	ZAR 15 billion	In progress	Roadmap executed
2 free Trade Agreement	Market focus	Agreement for key markets	In progress	In progress
ZAR 80million:11 million	Industry Govt levies	Matched funding	In progress	In progress
275, 000	Employment levels	375,000	In progress	245,000

Source: SAWIS, 2020

The main concern areas are producer return on investment, bulk vs packaged exports, and Black-owned land and water. Feedback from VinPro (2020) highlights that the average return on investment at the producer level is still under 2%, driven mainly by the prolonged drought in certain regions, volatile production input costs, and stagnant wine price, among other reasons. As

alluded to earlier, between 2006 and 2016, only 13% of the 3,145 producers were farming at viable income levels, 44% were operating at a break-even point, and 40% were making losses. The second-biggest concern is transformation and empowerment through Black ownership of land and water. Little progress had been made, with an increase to only 3% from 2% in 2016. Industrial levies of 20% were allocated to support transformation, in addition to allowing 20 Black-owned wine businesses to gain access to grants and technical services (SAWIS, 2020). The third main concern is the export ratio between bulk and packaged wine, making little progress. A lot more needs to be done to achieve the stated goal. The WISE 2025 approach, though instrumental in transforming the industry in general, requires more focused strategies to meet the target by 2025. The immediate needs of a player in the wine industry value chain vary, and a one-size-fits-all approach might not meet them. Therefore, more innovative ideas are required.

2.5 Conclusion

The South African wine industry is going through an exciting phase in the history of winemaking. However, the industry's history of sanctions by the international community, protectionism, and regulation by KWV has slowed the industry's progress in relation to other New World producers. Even though the industry has made tremendous progress since the 1990s, it has increased global competition. For the industry to achieve significant growth and become more competitive, wine experts require a consented effort from all players to improve quality and build strong brands through innovation and reducing input costs. Although most of the challenges facing wine producers have been highlighted, global competition, innovation, and volatile input production costs stand out as the major elements necessary to enhance industrial competitiveness. Efforts in the industry underscore the importance of knowledge and information development and technological innovation as pillars for transformation. The thesis make research contributions on these strategies in chapters 3, 4, 5 and 6.

3 Competitiveness of the South African wines and factors influencing performance

abstract

The study investigates the competitiveness of South African wines against rivals in the Southern Hemisphere New World (SHNW), and the determinants of their performance in the global wine market. It reveals the relative position of the South African wine industry and draws inferences on priority areas for enhancing competitiveness. International competition, especially among the Southern Hemisphere New World (SHNW) producers, has been cited as one of the causes of the poor performance by the South African wine industry. The 1990 to 2018 panel data from Global Wine Markets is used for the analysis. Trade specialisation and their factors are determined through the computation of the Revealed Comparative Advantage, estimation of the Galtonian regression model, and the estimation of the panel regression model. Findings reveal that all countries migrated to higher price points with variable degrees of success. South African wines were relatively less competitive than its rivals. The study finds that New Zealand and Chile were more effective at achieving specialisation gains. At the same time, South Africa lost some of its competitive advantages since 2005. Results show that grapevine per capita, the volume of wine exports, the value of exports, real GDP, and real exchange rate positively influence performance whilst volume of wine imports and the value of imports negatively impact performance. The study reveals the relative position of the South African wine industry and draws inferences on priority areas for enhancing competitiveness.

Keywords: Trade competitiveness, Wine value, Comparative Advantage, Panel regression

Note: An extract of this chapter is in the final stages of review for publication at the Economics Research Southern Africa (ERSA) Working Paper Series. Chikumbi L (2021). Competitiveness of the South African wines and factors influencing performance, Economic Research for Southern Africa (ERSA) ERSA-2021-0032.

3.1 Introduction

South Africa's trade performance in wine is outstanding. Wine is among the top five exportable agriculture products by value (VinPro, 2018). The use of the four performance indices⁵ indicates the wine industry gained a trade advantage and became a net exporter in 1994. These results are consistent with Van Rooyen et al. (2011) and Esterhuizen and Van Rooyen (2006). They found that, as a country, South Africa's trade performance in wine is good. However, unique dynamics are observed when comparing its performance with rivals. The evolution changes in export volume and export value for South Africa and rivals in the Southern Hemisphere New World (SHNW)⁶- Australia, Argentina, Chile and New Zealand are presented in Table 3.1.

Between 1990-1999 South Africa's percentage increase in value was 473%, the lowest of all the SHNW countries. While South Africa's share of total export volume of SHNW fell only slightly around two percentage points (from 21% in 2000 to 19% in 2009), its export value contribution increased by one percentage point, suggesting that South Africa gained some ground against some of its SHNW competitors. Again South Africa's export value share decreased from 14% to 11% (by three percentage points) from 2010 to 2018 (see Table 3.1. below).

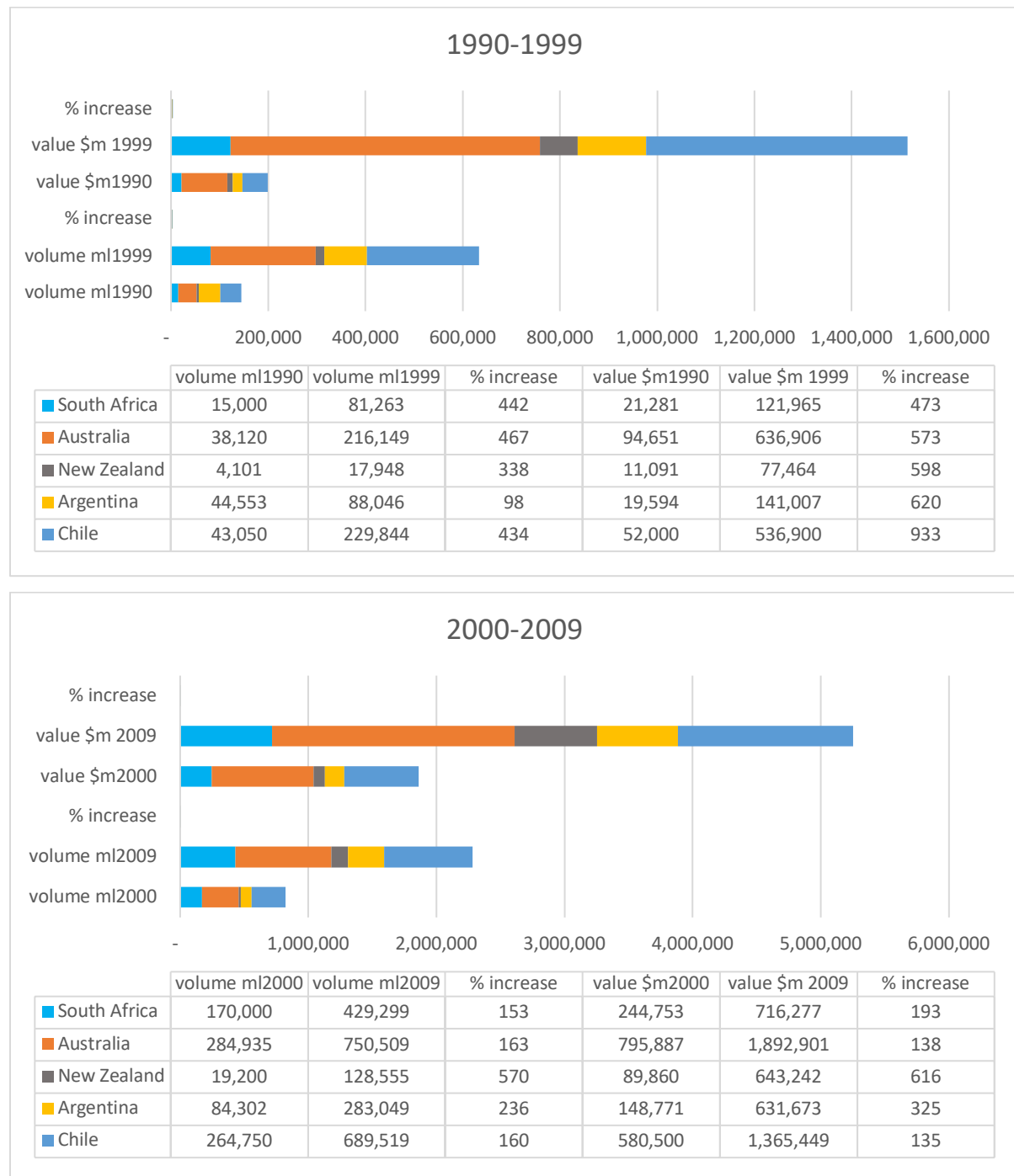
In the world of the wine market, quality is critical. The most successful countries are those that produce high-quality, high-value wine brands (Grant et al., 2015). Interestingly, “quality” is no longer exclusively influenced by producers or any intrinsic characteristics but by the value perceived by the market (Cusmano et al., 2010). In a market characterized by a big and growing percentage of fairly inexperienced consumers, the ability to recognize a certain brand and create its reputation has become a significant competitive advantage (Costanigro et al., 2014). Furthermore, customer perception and behavior are influenced by quality evaluations supplied by

5. The measures wine trade performance the four performance indices: (i) Trade Specialisation Index, (ii) Export Propensity Index, (iii) Import Penetration Index, and (iv) Export/Import Ratio. See more details on the methods and results in Appendix 3A.

6. The global wine market is divided geographically between Old and New World wines and each region experiences different successes and challenges. The Old World is customarily Europe, also known as the birth place of wine with countries i.e. Italy, France, Spain, Germany, and Portugal and the New World consists of countries in the Southern Hemisphere (SHNW) i.e. South Africa, Australia, New Zealand, Chile and Argentina, plus the wine-producing regions of the USA and Canada (Grant et al., 2015). Further, SHNW producers are similar in many aspects and show unique characteristics to that of the old World.

wine experts guidance (Odorici and Corrado, 2004). Figure 3.1 presents the percentage share of global export value for the SHNW (see details of method in Appendix 3B).

Table 3.1: Changes in export volume and value of SHNW producers per decade.



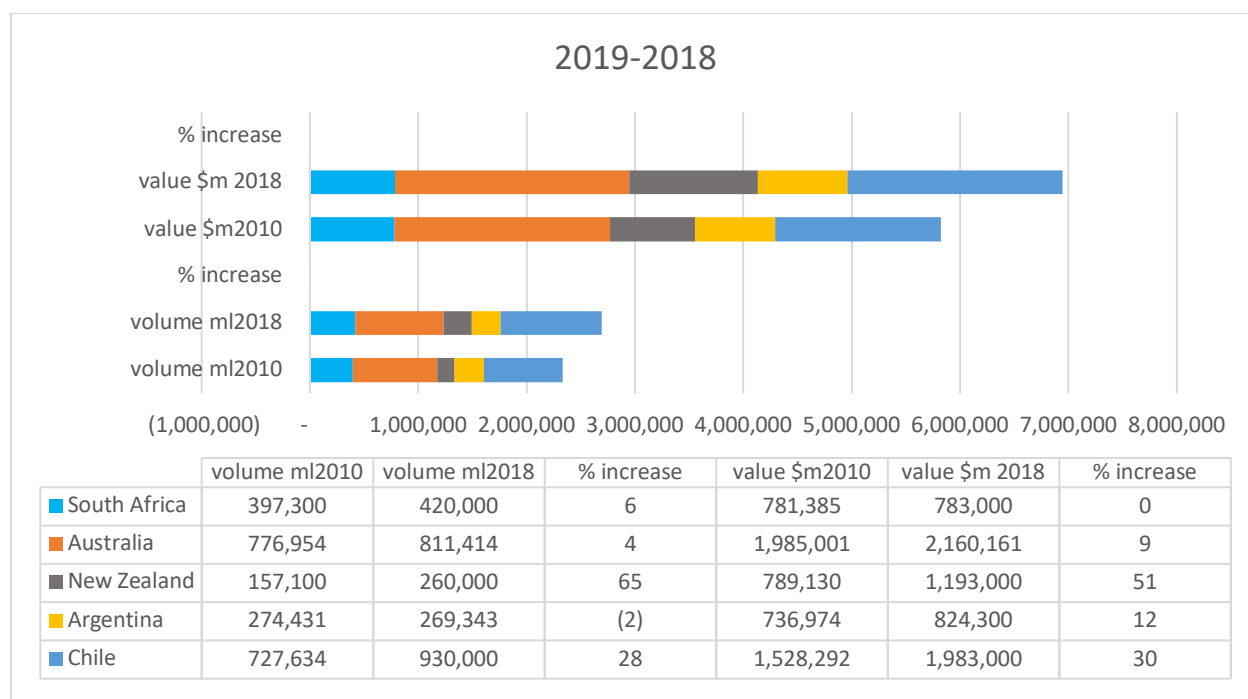
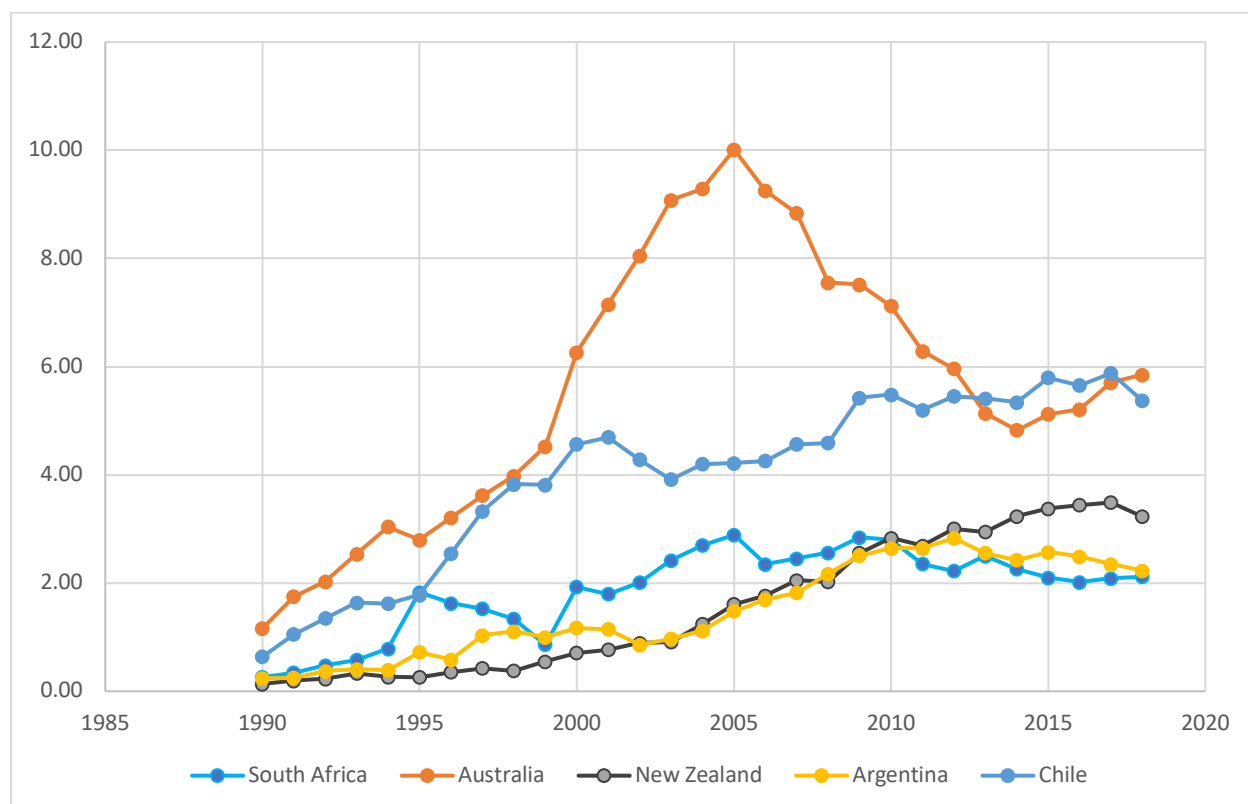


Figure 3.1: New World Countries % Share of Global Export value 1990-2016



Source: Own composition based on data obtained from *Global Wine Markets, 1835 to 2018: A statistical compendium*, Adelaide: University of Adelaide Press, 2019.

It is evident in figure 3.1. that Australia and Chile have always had the highest export value indices, with Australia reaching its peak in 2005 at 10.1%, which fell to 5.8% by 2018. On the other hand, Chile's export value has grown gradually over the years. The export share value of 5.37% in 2018, a reduction from 5.88% in 2017. New Zealand rose from a slight drop in 2008 and 2010 to its ascendancy and improved its value. In contrast, Chile's export value dropped in 2010 and has not measured up to New Zealand since. Comparing South Africa with its rivals, it is clear that the industry's share in world export value has stagnated since 2010. It records the lowest market share value of all the SHNW countries (2.12) towards the end of the study period. The study explores these changes in detail and evaluates the competitiveness⁷ of South African wines relative to other wine-producing countries in the SHNW.

The global wine market is increasingly “competitive” and requires continual vigilance for a producer to stay ahead of rivals. According to Esterhuizen and Van Rooyen (2006, p. 4), “(Wine), industries and firms are competitive when they can deliver (unique) products at qualities and prices as good or better than their competitors; and can attract sufficient investments of scarce resources such as capital, land, labour, technology, innovation, and initiative and management from other competing economic activities”. As a result, competitiveness is a major focus of all industry partners, including representative industry groups, corporate executives, shareholders, and the government, as they work to improve their ability to compete. Furthermore, there is a growing recognition that competitiveness necessitates more than a favourable trade environment. National plans and supporting institutions are equally important in reaping the full benefits of globalization (Esterhuizen and Van Rooyen, 2006).

The South African wine industry's success began in 1994 to 2005 when the growth began to subside. Even though the export market has been growing noticeably, the level of growth has been below that of major competitors in the SHNW (Grant et al. 2015; Fleming et al., 2014; Esterhuizen and Van Rooyen, 2006; Van Rooyen et al., 2011). Fluctuations in the exchange rate, a lack of government backing, a high crime rate, labor policies, high finance costs, a politicized land issue, poor quality of skilled labor, and worldwide competitiveness are among the key causes of the

7. The study defines competitiveness as the quality of being as good as or better than others of comparable nature. Borrowing from Esterhuizen and Van Rooyen (2006, p. 4), “(Wine), industries and firms are competitive when they can deliver (unique) products at qualities and prices as good or better than their competitors; and can attract sufficient investments of scarce resources such as capital, land, labour, technology, innovation, and initiative and management from other competing economic activities”.

downturn (Esterhuizen and Van Rooyen, 2006; Van Rooyen et al., 2011; Van Rooyen and Boonzaaier, 2018). What makes the SHNW different and comparable to South Africa is its unique characteristics⁸ (Fleming et al., 2014). More importantly, they all started making meaningful contributions in the global wine market in the 1990s (Fleming et al. 2014; Cusmano et al., 2010; Balogh and Ferto, 2015). The export market is critical for South African wines considering that half of its annual production is sold abroad (SAWIS, 2020). Also that exports attract higher earnings for the industry. Therefore, comparing the degree of South African wine competitiveness with rivals in SHNW and investigating factors influencing specialisation⁹ will help identify priority areas to focus on to enhance South Africa's competitiveness and sustain the industry.

The competitive performance of the industry is the consequence of a complex interaction of determining elements, each of which has an augmenting or limiting effect. The major market drivers for the South African wine industry, according to Van Rooyen et al. (2011), are strong local market competitiveness and an efficient network of supporting sectors. Exchange rate variations and changing market trends have both been demonstrated to have an impact on competitiveness. According to Pappalardo et al. (2013), wine industry competitiveness is influenced by a variety of elements, including natural resources, production parameters, and methodologies. Anderson (2013) emphasizes three key drivers of a country's success in wine production including terroir, tradition, and technology. Other determinants of comparative advantage include GDP, agriculture employment, production volume, grape area, WTO membership (Balogh and Ferto 2015; Anderson and Wittwer, 2013). This study uses some of these determinants and more to examine the factors influencing specialisation in SHNW.

Empirical measurements of comparative advantage have long been studied by trade economists. competitiveness can be assessed at the global, regional, national, industry, and firm levels, These

8. The players in New World and specifically those in the Southern Hemisphere (SHNW) differ from the Old World in terms of originality, climate, wine taste, varietal labelling, restrictive wine making, cellaring among others (Flemming et al. 2014; Cusmano et al., 2010; Balogh and Ferto, 2015). For example, the vines in SHNW were introduced by colonial masters from Europe; the climate is warmer; the grapes are more ripened and produces wines that tend to have more sugar and more alcohol; the wines are full-bodied with lower acidity and fruity; the wines tend to be labelled by the grape variety i.e. Cabernet Sauvignon; wines are often made for earlier consumption and shorter aging periods with fewer regulation intervention.

9. Specialization in this context is used synonymously with comparative advantage. The concept of Revealed Comparative Advantage (RCA), measures international specialization and estimates the relative degree of countries involved (Laursen, 2015). Comparative advantage is therefore, the driving force of specialization leading to competitiveness (Ricardo, 1821; Cho and Moon, 2013; Porter, 1990).

applications, however, differ in terms of the analysis' purpose, the survey's degree, and the spatial-temporal structure (Crescimanno et al., 2013; Schimmenti et al., 2009). Many studies have looked at the competitiveness of the world wine trade from various perspectives and methods, including (i) the gravity model, which is used to study the determinants of the wine trade (Bianco et al., 2017; Castillo et al., 2016; Dascal et al., 2002; Gouveia et al., 2018; Lombardi et al., 2016) and (ii) the historical perspective, which is used to look into the dynamics of the wine trade (Anderson and Norman, 2001; Ayuda et al., 2018; Vink et al., 2004), and finally (iii) The comparative advantage in international trade, which is used to look into the export competitiveness of wine (Balogh and Ferto, 2015; Balogh and Jám bor, 2017; Bozsik, 2005; Crescimanno and Galati, 2014; Deloitte et al., 2016; Esterhuizen and Van Rooyen, 2006; Van Rooyen et al., 2011, 2015; Zivzivadze and Taktakishvili, 2019).

Of these many studies highlighted, very few have specifically investigated the competitiveness of South African wines relative to its rivals. This study contributes to knowledge by providing an empirical account of competitive relationships between South Africa and its rivals. Furthermore, it establishes priority areas to focus on to enhance its competitiveness. Trade specialisation and their determinants are determined through (i) the computation of the Revealed Comparative Advantage, (ii) estimation of the Galtonian regression model and (iii) estimation of the panel regression model. The annual panel data for 1990-2018 obtained from Global Wine Markets is used for the analysis. The findings reveal that all countries migrated to higher price points with variable degrees of success. As a result, South African wines were relatively less competitive than their rivals. The study reveals the relative position of the South African wine industry and draws inferences on priority areas for enhancing competitiveness.

The structure of this chapter is as follows: Section 3.2 provides a literature review. Section 3.3 presents the methodology and data for the analysis. Section 3.4 discusses the empirical results and section 3.5 presents the conclusions and policy implications for the South African wine industry.

3.2 Literature Review

The concept of Comparative Advantage (CA) is traced back to the works of Adam Smith, David Ricardo and John Stuart Mill. Although the concept of CA is used interchangeably with competitiveness (competitive advantage), the difference is in the application. CA is more economic in nature and relates to a country's superior characteristics, such as natural endowment or national policies. Competitiveness, on the other hand, is more entrenched in strategic management and often refers to a company's superior competencies. Competitiveness, according to Van Rooyen et al. (2011), is defined as an industry's or sector's ability to outperform its competitors. However, other scholars suggest that countries or sectors might have competitive advantages as well (Porter, 1990).¹⁰

Bela Balassa (1965) popularised the notion of “Revealed Comparative Advantage” (RCA) as a way to approximate Comparative Advantage in autarky¹¹. The Balassa index compares the performance of countries in one industry to the performance of a reference group of countries, using export flows. The assumption is that the trade patterns show the inter-country differences in relative costs and non-price factors, which easily reveal the comparative advantages of the trading partners (Balassa, 1977). If trade performance is determined by Comparative Advantage, direct observations of trade performance should “show” Comparative Advantage. The notion is structural and enduring, and it gives significant indications in terms of a country's competitiveness, making it useful and applicable today.

Since the seminal work of Balassa (1965), many researchers have examined comparative advantage in international trade at the country level. For example, Bozsik (2005) researched the competitiveness of Hungarian wines in the European Union (EU) market. He employed relative export and import advantages and Relative Trade Advantage (RTA) indices to analyse the extent to which price differences determine the competitiveness of wine. The results show that most Hungarian wines, except bottled white wine, are comparable to other wines on EU markets in terms of price. The quantity of wine marketed was as crucial as the price level. White wines were

10. In this context and study, comparative advantage/specialization leads to competitiveness (Ricardo, 1821; Cho and Moon, 2013; Porter, 1990).

11. Autarky is known to be the condition where equilibrium prices are not affected by influences external to an economy (Houck, 1986).

found to be more competitive as their market share increased despite rising prices. The decisive factor affecting purchase with products (such as wine) is not necessarily the price advantage but often the brand (Boszik, 2005). The current study, however, did not consider the underlying factors for such a trend.

Zivzivadze and Taktakishvili (2019) investigate the competitiveness of Georgian wine exports using three approaches, the Trade Intensity Index, the Revealed Comparative Advantage Index, and the Competitiveness Index of Wine Exports. The results show that, for the period 2008-2018, Georgian exports had a comparative advantage in the international wine market. However, when it comes to large volumes of wine production, the industry found it difficult to compete with countries such as France, Italy, the USA, and Germany- because these countries are among the top wine producers in the world with well-established brands (Zivzivadze and Taktakishvili, 2019).

Anderson and Wittwer (2013) examined the Georgian wine industry concentrating on the determinants of Comparative Advantage using the RCA index. The findings suggest that terroir, tradition, and technology are three important factors of a country's CA in wine production. Another study by Anderson and Wittwer (2013) looked into the global wine market and the impact of exchange rates on competitiveness. According to the findings, currency rates have had a substantial impact on the fortunes of some countries. Countries that experienced real exchange rate appreciation were adversely affected since they received low prices for their exports and faced more foreign competition in their home market. In contrast, those countries that experienced a real depreciation gained from exports and imported less. The study also predicted that China would play a prominent role in the global wine market due to its increasing share of global wine consumption and a big market. The study used RCA to only determines the impact of the real exchange rate on comparative advantage. This study, however, applies a similar approach but determines the impact of many variables on SHNW comparative advantage.

Crescimanno and Galati (2014) analysed the competitiveness of Italian wines in the international market using the Revealed Trade Advantage approach. The findings reveal that the wine market has seen a significant structural transition as a result of new rivals entering the global production stage, a shift in demand regionally, and consumers' tastes shifting toward quality wines. Increased competitiveness of some markets, such as Asiatic, East, or North European countries, which did

not have a viticulture tradition and where the recognition of the health benefits of wine and the product as an expression of an Italian lifestyle were strategic factors in Italian wine's success. (Crescimanno and Galati, 2014). The paper used the RTA index and captured Italy's competitive advantage concerning individual world partners. Unlike the traditional approach, this paper uses the RCA index to capture South Africa's competitiveness against rivals in the SHNW.

Balogh and Ferto (2015) examined the pattern and determinants of major wine-exporting countries' global wine export competitiveness (including South Africa) using RCA and panel models from 2000 to 2013. Results show that France, Italy, Spain, Chile, Australia, and the USA are the most competitive wine exporters. Findings also reveal RCA divergence over time. Agricultural employment, grape area harvested, and WTO membership positively influences competitiveness, while GDP and exchange rate negatively impact export competitiveness. While the study looked into the magnitude and dynamics of revealed comparative advantage among major global competitors in the Old and New Worlds, as well as the determinants of global wine export competitiveness, the current study looks into the competitiveness of Southern Hemisphere players and the forces that drive it.

The competitiveness of wine can also be examined at a regional level (Balogh and Jám bor, 2017; Gaeta and Corsinovi, 2014; Itçaina et al., 2016; Meloni and Swinnen, 2013). Meloni and Swinnen (2013), for example, looked into the political economic and existing wine guidelines in the EU regarding volumes, prices, and quality and found that most EU guidelines originates from Italian and French public guidelines. Another study by Meloni and Swinnen (2016) looked into the political and economic history of vineyard planting rights in Europe, claiming that authorizing planting rights is a major issue in EU wine legislation. However, the fundamental technique was not considered in this study. This study, however, did not consider this approach.

Balogh and Jám bor (2017) analysed global comparative advantage in the EU wine industry. They tested the span and stability of trade indices (Balassa indices) for 2000-2013. The results showed that Bulgaria, Cyprus, Greece, France, Portugal, Italy, and Spain were the highest-ranked European wine producers globally and had the highest comparative advantage. However, the span and stability tests indicate that trade advantages have deteriorated for most countries except France, Italy, and Spain. The decline was attributed to EU specific economic reasons such as the

2008 guideline on a limited amount of land to be used and the world economic crisis. This study uses a similar RCA approach and further investigates the factors influencing RCA in the Southern Hemisphere New World region.

Cusmano et al. (2010) compared two New World countries (Chile and South Africa) and one Old World country (Italy) in terms of wine export value, production, and volume (Italy). The research combined secondary sources with original micro-level data on enterprises to examine the catching-up impact within the context of a sectoral innovation system. The findings reveal that rising countries with a wide range of institutional frameworks and innovation strategies have successfully participated in technical modernisation and product standardization. Furthermore, newcomers to the wine industry have adapted to changing demand exceptionally well, combining developing scientific ideas with institutional building efforts and strong marketing strategies. Through a process of technology modernization, product standardization, and marketing innovation, it was discovered that South Africa, in particular, is rapidly catching up to international norms. This was reflected in the rapid growth since post-independence. For the year 2000, Grant et al. (2015) compared Australian wine production and export performance to the ten major wine-exporting countries (including South Africa). They established three performance indicators and one productivity measure specifically for the study. The findings reveal that wine exporters had a variety of roles in relation to one another. For example, in the year 2000, South Africa was found to have a strong comparative advantage in production and exports, with export market penetration and value at 58 percent, a reflection of both the severe constraints imposed on the country during the apartheid regime and the subsequent reinvigoration of the economy.

Fleming et al. (2014) examined the influence of 11 large wine-export countries (South Africa included) on Australia's performance and focused on the challenges of other Southern Hemisphere New World producers and Old World producers for 2000-2009. They used four performance measures. All countries migrated to higher price points with varying degrees of success. They also discovered that New World producers, such as Spain and Portugal, were more successful at increasing export value than extracting value from their domestic markets. The findings also show that during the 2000s, Australian wine growers lost some of their competitive advantages. The study used data from Global Wine Markets from 1961 to 2009. (A Statistical Compendium). The focus was on the challenges issued by competition, including the competition from Southern

Hemisphere New World (SHNW). This study uses data from the same source but extended for 1990 - 2018 and focuses mainly on wine value and determinants of specialisation in SHNW.

They are two studies that looked specifically at the competitiveness of the South African wine industry. First, a study by Esterhuizen and Van Rooyen (2006) investigate the competitiveness of the South African wine industry using the wine competitiveness index (RTA). Two approaches were used for the analysis. Firstly, the Revealed Trade Advantage (RTA) was used to measure quantitatively to what extent the South African wine industry competes internationally and found a positive trend during the study period 1990 - 2003. Second, using the Wine Executive Survey¹², they analysed the major success factors of competitiveness as strict regulatory standards, the manufacture of low-cost, high-quality goods, as well as efficient supporting industries and the availability of local primary input suppliers. They did find, however, that factors such as the strength of the Rand, a lack of trust in the political support system, exchange rate fluctuations, the competence of public sector personnel, South Africa's labor policy, crime, and the growth and size of the local market had a negative impact on competition. They advised that these considerations be factored into the industry's strategic plan.

Secondly, a study by Van Rooyen et al. (2011) used a four-step framework to measure and analyse the competitive performance of the South African wine industry. The first step used the Wine Competitive Rating, based on trade performance as measured by the Relative Trade Advantage method (Balassa, 1989). The measure uses actual trade indices to measure performance. The second step identified the main factors influencing competitive performance using a Wine Executive Survey that recorded views and opinions of South Africa wine executives on competitive trends. The third step analysed the major factors and established determinants of competitiveness using a Porter's Diamond approach. The last stage used data from the three previous steps to identify and analyse changes in the South African wine industry's 'competitive space' over time, and then set an agenda for the industry to improve competitive performance. According to the conclusions of the study, South African wines are becoming more competitive worldwide, with a clear upward trend since the 1990s. The trend, however, has slowed over time.

12. Wine Executive Survey (WES) indicates executive opinions and perceptions of factors that enhance or constraint competitive performance. It involved rating 121 factors as either enhancing or constraining competitive performance, rated on a Likert scale with 1 (constraining) and 5 (enhancing). The goal of the WES was to establish an opinion benchmark for comparison with the empirical RTA measurement.

The study emphasized the impact of regulation and the presence of a supportive government policy environment in halting the trend. They also recommended more lobby discussions and building more trusting relationships between the industry stakeholders and the government (Van Rooyen et al., 2011).

These two studies on the South African wine industry's competitiveness (e.g. Esterhuizen & Van Rooyen, 2006; Van Rooyen et al., 2011) serve as a good foundation for this study. Not only did the study identify the negative factors influencing performance in the wine industry, but it also suggested ways to combat the negative trends. However, the study only analysed the RTA of 10 wine-producing countries (including SHNW) for 1961-2003. However, it did not explain the relative positions of these countries in terms of performance and their relative success in the global wine market. No competitive performance study has been conducted on the wine industry in the ten years since Van Rooyen et al.(2011). Therefore, this study contributes to the literature as follows: (i) provides an empirical account of the competitive relationships between South Africa and its rivals in the Southern Hemisphere (due to its similar characteristics in terms of climate, wine taste, varietal labelling, unrestrictive winemaking, and cellaring) for the extended period between 1990 - 2018; (ii) explains the relative positions of SHNW producers in terms of performance (i.e. export volume & value and specialisation/RCA) and their relative success in the global market; (iii) investigate factors influencing specialisation in SHNW and (iv) identifies priority areas to focus on and offer essential information for policymakers to make strategic decisions to re-position the South Africa wine industry for sustainable growth. Finally, the analysis examines changes in the 'competitive space' of SA wines and rivals in SHNW and investigate the factors influencing specialisation/comparative advantage using the methods described in the next section.

3.3 Methodology and Data

3.3.1 Measuring trade specialisation (Revealed Comparative Advantage)

Theoretically, a country's comparative advantage is determined the costs and prices of the product, However, because a comparable dataset for all nations is sparse or unavailable, Balassa (1965) introduced an indicator based on the assumption that a country's comparative advantage is reflected in its trading patterns over time. The concept of Revealed Comparative Advantage is based on

trade flows and approximates the amount to which comparative advantages exist rather than providing information about their ex-ante origin (i.e. factor endowments, institutions, and infrastructure) but approximates the extent to which comparative advantages exist (Laursen, 2015; Leromain & Orefice, 2014; Marconi, 2012). The study uses Balassa's Revealed Comparative Advantage approach to measure the trade specialization of SHNW producers as follows:

$$RCA = \left[\frac{\left(\frac{X_{ij}}{X_{it}} \right)}{\left(\frac{X_{wj}}{X_n} \right)} \right] \quad (3.1)$$

where RCA is trade specialisation, X is the export, i is a given country, and j is wine. t denotes a total of all products that a country exports and n are the totals of all products that the world exports. The Balassa index estimates the ratio of the share of a specific product in a country's total exports to the share of that product in the world exports. When the index value exceeds 1 ($RCA > 1$), it demonstrates a revealed comparative advantage in the product. A value less than 1 ($RCA < 1$) is demonstrative of a revealed comparative disadvantage.

The Balassa-index (RCA) is criticized for excluding imports, neglecting the various impacts of agricultural policies and exhibiting asymmetric values (Vollrath 1991; De Benedictis and Tamberi, 2004). However, the asymmetric value of the RCA -index reveals that it ranges from one to infinity; this is not an issue, unless it changes between zero and one in the case of comparative disadvantage, which overestimates a sector's relative weight. As a result, Dalum et al. (1998) proposed that the RCA -index be turned into the Symmetric Comparative Advantage ($RSCA$) index to overcome the asymmetric problem as follows:

$$RSCA = \frac{(RCA - 1)}{(RCA + 1)} \quad (3.2)$$

The ' $RSCA$ ' takes values between -1 and 1 , with values between 0 and 1 indicating a comparative export advantage and values between -1 and 0 , a comparative export disadvantage. Since the $RSCA$ distribution is symmetric around zero, a potential bias is avoided (Dalum et al., 1998). The main benefit of this method is that it attributes to changes below unity the same weight as changes above unity. Furthermore, the RCA -index (and its transformation, the $RSCA$ -index) excludes

imports, which are more likely to be influenced by policy interventions (Balogh and Jámor, 2017). Data for the analysis was obtained from Global Wine Markets, 1835 to 2018: A statistical compendium, Adelaide: University of Adelaide Press, 2019.

3.3.2 Analysing the stability patterns and magnitude of specialisation in SHNW

Evolutionary economics assumes that technology is a significant determinant of global specialisation (Dalum et al., 1998). Technological accumulation and patterns of industrial comparative advantage often remain steady and stable over time (Dosi, 1990; Sharma et al., 2009). If *RSCA* were expected to show such persistence patterns, it is reasonable to assume that specialisation would also remain stable over time.

If the *RSCA*-index is calculated for the (wine) industries at two different points in time, the two distributions of *RSCA* should be positively correlated with each other. However, because technologies are mainly specific and implicit in nature (i.e., firms' in-house technological advancement is usually achieved through contribution from innovation, competition, and public knowledge), the degree of correlation is likely to drop the further apart the years under consideration are.

In this context, the study uses a Galtonian (1889) regression model, a statistical technique for bivariate distributions. The method was first used by Hart and Prais (1956), who analysed the size distributions of firms. Cantwell (1989) used the technique to analyse technological innovations in industries, Creedy (1985) used it to analyse income distribution in the UK, and Sutcliffe and Sinclair (1980) used it to study the seasonality of tourist arrivals in Spain. In the context of analysing structural changes in trade specialisation of SHNW producers, the study estimates the Galtonian regression as follows:

$$RSCA_{ij}^{t2} = \alpha_i + \beta_i RSCA_{ij}^{t1} + \varepsilon_{ij} \quad (3.3)$$

where superscripts *t1* and *t2* describe the start and end years, respectively. The dependent variable, the value of *RSCA* at time *t2* for wine sector *i* in country *j*, is regressed on the independent variable, which is the value of *RSCA* in year *t1*. α and β are standard linear regression parameters and ε is a

residual term. In this analysis it is assumed that the regression is linear and that the residual ε_{ij} is stochastic ($\varepsilon_{ij} \sim N(0, \sigma)$) and independent of $RSCA_{t1}$ (independently identically distributed).

As in the case of SHNW country analysis, the idea behind the regression is that if $\beta = 1$, then this suggests an unchanged pattern of RSCA between periods $t1$ and $t2$. This implies no change in the overall wine trade specialisation. If $\beta > 1$, then the wine trade specialisation is strengthened; a country tends to be more specialised in sectors where it is already specialised, and less specialised where initial specialisation is low. Such a movement can be termed β -divergence in trade patterns. Similarly, if $0 < \beta < 1$, it can be termed β -convergence, i.e. on average, sectors with initial low RSCAs increase their values over time while sectors with initial high RSCAs decrease their values (Jambor, 2013; Torok and Jambor, 2011). The magnitude of $(1 - \beta)$ therefore measures the size of the convergence effect, or of what is termed the 'regression effect' towards the mean. However, in the special case where $\beta < 0$, a change in the index sign is shown. According to Dalum et al. (1998), $\beta > 1$ is not a necessary condition for growth in the overall specialisation pattern. They argue that sufficient conditions for specialisation or de-specialization need further analyses.

The study analyses the changes in the degree of specialisation by measuring the variance of the RSCA index, which shows the extent of the dispersion of the distribution around the mean. Previous studies (Patel and Pavitt, 1987; Pavitt and Soete, 1980; Soete, 1987) used the standard deviation of the revealed technological advantage index as a measure of such specialisation. The analysis is extended to the previous RSCA (see, equations 3.1 and 3.2) regression analyses, where the standard deviation of the RSCA index is identified as a measure of specialisation. The study examines whether SHNW producers have become more or less specialised, and assesses the extent of the specialisation patterns for each SHNW country. The study follows the procedure used by Hart (1976) and Cantwell (1989). On the basis of equation (3.3), if the variance of the RSCA-index at time $t2$ is denoted by $(\sigma_{t2})^2$ then:

$$(\sigma_{t2})^2 = \beta_j^2 (\sigma_{t1})^2 + \sigma_\varepsilon^2 \quad (3.4)$$

where β_j^2 is the square of the regression coefficient (from equation (3.3)), $(\sigma_{t1})^2$ is the variance of the RSCA index at time $t1$, and σ_ε^2 is the variance of the error term. The coefficient of determination R_j^2 becomes:

$$R_j^2 = 1 - (\sigma_\varepsilon^2 / (\sigma_{t2})^2) = ((\sigma_{t2})^2 - \sigma_\varepsilon^2) / (\sigma_{t2})^2. \quad (3.5)$$

When equations (3.4) and (3.5) are combined to give:

$$(\sigma_{t2})^2 - \sigma_\varepsilon^2 = \beta_j^2 (\sigma_{t2})^2 = R_j^2 (\sigma_{t2})^2 \quad (3.6)$$

The equation (3.6) is rewritten to show the relationship between the variance of the two distributions as follows:

$$(\sigma_{t2})^2 / (\sigma_{t1})^2 = \beta_j^2 / R_j^2 \quad (3.7)$$

This is simplified as:

$$\sigma_{t2} / \sigma_{t1} = |\beta_j| / |R_j| \quad (3.8)$$

R_j is the square root of the coefficient of determination, obtained from the regression, and σ^2 is the variance of the dependent variable. Equation (3.8) shows that the degree of trade specialisation rises when $\beta^2 > R^2$, (leading to divergence) and falls when $\beta^2 < R^2$ (leading to convergence), i.e. those RSCAs initially below the SHNW country average are, in the final year, above average and vice versa. The relative position of the respective industries remains unchanged if $\beta = R$.

A high variance of the distribution of RSCA indices over time indicates a high variance in specialisation or a narrow degree of specialisation, while a low variance indicates that the country has a broad range of technological advantage. Using the estimated regression values, the extent of specialisation increases if $|\beta^{\wedge j}| / |R^{\wedge j}| > 1$, and decreases if $|\beta^{\wedge j}| / |R^{\wedge j}| < 1$.

The estimated coefficient ($R^{\wedge}$) is a measure of the mobility the rise and fall of the *RSCA* distribution for SHNW producers. A high value of $R^{\wedge}$ indicates that the relative position of SHNW producer is little changed, while a low value indicates that some producer countries are moving closer together and others further apart, quite possibly to the extent that the ranking of these industries changes. The magnitude of $(1 - R^{\wedge})$, therefore, measures what is described by Cantwell (1989) as the ‘mobility effect’. The ‘mobility effect’ would capture the tendency of the rankings of the SHNW specialisation/comparative advantage to change over time. The Galtonian effect, on the other hand, would capture any tendency of reversion towards the mean for the distribution as a whole. It could

be that even where the regression effect suggests a fall in the degree of specialisation due to a proportional move in industries towards the average ($\beta < 1$) that this is outweighed by the mobility effect, due to changes in the proportional position between industries ($\beta > R$).

3.3.3 Determinants of specialisation in SHNW: 1990-2018

The conceptual framework of the model follows the explicit production function where the set of explanatory variables (see Table 3.2.) are taken into account as potential factors explaining the specified dependent variable, RSCA. In addition, guided by empirical literature (Van Rooyen et al. 2011; Pappalardo et al. 2013; Anderson, 2013; Balogh and Ferto 2015; Anderson and Wittwer, 2013), the study consider some country-specific variables as possible explaining the extent of specialisation in SHNW for 1990-2018. To explore the dynamic relationship between the dependent and explanatory variables, the conceptual framework is summarized as follows:

$$Y_{it} = \alpha + X_{it}\beta + \varepsilon_{it} \quad (3.9)$$

for

$$i = 1, 2, \dots, N.$$

$$t = 1, 2, \dots, T.$$

where

- i. Y_{it} is the dependent variable (leverage) pooling N cross-sectional observations and T time series observations;
- ii. α is the intercept;
- iii. Vector X_{it} contains K explanatory variables for country i in year t ;
- iv. Vector β contains K regression coefficients to be estimated; and
- v. ε_{it} is the error term,

with the assumption that the disturbance terms ε_{it} are independently and identically distributed and have zero means. $E(\varepsilon_{it}) = 0$, constant variances $Var(\varepsilon_{it}) = \sigma^2_{\varepsilon}$, and all the other classical assumptions hold.

The specific outfitted model in an estimable econometric form, the panel regression model, is given as follows:

$$\begin{aligned}
RSCA_{it} = & \alpha + \beta_1 GVPcapita_{it} + \beta_2 VWXs_{it} + \beta_3 VWMs_{it} + \beta_4 UVXs_{it} + \beta_5 UVMs_{it} \\
& + \beta_6 BeeCsup_{it} + \beta_7 RGDP_{it} + \beta_8 REXCH_{it} \\
& + \varepsilon_{it}
\end{aligned} \tag{3.10}$$

where α is the constant, β s are coefficients to be estimated, and ε_{it} denotes the error term. The study defines the explanatory variables ($GVPcapita$, $VWXs$, $VWMs$, $UVXs$, $UVMs$, $BeeCsup$, $RGDP$, and $REXCH$) in the next paragraph. Although the equation represents a simple model, its assessment raises a few significant econometric issues. The equation is estimated using panel data for a longer time period and a smaller number of countries (28 years and 5 countries). The advantages of the panel data approach is that it controls for individual heterogeneity. The time-series and cross-sectional studies do not control for individual heterogeneity and risk generating biased results (Moulton, 1987). A panel- based approach will also be more desirable in order to deal with unobservable effects. Introducing the individual heterogeneity in the equation gives:

$$\varepsilon_{it} = \mu_i + v_{it} \tag{3.11}$$

where μ_i is individual heterogeneity or individual effect and v_{it} the idiosyncratic errors or idiosyncratic disturbances, so called because they change across t as well as i . Since individual effects are included in the model, they must be treated as either fixed or random. Including individual effects with the fixed and random as follows:

$$\begin{aligned}
RSCA_{it} = & \alpha + \beta_1 GVPcapita_{it} + \beta_2 VWXs_{it} + \beta_3 VWMs_{it} + \beta_4 UVXs_{it} + \beta_5 UVMs_{it} \\
& + \beta_6 BeeCsup_{it} + \beta_7 RGDP_{it} + \beta_8 REXCH_{it} + \mu_i \\
& + v_{it}
\end{aligned} \tag{3.12}$$

If μ_i is treated as a random variable, it gives a random effect model (REM). In this case $\mu_i \sim \text{IID}(0; \sigma^2_u)$, $v_{it} \sim \text{IID}(0; \sigma^2_v)$, and μ_i is independent of v_{it} . In addition, the explanatory variables are independent of the μ_i and v_{it} values for all i and t (Baltagi and Griffin, 1995). Otherwise, if μ_i is assumed to be the fixed parameters to be estimated and the remainder disturbances are stochastic with v_{it} independent and identically distributed $\text{IID}(0; \sigma^2_v)$, then the explanatory variables are

assumed to be independent of v_{it} for all i and t . In this case, the fixed effect model (FEM) is applied.

Defining the determinants of specialisation in SHNW producer countries

The industry's competitive performance is the result of a complex interrelation of determining factors, each playing an enhancing or constraining role. Therefore, the following hypotheses, drawn from available empirical literature (Van Rooyen et al. 2011; Pappalardo et al. 2013; Anderson, 2013; Balogh and Ferto 2015; Anderson and Wittwer, 2013) are considered to investigate the determinants of specialisation/RSCA in SHNW:

Grapevine area per capita (GVPCapita): This is measured as hectareage per hundred people. It is assumed that the higher the GVPCapita, the greater the degree of specialisation. It is expected that as countries' grapevine area increases, more is invested in innovation and technology, leading to specialisation over time.

Volume wine exports (VWXs): The total amount of exported wine from production is measured in kilolitres. The study hypothesise that the greater the exports, the more specialised the wine industry becomes. This is so since exports attract higher earnings for the industry.

Volume wine imports (VWMs): Also measured in kilolitres is hypothesises that the greater volume of wine a country imports, the less its specialisation. It is more profitable to export wine than it is to import. Preferably, countries should produce their own wine to accrue all the benefits along the value chain from grape production up to the final retail stage.

Value of exports (UVXs): The export value of wine measured in US\$ '000 influences specialisation because the wine industry's success is directly linked to the quality and value of wine. Competitiveness in the wine export market is becoming increasingly dependent on the price points at which the wines can be traded. The more valuable the traded wine is the more specialized the wine industry becomes.

Value of imports (UVMs): The import value of wine, also measured in US\$ '000, will negatively impact industry specialisation. This is because high-value wine imports will be more desired by consumers than the low-value wines produced locally.

Volume of beer consumption (BeerCsup): This variable is measured in kilolitres and influences specialisation. When more people drink beer, it is assumed that fewer people will be drinking an alternative, in this case, wine, thereby affecting the local wine consumption. According to SAWIS (2020), beer is the preferred alcoholic beverage in South Africa. It accounts for approximately 75%, with wine consumption only at 10% and fruit beverages and spirits at 12%. Therefore, it is assumed that shifting beer consumers to wine would significantly improve the SA wine industry's competitiveness. For example, the per capita wine consumption for South Africa is currently at 11 litres which are low compared to countries such as Portugal (59 litres), France (51 litres), Italy (44 litres), Argentina (27 litres), and Namibia (20 litres).

Real GDP - US\$ million (RGDP): The standard proxy for economic development is GDP and is measured as GDP per capita at PPP constant 1990 international US\$. It is reasonable to expect that higher factor endowments (land, labour, capital and technology innovation) in a country leads to higher comparative advantages (Jambor, 2014). All in all, higher factor endowments increase comparative advantages, implying that countries with more land, labour, capital, and technology have better opportunities to become competitive. Therefore, a positive Real GDP is expected to increase a country's comparative advantage.

Real exchange rate - US\$ million (REXCH): Denotes the exchange rate between the US dollar and local currencies. There is no clear consensus on exchange rate changes in the literature. However, one would expect that an increase (depreciation) of the SHNW currency would imply a trade advantage for exports and a trade disadvantage for imports. The study defines a fall in the foreign currency unit per US value as depreciation. Therefore, a possible negative relationship in the empirical results implies that a depreciation of the SHNW currency will increase the degree of specialisation. A study by Anderson and Wittwer (2010) found that countries that experienced real exchange rate appreciation were adversely affected since they received low prices for their exports and faced more foreign competition in their home market. In contrast, those countries that

experienced a real depreciation gained from exports and imported less. Table 3.2. provides an overview of the description of variables and related hypotheses.

Table 3.2. Description of independent variables and expected Signs

Variable	Description unit/measure	Expected signs
<i>GVPcapita</i>	Grapevine area per capita (ha per 100 people)	+
<i>VWXs</i>	Volume of exports (KL)	+
<i>VWMs</i>	Volume of imports (KL)	-
<i>UVXs</i>	Value of exports ('000 US\$)	+
<i>UVMs</i>	value of imports ('000 US\$)	-
<i>BeerCsup</i>	Volume Beer consumption (KL)	-
<i>RGDP</i>	Real gross domestic product US\$m	+
<i>REXCH</i>	Real exchange rate Local currency per US\$	+

Source: own composition.

Diagnostic tests and estimation techniques

Prior to estimating the equation (3.10), the study runs a number of diagnosis and specification tests. Starting with a unit root test, a cross-sectional dependence test, followed by a serial correlation test, a heteroscedasticity test and the Hausman test. Thereafter, the description of extension models, i.e. the feasible generalized least squares (FGLS) and the panel-corrected standard errors (PCSE) was made.

Panel unit root test

A number of procedures have been devised for the analysis of unit roots in a panel context. The concept is to incorporate data from both the time-series and the cross-sectional dimensions. Panel-based unit root tests have a higher power than the individual-based time series. The most commonly used tests in literature are Levin and Chu (2002), Pesaran and Shin (2003) and Fisher-type tests using Augmented Dickey Fuller (Maddala and Wu, 1999).

Generally, the unit root tests classification is based on the Autoregressive (AR) process across a cross-section or series. Therefore, considering the AR (1) process for panel data:

$$y_{it} = \rho_i y_{it-1} + \delta_i X_{it} + \varepsilon_{it} \quad (3.13)$$

where $i = 1, 2, \dots, N$ cross-sectional units or series, observed over periods $t = 1, 2, \dots, T_i$.

X_{it} represents the exogenous variables in the model, including any fixed effects or individual trends, ρ_i denotes the autoregressive coefficients, ε_{it} is the error term, assumed to be mutually independent idiosyncratic disturbance. If, $|\rho_i| < 1$, y_i is said to be weakly (trend-) stationary. On the other hand, if $|\rho_i| = 1$, y_i contains a unit root. For the purpose of the unit root test, the assumption that persistent parameters are common across cross-sections so that $\rho_i = \rho$ for all i is made.

The study uses the Levin et al. (2002) unit root test. The test is based on the following equation:

$$y_{it} = \alpha_i + \delta_{it} + \theta_t + \rho_i y_{i,t-1} + \varepsilon_{it} \quad (3.14)$$

where $i = 1, 2, \dots, N$ cross-section units or series, that are observed over periods $t = 1, 2, \dots, T_i$. The equation (3.14) allows for two-way fixed effects and unit-specific time trends. Because the coefficient of the lagged dependent variable is homogeneous across all units of the panel, unit-specific fixed effects are a significant source of heterogeneity. The test involves the null hypothesis for all against the alternative for all with additional assumptions under the null also being required about the coefficients corresponding to the deterministic components. The test uses the following hypothesis: for H_0 : each time series contains a unit root and for H_1 : each time series is stationary.

Cross-sectional dependence test

Panel-data models are likely to exhibit substantial cross-sectional dependence in the errors, which may emerge due to the presence of unobserved components that eventually become part of the error term, spatial dependence, and idiosyncratic pairwise dependence in the disturbances, with no particular pattern of common components or spatial dependence (Baltagi et al., 2005; Pesaran, 2004). To test for cross-sectional dependence, the study uses the Pesaran (2004) test.

Autocorrelation test

In linear panel-data models, serial correlation biases the standard errors and leads to inefficient results. A Wald test on the null hypothesis of no autocorrelation is used to test for serial correlation in fixed-effects models. This test is based on a discussion of idiosyncratic errors in a linear panel-data model by Woodridge (2002). The simulation by Drukker (2003) backs up the claim that the test has good power. When the test is found to be significant, the variables are considered to be serially correlated, and if otherwise, not correlated.

Heteroscedasticity test

The fixed-effect model assumes homoscedasticity of the stochastic component in the regression errors across countries and time. When this assumption is violated, then the estimates will still be consistent but inefficient. A group-wise Lagrange Multiplier(LM), Likelihood Ratio(LR) and Wald test are performed on the residuals of the fixed-effect model. The null hypothesis is homoscedastic and the alternative is heteroscedastic. The null hypothesis test follows a χ^2 distribution with N-1 degrees of freedom, where N is the number of groups in the sample; in this case, the number of SHNW producers.

Extended estimation methods

There are many estimators that can be applied to panel data. The Ordinary Least Square (OLS) estimator is presented in this study because of its ease of use and also because of its status in the empirical literature. Pooled OLS, on the other hand, has been found to produce biased findings because it ignores unobserved cross-country variation. There are excellent grounds to expect that unobserved particular characteristics such as legislative, legal, cultural, and institutional issues, for example, are likely to affect cross-border trade flows. The commonly used panel models that control for the existence of such effects are the fixed effects (FE) model and the random effects (RE) model (Baltagi and Griffin, 1995) described earlier (see, equations 3.10, 3.11 and 3.12). However, in order to decide which of the two model is appropriate, the Hausman test is performed.

The Hausman Test

The main distinction between the random-effect and fixed-effect models is whether there is correlation between α_i and the set of regressors. Hausman (1978) proposed a test based on the difference between estimates of random effects and fixed effects, i.e., $H_0: \alpha_i$ is uncorrelated with

the explanatory variable, while $H_1: \alpha_i$ is correlated with the explanatory variables. Under the null hypotheses, the random-effects estimator (β_{RE}) is consistent and efficient; the fixed-effects estimator (β_{FE}) is consistent, though not efficient. Under the alternative hypotheses, the fixed-effects estimator is consistent and efficient, but the random-effects estimator is now inconsistent. Therefore, under the null hypothesis, there should be no systematic differences between β_{FE} and β_{RE} such that the null should be $H_0: (\beta_{FE} - \beta_{RE}) = 0$, and the alternative, $H_a: (\beta_{FE} - \beta_{RE}) \neq 0$. The Hausman test statistics are given as:

$$H = (\beta_{FE} - \beta_{RE})' S^{-1} (\beta_{FE} - \beta_{RE}) \sim \chi_k^2 \quad (3.15)$$

where S can be computed using the estimated covariance matrices from the within and the GLS estimation. Under the null hypothesis, the H statistic follows asymptotically a χ^2 distribution.

FGLS and PCSE techniques

Panel data are known to have serial correlation and heteroscedasticity problems. When high autocorrelation and heteroscedasticity are present in the model, a fixed-effects model or a random-effects model may result in inefficient estimates. In this case, special techniques (i.e. feasible generalized least squares (FGLS) and the panel-corrected standard errors (PCSE)) are employed for the analysis. The FGLS method was developed by Parks-Kmenta (1967; 1971; 1986) and uses GLS estimation, while the PCSE method was developed by Beck and Katz (1996). The two methods both control for the presence of heteroscedasticity, autocorrelation, and multicollinearity and are known to produce efficient estimates (Baltagi et al., 2005; Baltagi and Griffin, 1995; Podesta and Wirth, 2009).

3.3.4 Data Source

The variables for empirical analysis are collected from an annual database of Global Wine Markets, 1835 to 2018, Wine Economics Research Centre, University of Adelaide. The dataset includes detailed annual time series for 1835 - 2018 however, the study only considers the years between 1990 and 2018. This is because only in the 1990s did SHNW producers start making contributions to the global wine market (Fleming et al. 2014; Cusmano et al., 2010; Balogh and

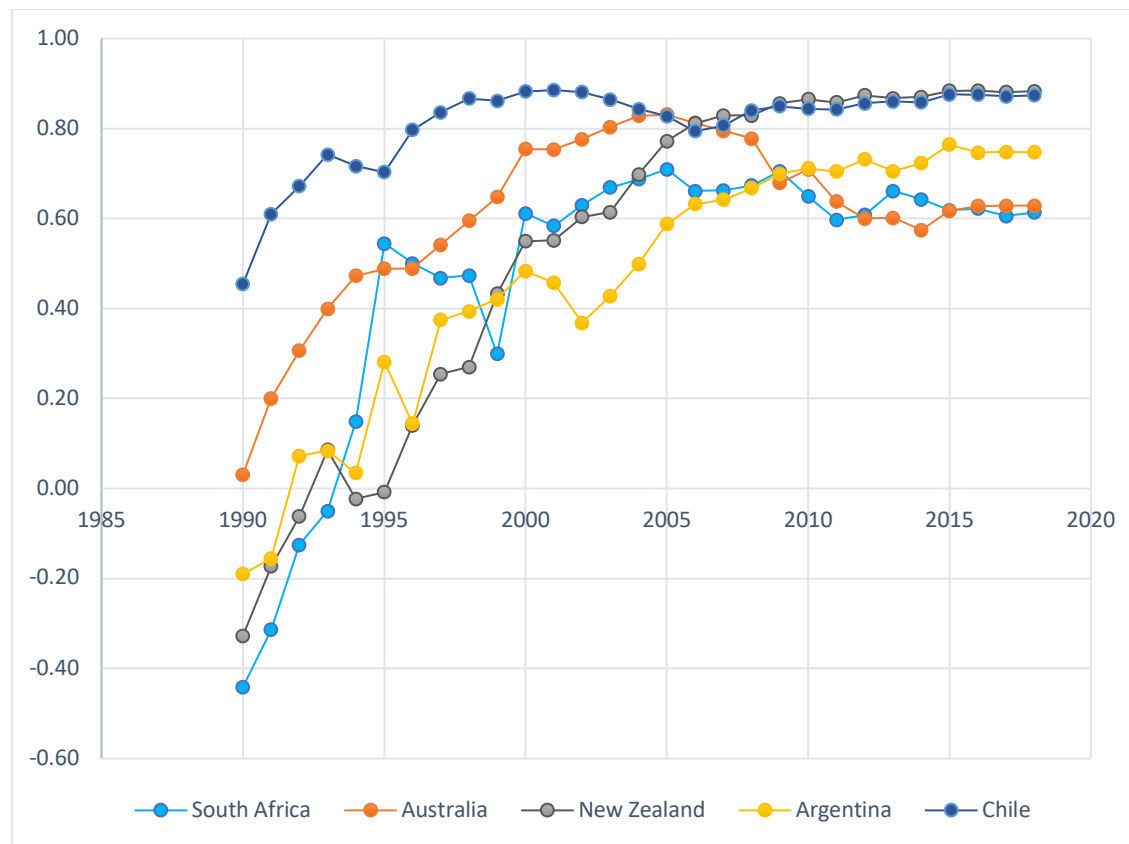
Ferto, 2015; Grant et al. 2015; Fleming et al., 2014; Esterhuizen and Van Rooyen, 2006; Van Rooyen et al., 2011).

3.4 Estimation Results

3.4.1 Measuring trade specialisation (Revealed Comparative Advantage)

Trade specialisation comes about due to increased productivity, providing a comparative advantage (Cho and Moon, 2013). The study measures South Africa's trade specialisation against that of rivals in SHNW to gauge its competitiveness and identify areas for growth. The results are presented in figure 3.2. Generally, SHNW producers have made significant progress since the 1990s, when they contributed only 12% of the global export of wine production volume. However, by 2016 this had increased to 38% (Anderson and Pinilla, 2018). Their progress is even more noticeable when export value is considered. Their growth results from an upgrading process along the quality ladder and their entry into the premium market segment formerly dominated by French and Italian wines (Cusmano et al., 2010). However, this growth is not uniform among SHNW producers (see figure 3.2). To explain this divergence in trends, the study examines the specific characteristics of South Africa and its rivals in SHNW and offer some comparative observations.

Figure 3.2: RCA of South Africa with rivals in SHNW - 1990-2018



Source: Own composition based on data obtained from *Global Wine Markets, 1835 to 2018: A statistical compendium*, Adelaide: University of Adelaide Press, 2020.

South Africa

South African wines' scores in the 1990s reflect both the severe limits imposed on the country during apartheid and the following and massive revitalisation of the industry when sanctions were repealed. (Vink et al., 2004). The results of equations (3.1 and 3.2) (also see figure 3.2) show that South Africa, New Zealand, and Argentina began the decade with a trade disadvantage in wine, with the lowest scores of -0.44, -0.33 and -0.19, respectively. However, by the end of the decade, in 2000, they had improved their scores to 0.61, 0.55 and 0.48 for South Africa, New Zealand, and Argentina, respectively. By comparison, Australia and Chile scored the highest in the same period, each achieving 0.33 and 0.45 in 1990 and 0.75 and 0.88 in 2000.

Before independence, South Africa received very little recognition on the international wine market for two main reasons. First, the formation of the largest cooperative, Koöperatieve Wijnbouwers Vereniging (KWV), which at the time set policies and prices for the entire industry,

discouraged the production of fine wine other than brandy, spirits and fortified wines (Robinson, 2006). Second, boycotts of South African products in protest of the country's apartheid system exacerbated its isolation from the international market. As a result, the export market did not open up until 1994, when South Africa gained independence, and the wine business began to shift (Vink et al., 2004), see figure 3.2.

Between 2000 and 2009, South Africa improved its index score, reaching its peak at 0.71 in 2005. This improvement in revealed comparative advantage is associated with trade liberation, an abundant factor endowment, and technological advancements in wine production (Vink et al., 2004). In 1999, when the South African Wine Industry Trust was established with a mandate to advance the industry's transformation and promote exports (SAWIS, 2020), positive change emerged. Before that, progress was slow; in fact, there was a drop in RSCA scores because of residual stress on producing cheap wine for the domestic market rather than quality wine for the international market (Robinson, 2006), see figure 3.2. At the same time, all SHNW member countries improved significantly, with New Zealand achieving the highest score of 0.86, followed by Chile with 0.85. During 2010-2018, South Africa was comparatively the least successful SHNW producer, scoring only 0.61. During that time, New Zealand and Chile became the front-runners, followed by Argentina and Australia. South African wines have not reached its 2005 peak again.

New Zealand (NZ) initially had a relatively low revealed comparative advantage (disadvantage) in wine production in the 1990s, scoring only -0.33. However, it subsequently bypassed almost all other SHNW producers, except Chile, which equalled New Zealand's score at the end of the study period in 2018. This can be explained in part by the strong institutional presence and the shifting link between the size of the New Zealand wine industry and the volume of the national crush (Fleming et al., 2014; Grant et al., 2015). The area under grape cultivation doubled from 5,980 hectares to 12,822 ha between 1990 and 2000, with the number of wineries increasing from 150 to 358. The industry's strategic focus was on quality grape-growing, which reflected an industry-wide quest to produce quality wine (Fleming et al., 2014). This strategy manifested in an increase in price over the same period, with average grape prices per tonne rising from \$NZ453 to \$NZ1,195 (Grant et al., 2015). At the same time, exports, dominated mainly by white wines (76%), increased significantly.

The number of wine companies increased from 358 to 698 between 2000 and 2011, with foreign owners controlling an estimated 40% of the country's wine production (NBNZ, 2012). This made the country's wine industry a success story of how national institutions can successfully accommodate foreign capital. For the first time in 2004, the industry's export sales exceeded its domestic sales (Brodie et al., 2008). Figure 3.2 shows that New Zealand rose from a slight drop in 1993 to its ascendancy and continued to improve its export market during the 2000s, achieving the highest RSCA value at 0.87 in 2018. The improvements in the industry are attributed to a holistic consensual effort by a well-coordinated industry that put in place calculated measures of innovations and strategies for the growth of the industry.

Chile

On the other hand, Chile had a relatively high revealed comparative advantage (RSCA) value in wine in 1990 at 0.45 (figure 3.2). By 2000, the Chilean wine industry attained the highest RSCA value (0.89) for the study period. The Chilean wine industry peaked in 2000-2001 and has not reached that height again (see figure 3.2). However, its greatest strength lies in the agro-climatic conditions that make it highly competitive (Anderson and Nelgen, 2011). Production costs in grape and wine production were possibly also low relative to Australia and New Zealand (Grant et al., 2015). In 2000-2009, total wine production exports increased from 45% to 70%, considerably higher than South Africa at 42%, Australia at 66% and New Zealand at 63% (Anderson and Nelgen, 2011).

The introduction of democracy in Chile boosted wine exports a great deal in the 1990s, achieving a mean annual export value of U\$109 million during the first five-year period between 1990 and 1994, compared to U\$13 million a decade earlier. According to Chadwick (2003), the improved wine quality was sustained by planting fruit-driven varieties and using current viticulture procedures, which were mostly pioneered by foreign investors (Kunc and Bas, 2009). The industry organisations Vias de Chile and ChiledVid fought for a stronger presence in the export market in the 2000s. They later achieved greater export penetration in the world wine market (Kunc and Bas, 2009). Wines of Chile was developed and has grown to become a key step forward in the export orientation of the industry (Anderson and Nelgen, 2011). The 93 wineries that make up the organization account for 90% of Chile's bottled wine exports. Intangible Business ranked Chilean

wines as the world's second-most powerful wine brand in 2009. (Anderson and Nelgen, 2011, p. 68). Chile continued to improve its export market during the 2000s, achieving the highest value at 0.89 in 2001. However, it slightly reduced its RSCA value to 0.79 in 2006 and again picked up to an average range of 0.80 - 0.88. Interestingly, the industry has had the highest RSCA value since the 1990s relative to other SHNW producers. It scored the highest at the start of the study period in 1990 with 0.45 and continues to maintain its top position in 2018 at 0.89 (see figure 3.2).

Argentina

Argentina had a relatively low value of revealed comparative advantage, the index below 0 (disadvantage) in wine (figure, 3.2). This reflects the fact that, like South Africa, its drive into export markets began later. The comparatively low RSCA values reflect Argentina's mixed success in developing the industry from the 1990s. During the 20th century, Argentina's wine strategy, supported by government policy, focused solely on the domestic market and cheap wines (Stein, 2008). As a result, the industry lacked modern equipment for winemaking, with very little or no oenological expertise available. The problems of this era were worsened by economic stagnation, debt, and the recessions of the 1980s (Stein, 2008).

The industry started to recover in the 1990s with the help of economic reforms that were instigated by the Menem government (1989-99). The relaxation of stringent government prohibitions on foreign direct investment (FDI) allowed the wine sector to upgrade its equipment and vine stock. Furthermore, the inflated peso made it easy for enterprises in the industry to borrow money from abroad at a low cost. Argentinian wines, like those from South Africa, have struggled to compete on quality in wine export markets since the process of improving quality has been slow (San Martin et al., 2008). This was the case until 1999, when the industry took measures to change the export demand function for Argentinian wines (Wines of Argentina, 2011). To target a 10% share of the global wine market by 2020, the industry established a special fund to encourage wine exports to the United Kingdom and the United States. To promote their wines, the industry organized wine tastings, held fairs, tours, and other events overseas, and invited high-ranking members of the global wine industry to visit Argentina's wine regions and wineries (Fleming et al., 2014). They also formed strategic partnerships that improved distribution channels abroad (Thach and Cuellar, 2010).

However, relative to other SHNW producers, Argentina's wine export value per ton of grapes was low in the 2000s (Anderson and Nelgen, 2011). The drop in RSCA growth value from 2000-2002 reinforces this view (see figure 3.2). Nonetheless, Argentina's competitive position in the worldwide market was bolstered by low labor expenses, which allowed wine producers to retain low production costs (Schrock et al., 2001; Stein, 2008; Thach and Cuellar, 2010). The Plan Estrategico Vitivinicola 2020 (Wine Strategic Plan 2020) was established in 2004 with the primary purpose of enhancing the value of wine exports (San Martin et al., 2008). Each and every one of these endeavours has been a resounding success (see figure 3.2). Exports have increased since the action plan was implemented. As a result, the RSCA values have improved comparatively, reaching the highest value of 0.75 in 2018, greater than Australia at 0.63 or South Africa at 0.61.

Australia

Comparatively, Australia had a positive RSCA value in wine in 1990, and by 2005 it attained its highest RSCA value of 0.83. However, similarly to South Africa, Australia has not achieved those heights again since (see figure 3.2).

Several causes affected the expansion of the Australian industry in the 1990s. First, the entry of baby boomers into the middle age bracket, as well as the establishment of supermarkets as retail wine sales locations (Anderson and Nelgen, 2011). In addition, a decrease in the value of the Australian dollar in the mid-1980s aided Australia's early export success (Anderson, 2000), while a devaluation of the home currency in the second part of the 1990s aided export resilience (Sheales et al., 2006). Lastly, the Australian federal government introduced a four-year accelerated depreciation program for the cost of grapevine establishment that encouraged industrial expansion (Grant et al., 2015). These strategies allowed Australia to gain ascendancy, as is evident in figure 3.2. Australia developed an innovative strategy supporting various institutions within the industry that favoured establishing priority areas of research and development financed by producer levies and matching government funds (Aylward, 2006). This strategy allowed Australia to acquire market share in the United Kingdom and the United States. The innovations were instrumental in reorganizing the industry's structure. For example, by introducing innovative mechanical harvesting and trimming procedures, the sector was able to cut high labor expenses (Grant et al., 2015). As a result of the restructuring, a number of mergers and acquisitions occurred, resulting in industry-wide economies of scale..

This industrial consolidation allowed the production of large volumes of consistent, popular, low-cost premium wine for the US and UK markets (Anderson and Nelgen, 2011), which accounted for 70% of Australia's wine export volume in 2000-2001 (Spencer, 2002). Australia's marketing operations, which improved Australia's image as a producer of good value-for-money wines, were also crucial to its export success (Anderson, 2000). This strategy earned the Australian wine industry the reputation of being a high-tech producer of technically faultless wines. The RSCA growth value from 1990 to 2005 reinforces this view (see, fig 3.2). However, after the pivotal point in 2005, the Australian wine industry slowed down RSCA value. The results show that Chile's, New Zealand's and Argentina's RSCA growth values supersede Australia's. Nevertheless, Australia finished the decade with the RSCA value slightly higher than South Africa's, at 0.63 to the latter's 0.61.

In summary, the major finding from this analysis was that SA competes favourably in the global space; however, it still lags behind some players in the SHNW. This analysis is vital considering the similar characteristics in this region and the potential for growth presented. A review of the critical success factors and lessons learnt from the analysis (3.4.1) suggests that South Africa wine competitiveness could be enhanced by the following strategies and programs (i) the creation of strong institutions within the industry that can advance the growth agenda across the sector; (ii) attract and increase foreign direct investment; (iii) increase export sales; (iv) create a well-coordinated wine industry across the value chain; (v) reduce input production costs; (vi) increase the number of bottled/package export sales; (vii) promote SA brand through effective marketing and; (viii) build strong relationships between the government and the wine industry. Thus, it is up to the South African wine industry to scale up and emulate some of the rivals' strategies to be competitive in the global wine market. While the empirical results of this study provide vital insights into the competitive trends in the SHNW countries, these findings in isolation are broad and limited in their application. However, the study provides insights into the extent of South Africa competitiveness. Furthermore, it draws some lessons on what actions can be taken to drive an upward trend in the competitive performance of the industry. Furthermore, the conclusions and strategic proposals in this study can be applied in future research and used by players in the industry to increase South Africa competitiveness.

3.4.2 Analysing the stability patterns and magnitude of specialisation in SHNW

Examining stability patterns and the magnitude of specialisation will help the understanding of the transformation structures of SHNW producers over time, which might in turn indicate potential problems and suitable solutions for growth. The study uses the Galtonian model in equation (3.3) and present the results of the analysis in table 3.3.

Basically, β measures the stability of a country's specialisation pattern between the two periods. A low β indicates a high degree of turbulence, but if β is equal to 1 ($\beta = 1$) then the pattern has remained unchanged. Table 3.3 shows that all SHNW producers have high autoregressive coefficients β , suggesting specialisation patterns are stable over time. New Zealand and Argentina report the highest coefficients at 0.91 and 0.87 respectively, while Chile reports the lowest coefficient at 0.67 for the study period. South Africa comes fourth with 0.78, just after Australia with its coefficient of 0.79.

Table 3.3: Stability & magnitude of trade specialisation -SHNW 1990-2018

	α	β	S.E	β / R
S.Africa	0.1393	0.7824***	0.0580	0.8949
Australia	0.1492	0.7900***	0.0391	0.8405
N.Zealand	0.0921	0.9073***	0.0277	0.9294
Argentina	0.0915	0.8722***	0.0549	0.9626
Chile	0.2793	0.6722***	0.0490	0.7668

Note: *, **, *** denote results that are significantly different from zero at the 1%; 5%; and 10% levels

The degree of specialisation pattern: converge or diverge.

β / R measures whether the level of specialisation has gone up or down between the two periods (an increase or a fall in the spread of specialisation, where R is the regression correlation coefficient). If $\beta / R > 1$, it implies specialisation has increased (diverged); if $\beta / R < 1$ then specialisation has decreased (converged). Despite having stable specialisation patterns over time, all SHNW producers countries show a reduction in the specialisation pattern for the study period (see Table 3.3 i.e. $\beta / R < 1$). These results support the findings by Balogh and Ferto (2015) who also reveal RCA divergence over time for the 6 countries investigated. There are a number of

reasons for this downturn (beyond the scope of this study) including, global economic crises, changes to individual agricultural policy, and competition from the Old World.

To conclude, specialisation for all SHNW producers has stabilised for the study period however, it is evident that the degree of specialisation has fallen in the region. This convergence of specialisation patterns implies there is not enough innovations to attract a divergent pattern. A number of reasons for this downturn includes global economic crises, changes to the agricultural policy, and competition from the Old World to name a few. A take for the South African wine industry would be to push for more innovative strategies to grow the wine industry. The study demonstrates in the next chapter (Chapter 4) how innovation could possibly improve competitiveness. In the next section, the study looks at factors influencing specialisation in SHNW.

3.4.3 Determinants of specialisation in SHNW-1990-2018

Diagnostic tests

Panel models have problems of serial correlations, heteroscedasticity and cross-sectional dependence (Baltagi et al., 2005; Baltagi and Griffin, 1995; Podesta and Wirth, 2009). Before estimating panel regression models using equation (3.10), the following standard diagnostic tests were run to ensure there is no violation of the classical linear assumptions (See details of the methods and results in Appendix 3C). First, using the correlation matrix of coefficients, the multicollinearity test found correlation coefficients of below 0.80. Anything above the threshold would produce undetermined coefficients and infinite standard errors, subsequently reducing the accuracy of the null hypothesis (Gujarati and Porter, 2009; Hensher et al., 2012). Second, using the Levin lin Chu (2002) to test the presence of unit roots confirms that the variables were stationary with personal effects and individual specifications. Third, the test results for (Pesaran tests, Wooldridge test and the Lagrange Multiplier Likelihood Ratio test) confirms the presence of cross-sectional dependence, autocorrelation and heteroscedasticity, respectively. Finally, the Hausman test was run to determine the appropriate model for the analysis. The null hypothesis was rejected and concluded that the fixed-effects model was more appropriate (see result details in Appendix 3C).

Because the diagnostic test results confirm the presence of autocorrelation, cross-sectional dependence, and heteroscedasticity in the panel data, the feasible generalized least squares (FGLS) and the panel-corrected standard errors (PCSE) models are used for the analysis. The two approaches are known to control for the presence of heteroscedasticity, autocorrelation, and multicollinearity (Baltagi et al., 2005; Baltagi and Griffin, 1995; Podesta and Wirth, 2009). The study employs four models to ensure robust testing of estimates (i.e., REM, FEM, PCSE and FGLS). However, only PCSE results in the last column of Table 3.4 are discussed.

Table 3.4: Determinants of specialisation in SHNW (dependable variable= RSCA)

	FEM	REM	FGLS	PCSE
GVPcapita	0.0660 (0.1418)	0.3213** (0.1222)	0.5476*** (0.1194)	0.4587*** (0.1239)
VWXs	0.0072*** (0.0013)	0.0051*** (0.0009)	0.0029*** (0.0007)	0.0041*** (0.0008)
VWMs	3.39e-07 (1.20e-06)	-3.77e-06*** (1.08e-06)	-1.55e-06* (8.95e-07)	-1.75e-06* (9.73e-07)
UVXs	0.1727*** (0.0210)	0.1236*** (0.0174)	0.1005*** (0.0181)	0.1037*** (0.0200)
UVMs	-0.0013 (0.0058)	-0.0109* (0.0061)	-0.0031 (0.0047)	-0.0046 (0.0050)
BeerCsup	1.39e-07* (7.37e-08)	-2.89e-08 (2.87e-08)	-4.36e-08 (3.89e-08)	-8.25e-09 (4.10e-08)
RGDP	-5.97e-07* (3.43e-07)	9.68e-07*** (1.93e-07)	7.08e-07** (2.22e-07)	6.80e-07** (2.28e-07)
REXCH	0.0469*** (0.0113)	0.0486*** (0.0082)	0.0495*** (0.0089)	0.0389*** (0.0112)
_cons	-0.4105*** (0.1058)	-0.3937*** (0.0778)	-0.3783*** (0.0885)	-0.3777** (0.1099)
No. of obs	145	145	145	145
No. countries	5	5	5	5

*Notes: *, **, and *** indicates significance at 10%, 5%, and 1%, respectively. Standard errors are provided in parentheses. Own Calculations based on data obtained Global Wine Markets, 1835 to 2018: A statistical compendium*

Generally, the regression results from all four methods are consistent with the hypotheses specified. Results show that grapevine area per capita, the volume of wine exports, the value of wine exports, real GDP, and real exchange rate positively influence specialisation in SHNW. The volume of wine imports and the value of wine imports negatively influence specialisation/comparative advantage. Although the volume of beer consumption is found to have the expected negative sign, it is not statistically significant. Reporting only on PCSE results, *GVPcapita-grapevine area per capita* is positively related to specialisation at 1% significant level, implying that the more grapevine area planted, the greater the degree of specialisation. A unit increase in grapevine hectareage (ha per 100 people) will increase RSCA by .45 points. It is expected that as the countries' grapevine area increases, more is invested in innovation and technology, leading to specialisation over time. *VXMs-volume of wine exports* is positively related to specialisation, as predicted by theory. A unit increase in the volume of exports (KL) will increase RSCA by .004 points. This confirms the hypothesis that the more a country exports, the more competitive it becomes since practice has shown that exports attract higher price points than domestic wine prices (VinPro, 2018).

Concerning VWMs- the *volume of wine imports* was found to negatively correlate with specialisation in SHNW. Although the variable is significant at the 10% level, the coefficient is not economically significant. The importation of high-value wines affects SHNW negatively since these wines compete with local wines. This suggests that countries should grow and produce their own wine as imports tend to reduce specialisation. However, UVXs - *the value of wine exports* and specialisation was positively related at a 1% significant level, implying that a unit increase in the value of exports ('000) will increase the degree of specialisation by 0.10 points. This indicates that higher price points are vital to remaining competitive in the world wine market.

Even though the UVMs-*value of wine import* and BeerCsup-*beer consumption* show the expected negative signs, the coefficients are not statistically and economically significant. This implies that they do not influence the specialisation of SHNW. On the other hand, factor endowments (Real GDP) are positively related to specialisation at a 5% significant level. A unit increase in real GDP (\$ million) will influence specialisation at a negligible value point, going by a minimal coefficient

value. In other words, higher factor endowments increase the comparative advantage, suggesting that countries with more land, labour, capital and technological know-how have better chances of becoming more specialised and competitive. The results support the findings by Balogh and Ferto (2015) who found GDP to have a positive influence on competitiveness. REXCH- *real exchange rate* also plays a vital role in SHNW producer economies. Table 3.4. shows that a unit increase in the real exchange rate (\$ million) will increase specialisation by 0.04 points. This implies that a high US dollar rate devalues the local currency, making exports cheap for SHNW and contributing to specialisation. These results support the argument of Anderson and Wittwer (2013) that exchange rates play a vital role in the wine market.

While the empirical results of this study provide important insights into the competitive trends in the SHNW countries, these findings in isolation are broad and limited in their application. However, identifying the factors influencing RSCA in SHNW economies could still guide South Africa in making policies that would enhance growth. Furthermore, South Africa can leverage these findings and localise them into strategies to increase its industrial competitiveness.

3.5 Conclusion and limitations

Competitiveness is vital for the growth and sustainability of the South African wine industry. Global competition, especially among the New World, has been cited as one of the causes of South Africa's underperformance (Grant et al., 2015; Fleming et al., 2014; Esterhuizen and Van Rooyen, 2006; Van Rooyen et al., 2011). The economic sustainability of the South African wine industry is highly dependent on its international competitiveness, with 50% of production consistently being exported (SAWIS, 2020). In addition, export sales tend to attract higher earnings for the industry. Therefore, comparing the degree of South African competitiveness against rivals in the SHNW and investigating factors influencing specialization will help identify priority areas to focus on to enhance competitiveness and sustain the industry. The 1990 to 2018 panel data from Global Wine Markets is used for the analysis. The study answers the research question: “***What is the degree of South Africa's competitiveness against rivals in the Southern Hemisphere New World (Australia, Chile, Argentina and New Zealand) and what factors determine specialization in these economies?***” The findings of the analysis lead to the following conclusions.

Firstly, the study examines trade specialization (RSCA). It was clear that South African wines are comparatively less competitive than those of its rivals in SHNW. Over the study period, between 1990-2018, other SHNW producers improved significantly, with New Zealand, Chile, Argentina and Australia (in that order) achieving higher scores than South Africa. South African wines reached its peak in 2005 and have not reached those heights since. A review of key success factors and lessons learnt from the analysis in 3.4.1 suggests that South Africa competitiveness could be enhanced by the following strategies and programs: (i) create strong institutions within the industry that can advance the growth agenda across the value chain; (ii) attract and increase foreign direct investment; (iii) increase export sales; (iv) create a well-coordinated wine industry; (v) reduce input production costs; (vi) increase the number of bottled/package export sales; (vii) promote SA brand through effective marketing and; (viii) build strong relationships between government and the wine industry.

Secondly, when the study estimated the Galtonian regression model to analyse the stability, magnitude, and specialisation patterns in SHNW countries, results showed that all SHNW producers reported high stability in specialisation patterns, with New Zealand and Argentina reporting the highest coefficients at 0.91 and 0.87, respectively. South Africa came fourth with 0.78, just after Australia (0.79). However, despite having stable specialisation patterns over time, all SHNW producers reported a reduction (convergence) in specialisation patterns for the study period. An indication that there is not enough innovation to attract a divergent pattern in the region.

Thirdly, the panel model estimation of the determinants of specialization in SHNW found that the regression results were consistent with the hypothesis specified in the study. Findings showed that real GDP, real exchange rate, grapevine area per capita, the volume of wine exports, and the value of wine exports positively influenced specialization in SHNW. In contrast, the value of wine imports and the volume of wine imports negatively impact trade specialization.

The findings suggest that South Africa's competitiveness can be improved by emulating rivals' strategies and programs and creating a dynamic, innovative business environment. One way to do this would be to improve the quality and value of the wine produced and increase grapevine per

capita. By stimulating local demand for wine consumption by shifting some alcohol consumers to wine. Alcohol consumption in South Africa accounts for 75% of the total beverage, with only 10% for wine. The per capita wine consumption is currently at 11 litres which are low compared to countries such as Portugal (59 litres), France (51 litres), Italy (44 litres), Argentina (27 litres), and Namibia (20 litres). Therefore, shifting beer consumers to wine would significantly improve SA wine competitiveness.

Other ways to improve South Africa's competitiveness would be developing the service export capacities and building strong industry institutions. Such institutions would coordinate the various wine stakeholders to create valued quality brands and increase packaged wine exports. One of the strategies of the Wine Industry Strategic Exercise (WISE) 2025 is to export more packaged wine from the current 60:40 ratio to 40:60 by 2025 (SAWIS, 2020). In addition, firms within the industry should be encouraged to compete locally and internationally at trade shows, and incentives should be extended to innovators.

Through innovation and technological advancement, the industry should be able to reduce the cost of production by using more efficient equipment such as mechanical grape harvesters, fertilizer spreaders, Rotary mowers and Row tractors. Further, a deliberate strategy to encourage FDI could help inject the financial resources needed into the industry. Van Rooyen et al. (2011) noted that the industry growth might have been obstructed by a lack of trust between the government and the industry. Therefore, the industry could benefit significantly if it finds ways of building a solid partnership with the government to promote and grow the industry.

There is a direct link between wine quality and skills. It is known that South African wines lack skilled personnel to improve the quality of the wines to the standards required in the international market (Ewert, 2005). The estimated percentage share of global export value at 2.23% in 2018 (figure 3.1) is enough evidence that South Africa wine needs to upgrade to be competitive in the international arena. Improvements in human resources can be achieved in partnership with universities to build capacity and reinforce competitiveness in the industry. By building up a skilful labour force, the industry can increase efficiencies and develop quality products and wine brands that can sell through effective marketing.

The study also has some limitations. The results from the study are measured at the macro-level and do not take into account the quality of the wine product. The models assume that wine products across SHNW are homogenous goods which may not be the case. Additional research is required to better understand the drivers of competitiveness, especially at a firm-level that considers the quality of the wine. Perhaps the next stage of research that addresses this would provide a more robust and insightful view of the factors that influence the wine industry. Historical data for the South African wine industry and rivals in SHNW are available from 1835 to 2018; however, the study only prioritized data from 1990-2018. Despite these limitations, the study provides insights into the extent of South Africa competitiveness. It draws lessons on what actions to take to drive an upward trend in the competitive performance of the industry. Furthermore, the study's conclusions and strategic proposals can be applied in future research and used by wine players to increase competitiveness.

4 Measuring consumer willingness to pay for natural preservatives in wine:

A Discrete Choice Experiment analysis

Abstract

Sulphur dioxide (SO_2) as a preservative, is often perceived by wine consumers as causing headaches and migraines. Differentiated wines based on their SO_2 content may be a profitable marketing avenue for the struggling industry. Recently, the South African wine industry launched the world's first 'no sulphite added' wine made from indigenous Rooibos & Honey bush toasted wood chips. This wood chip contains antioxidants properties known to protect the wine from oxidation. The study interviewed more than 600 wine consumers to investigate their perceptions of wine preservatives and preference for several wine attributes. Specifically, used discrete choice experiments to elicit willingness to pay for the innovative alternative based on *Rooibos & Honeybush* wood chips. In addition to wine preservatives, and also examine consumers' preferences for organic wine attributes and wine quality measured by a 100-point quality score and cost. Based on the results from the mixed logit model, the study finds that consumers are willing to pay additionally R60.40 per bottle of wine with natural Rooibos & Honey bush wood chips, while they are ready to pay R19.45 more for organic wine and R1.55 for each point on quality score. Consumer preferences are not statistically different between red and white wine but differ considerably across consumers. In particular, those who believe SO_2 in wine causes headaches are willing to pay at least three times more for replacing sulphur-based preservatives with a natural one.

Keywords: Wine Preservatives; Willingness to Pay; Discrete Choice Experiment

Note: An extract of this chapter has been published in the Journal of Wine Economics and Policy (Chikumbi, L., Scasny, M., Muchapondwa, E., & Thiam, D. (2020). Premium price for natural preservatives in wine: A discrete choice experiment. Wine Economics and Policy 10(1): 101-118. doi: 10.36253/wep-9508)

4.1 Introduction

Valuation of consumers' willingness to pay (WTP) for natural preservatives in wine is not only of outmost interest to the wine industry but has economic and political implications, particularly in cases where the industry's sustainability is at risk. The industry has been hit with major challenges not limited to the increases in input production costs, energy costs and competition from New World as shown in chapter 2 and 3. It is from this background that stakeholders are encouraged to find innovative ways to alleviate the struggles experienced in the industry.

In response to the potential impact of uncertain events, farmers implement various risk management strategies with respect to their production plans, the available finance, physical and human capital, and the degree of aversion to risk. These risk management strategies may include (among others) crop diversification, crop insurance, effective coordination, technology and innovation. For example, innovation is widely accepted to be a driving force for agricultural development. Progressively, scientists and extension agents recognize the key role of innovative farmers and acknowledge their experiments and innovations for agricultural development (Chambers & Thrupp, 1994; Klerkx & Leeuwis, 2008; Reij, C. & Waters-Bayer, 2014) and for farming systems resilience (Fischer et al., 2002; Milestad et al., 2008).

It has been shown that firms' capacity to innovate, and new product development in particular, has a significant potential to improve firm performance and increase market share (Banbury & Mitchell, 1995; Caves & Ghemawat, 1992; Low, David R., Chapman, Ross L. and Sloan, 2007; Zahra & Covin, 1993). However, product innovation cannot fully achieve this goal without effective market orientation (Atuahene-Gima, 1996; Erdil et al., 2004; J. K. Han et al., 1998). This may require engaging various parties in understanding customers' current and future needs and the key factors for developing and designing a new or improved product that meets those needs (Kohli, A. K., & Jaworski, 1990,p.3). In line with a product innovation strategy supported by market orientation, the wine industry may explore the potential of a natural preservative for wine as an alternative, with a view to developing a new product that will increase industrial specialisation and consequently improve the competitiveness of South African wines in global wine competition.

Since time immemorial, sulphur dioxide (SO_2) has been used by winemakers to preserve wine (Lester, 1995). Because of its antioxidant and antibacterial properties, SO_2 plays an important role in not only preventing oxidation, but also maintaining freshness (Goode & Harrop, 2011). It is important to note that trace amounts of (endogenous) SO_2 , about 10–40 ppm, i.e., 10–40 mg per liter, are naturally formed by wine yeast during fermentation (Liu et al., 2006), but winemakers add extra SO_2 throughout production (Burgstahler & Robinson, 1997) to prevent spoilage and enhance aging potential (Goode & Harrop, 2011). Thus, while too much sulphur can ruin a bouquet, wine can spoil quickly when sulphur is missing.

Although some studies believe the health effects of SO_2 are overstated (Vally & Thompson, 2001), there is overwhelming evidence that SO_2 may induce adverse reactions in wine drinkers suffering from sulphite sensitivity (Amato et al., 2017; Costanigro et al., 2014; D'Amico et al., 2016; Grogan, 2015). A wider share of the consumer population perceives that drinking even moderate amounts of wine, particularly red varieties, triggers minor health effects, including respiratory and gastrointestinal symptoms, headaches and migraines (Gaiter & Brecher, 2000; Lester, 1995; Robin, 2010). It is estimated that about 1% of wine consumers are sulphite-sensitive (Papazian, 1996).

While medical science has not reached a consensus on whether SO_2 does in fact cause the reported minor health effects, public health authorities have made it mandatory for wine makers to restrict the use of sulphur in wines and display its quantity on wine bottles. This was made possible by the design of specific legislation to control sulphite levels in final products (Rossi & Fusco, 2019). The role of this legislation was to control and monitor the upper limits of sulphite and to help to standardize oenological methods in lowering sulphite concentrations in wines (EFSA, 2014; Granchi et al., 2019; Kontaxakis, E., Trantas, E., & Ververidis, 2020). For instance, in South Africa – the study site – the Liquor Product Act 60 of 1989 requires that dry white wine produced after January 1995 may not contain more than 160 mg/l sulphur. Off-dry and sweeter wines may contain up to 200 mg/l, while sulphur content is allowed to be up to 300 mg/l for late harvests. The limit for dry red wine is 150 mg/l. Organic wines still contain sulphur, albeit at very low levels; however,

if the level of sulphur is below 10 mg/l, the product may be labelled “no sulphur added”. The shelf life of these wines is necessarily limited.¹³

Even though replacement of SO_2 is uncommon, there is a small number of wine-makers who produce wine with lower SO_2 . As noted earlier, organic wines usually contain trace amounts of sulphur. In some countries, such as the US, all organic wines are SO_2 -free, excluding SO_2 naturally formed by wine yeast (Alcohol and Tobacco Tax and Trade Bureau, 2014). This is, however, not the case in South Africa, where wines can be classified as organic regardless of whether they contain SO_2 or not. Given that the absence of added SO_2 in wines can be viewed as a quality differentiation factor, and that ‘no sulphite added’ wines may appeal to health-conscious consumers, this study is warranted. Since the emergence of these health effects, winemakers around the world are encouraged to find alternative healthy ways to preserve wine.

Natural preservatives like yeast and other natural components of grapes and wine are used as an alternative to sulphur-based preservatives. Other alternatives to conventional wine-making include carbon dioxide additive, chemical preservation, fermentation, filtration, fining, oxidative wine making, pasteurisation, reductive winemaking, stabilisation, sterile bottling, and temperature management, hydrostatic pressure, pulsed electric fields, ultrasound radiation and ultraviolet radiation (Falguera et al., 2013). Bentonite —a pure natural absorbent swelling clay— has been used for ages to support sedimentation of yeast sludge and to bind thermosensitive proteins that prevent wine turbidity. Other nature-based substances such as plant proteins, collagens and gelatine are commonly used for wine clearing. The ongoing search for unique and innovative wine products has sparked interest in the global wine market; finding alternatives to SO_2 is one such goal.

Breaking into this niche, in 2013 South Africa produced the first wine made from natural preservatives (*Rooibos & Honeybush*). Rooibos (*Aspalathus linearis*) and Honeybush (*Cyclopia*)

13. In the European Union, Regulation 1333/2008 amended by Commission Regulation 59/2014, sets a limit for total SO_2 at 150 mg/l in red wines and 200 mg/l in white wines, and because some individuals are sensitive to SO_2 , it is mandatory to include ‘contains sulphites’ on the label if total SO_2 is over 10 mg/l (i.e., SO_2 content of not more than 10 mg/kg or 10 mg/l is not considered to be present). EC Regulation 203/2012 sets the limit for organic wines at 100 mg/l for red wines and at 150 mg/l for white and rose wines. Organic and natural winemakers restrict its usage even further. For instance, The Charter of The Authentic – Natural Winemakers’ Association in the Czech Republic requires limits of SO_2 at 90 mg/l for red and orange wines and 100 mg/l for white and rose wines, see <http://vinarstvivykoul.cz/wp-content/uploads/2016/07/Stavek-Charta-autentistu-A2.pdf>.

plants are indigenous to the Western and Eastern Cape provinces of South Africa (Du Toit et al., 1998; Small & Catling, 2009) and have been harvested and processed mainly to produce herbal teas (Joubert et al., 2008). Research concerning the antioxidant capacity has been conducted by the Department of Oenology at the University of Stellenbosch in collaboration with two wineries (Audacia and KWV) to utilise this indigenous wood for wine preservation (Burgstahler & Robinson, 1997; Joubert et al., 2008; Rankine, 2004; Rudd, 2016). Drawing attention to consumer behaviour in the marketplace has highlighted a trend of consumers choosing healthy food products. Most consumers, particularly in recent times, are attentive to artificial additives and prefer to purchase organic foods. Given that ‘no sulphite added’ wines seem attractive to health-conscious consumers, it is interesting to explore this potential niche market in depth to gauge consumers’ perceptions of the importance of these wines. Determining whether consumers choose such wines is important as it would reveal whether wine players (in the South African wine context) can exploit this source of avenue in an effort to save the struggling industry. Indeed, key evidence that would inform wine players is how valuable ‘no sulphite added’ wine is to consumers, and what share of consumers would consider such a trait as important in their buying decisions.

Several peer-reviewed papers address consumers’ willingness to pay (WTP) for wine without added SO_2 (Amato et al., 2017; Costanigro et al., 2014; D’Amico et al., 2016; Grogan, 2015). While there is agreement about the negative effects of SO_2 on health, and even that consumers are ready to pay more money to avoid added SO_2 in wine, no study examines consumers’ preferences for SO_2 alternatives. I conduct a novel study by estimating the premium price that wine consumers are willing to pay for SO_2 alternative.

To fill the research gap, the study uses a primary survey and discrete choice experiment (DCE)¹⁴ to analyse preferences for three qualitative non-monetary attributes of wine: natural preservatives, organic production, and quality measured by a 100-point score, and the fourth attribute is price. Specifically, the study answers the following four research questions: (1) Are consumers ready to pay for wines made with natural preservatives (*Rooibos & Honeybush*), organic production, and with a higher quality score?; (2) Do preferences for wine colour and hence marginal willingness to pay for the three qualitative wine attributes differ for red and white wine?; (3) Since a sulphur-

14. Although the DCE has some limitations such as hypothetical bias (see Lusk and Schroeder, 2004), it allows researchers to control for exogenous factors that may otherwise weaken the results and also ensures that the effects of each attribute on preferences are identified (Kroes and Sheldon, 1988).

based preservative is perceived to trigger headaches, are consumers who believe that SO_2 in wine causes headaches willing to pay more for the wine attributes, particularly for *Rooibos & Honeybush* preservatives?; and, lastly, (4) Do preferences vary among various consumer characteristics such as gender, race, and the frequency of wine drinking? The study uses the stated preference approach to understand consumers' perceptions and, in particular, how consumers would value a wine that was produced using *Rooibos & Honeybush* as a preservative for both conventional and organic production.

Findings reveal that wine consumers in South Africa are willing to pay a price premium of R60.40 per bottle of wine if *Rooibos & Honeybush* rather than SO_2 is used as a wine preservative, and this premium does not differ between red and white wine. Of 611 wine consumers interviewed, about 68% believe that consuming a moderate volume of wine causes headaches, and the same consumers are willing to pay three times more for the natural preservatives R96.08 than those who do not think SO_2 in wine causes headaches R30.82. The price premium for organic wine is smaller, about R19.45, and differs between the two segments with R25.93 vs R15.76 respectively. Wine quality (measured by a 100-point Quality Score) matters as well, but respondents are willing to pay only about R2.55 and R0.76 for the two segments. There is large heterogeneity in consumers' preferences.

The remainder of the paper is organised as follows. Section 2 reviews the literature. Section 3 describes the methodology and the data used for the analysis. Section 4 summarizes the empirical results, and Section 5 concludes.

4.2 Literature Review

There is no valuation study that examines consumers' preferences for an alternative to sulphur-based preservatives in wines. However, several studies analyse preferences for wines with 'no sulphites' added – two elicited stated preferences, one aimed at revealed preferences. Using a conjoint choice approach, Costanigro et al. (2014) analyse the willingness to pay for non-sulphated wines in the US. Analysing the best-worst choices by ordered logit, they find that US consumers are, on average, willing to pay \$0.64 (R9.24) per bottle of wine to avoid added SO_2 .

About 34% of respondents experienced headaches after drinking wine, and these consumers are ready to pay more for wine with no sulphur, \$1.23 (R17.76). They also find that the same group is only slightly (3.4%) more likely to purchase a wine if it does not contain added sulphites.

Similarly to the study by Costanigro et al. (2014), D'Amico et al. (2016) also use a direct survey to analyse the purchase interest of Italian wine consumers for organic wine with no added sulphur. Estimating the ordered logit, they find that the majority of Italians (54.5%) were not willing to pay a premium for no added sulphur, and only 10% would pay a small premium. Environmental consciousness and 'wine curiosity' led consumers to pay a higher price for organic wines with no added sulphur. On the other hand, naturalness and designation of origin increased the probability of paying a premium price for wine with no added sulphur. The study also discovered that insufficient information is a barrier to accepting a higher price for organic wines and wines with no added sulphur. This study also highlights the need to educate consumers on health effects in order to obtain a positive evaluation of the health-related attributes of wine.

Instead of stated preferences, Grogan (2015) aims at revealed preferences to examine the value of added sulphur in French organic wines using an organic wine dataset from 546 wineries. Estimating the hedonic pricing model, they find that the addition of the SO_2 preservative reduced the price of red organic wine by 23% for wines that were intended to be drunk immediately after purchase; however, this effect becomes positive for wines that were intended to be cellared for at least one to three years. Adding SO_2 had neutral to positive effects for most white wines.

A more recent study by Amato et al. (2017) analyses consumers' willingness to pay for wine bearing a SO_2 -free label in Italy and Spain using experimental auctions. They employed a Tobit model for the analysis. Results in both countries show that consumers who associated the headaches with drinking wines with SO_2 are also willing to exchange the habitually consumed bottle of wine with a 'no-added sulphite' wine and they would even be willing to pay something extra for such wine.

In addition to research that directly examines the effect of added SO_2 on wine price and consumer decisions, other studies examine consumers' preferences and willingness to pay for wines perceived to be healthier. For example, a study by Barreiro-Hurlé et al. (2008) reveals a positive

valuation for resveratrol-enriched wine, a health-promoting ingredient. Organic wines are also often perceived as being health-promoting (Barreiro-Hurlé et al., 2008; Fotopoulos et al., 2003), and health-conscious consumers are particularly receptive to marketing campaigns promoting natural (and organic) wines (Goode & Harrop, 2011).

Another stream of literature focuses on organic wines (Antonazzo et al., 2015; Remaud, H., Mueller, S., Chvyl, P. & Lockshin, 2008). These studies highlight the effect of environmental concerns, and, as Olsen et al. (2012) argue, the price premium for organic wine may be viewed as the financial “self-sacrifice” made in order to protect the environment. It is important to note, though, that ‘organic’ is a multifaceted attribute encompassing numerous consumer values, and consumers may even have difficulty explaining why they value organic wine over other varieties (Barreiro-Hurlé et al., 2008).

Several studies aim at various intrinsic (such as sensory characteristics) and extrinsic wine attributes (such as price, grape origin, vintage, or brand). Gil and Sánchez (1997) vary wine price, age, and origin and find that, in the absence of other quality cues, the origin is the most important wine attribute. Robertson et al. (2018) examine the subjective knowledge about wine associated with the relative importance of four extrinsic product attributes. They find knowledge of wine age, brand, and the region of wine origin to be increasingly important, whilst the price of wine was the dominant attribute regardless of the level of product knowledge.

Similarly, Mueller et al. (2001) use informed sensory hedonic tests to understand the interplay of wine sensory characteristics and extrinsic attributes such as packaging, price and brand awareness. With enrichment of choice experiments by the sensory tests, they were able to simulate consumers' purchase, which allowed them to examine preferences for new wines and predict their market uptake. Lockshin et al. (2006) and Mtimet and Albisu (2006) examine how market involvement influences the valuation of wine attributes such as brand, region of production, quality medals, and aging.

To sum up, despite relatively large literature on consumers' preferences for wine attributes, including organic quality and the non-use of *SO*₂ as a wine preservative, literature that would elicit consumers' preferences for a natural preservative is non-existent. This study therefore fills the gap

by investigating consumer preferences for *Rooibos & Honeybush* (a natural preservative) and evaluates specifically whether or not, and to what extent, consumers are willing to pay for wines that are preserved by it.

4.3 Methodology and Data

4.3.1 Sampling and implementation strategy

Historically, black South Africans were prohibited from purchasing and consuming clear liquors, making the white consumer group the largest group of wine drinkers (Ndanga et al., 2009). However, after the change of regime (post-apartheid) and with the growing number of black middle class, whites are no longer the majority wine consumers. Nevertheless, there are no background statistics on wine consumer segments. For this reason, the study used multistage sampling to select areas and places to conduct the interviews. In the first stage, Cape Town city was purposely chosen from the Western Cape province¹⁵ because it has the largest number of people and wine consumers (StatsSA, 2019). About 95% of South African wine is produced in this province. The second stage involved randomly selecting clusters of shopping malls across the city. These malls encompass retail businesses that sell wine, i.e., restaurants, liquor-stores, supermarkets and bars. The third and final stage involved randomly selecting wine customers who went shopping in the pre-selected shops to form the sample. Eligibility criteria included any person above age 18 (this is the legal alcohol drinking age in South Africa) and who had consumed at least a bottle of wine (750 ml) in the last 6 months. Participants were approached by enumerators and asked if they could voluntarily take part in a wine survey for academic purposes. Five enumerators were recruited from postgraduate students enrolled at the School of Economics at the University of Cape Town, who were trained prior to pre-testing of the instrument. No incentive was offered to the survey participants. The interview was conducted in English and the enumerators used a pen-and-paper mode of interviewing.

15. Western Cape is a province of South Africa located on the south-west coast of the country and has 6.6 million inhabitants, of which two-thirds live in the metropolitan area of Cape Town, which is also a provincial capital and tourist destination. The total population of South Africa is about 58 million.

A survey instrument was comprehensively pre-tested in two waves of testing with 44 and 52 wine consumers in the Western Cape province of South Africa during 10-14 June 2019, and 24-28 June 2019, respectively. Based on respondents' feedback, the survey instrument was modified to improve its readability and comprehension. The questionnaire consisted of four sections. The first section contained a brief explanation of the purpose of study without mentioning details of the study so as to minimise a potential framing bias. Questions regarding the wine acquisition practice were asked. The second section dealt with consumer information and knowledge about SO_2 content in wine, perceived health effects, cultivar production types and quality score of wine. The discrete choice experiment was presented in the third section. In the event respondents chose no change (status quo), respondents were asked to provide their main reason in order to identify protest responses. The final section collected socio-economic and other relevant information about the respondents. To facilitate understanding and render the survey more pleasant to respondents, visual information was included (see, Figure 4.1).

The main survey was conducted between July 8–22, 2019, and a total of 611 participants completed the survey. The demographic characteristics of the sample are reported in Table 4.1. While the sample may not be representative of the South African population, the recruiting strategy was highly successful in targeting respondents in areas where the majority of wine consumers reside. Almost everyone purchased at least a bottle of wine in a typical month. The majority of respondents (78%) are aged 21-50 years. There are 42% males and 51% females, while 7% choose not to provide information about their gender.

The majority of the respondents reside in Africa (80%), some in Europe (10%), while 4% and 3% came from Northern America and Asia, respectively, and the rest (3%) from other parts of the world. Regarding race, the sample included 33% Caucasian, 31% African, 23% coloured (mixed race), and the minority being Indian and Asian (5% each). In addition, over 66% held a university degree. Median net annual household income is between R200,000 and R350,000 (€12,500–€21,875), coinciding with the average annual household income for South Africa at R270,000 (StatsSA, 2019). However, one third of the respondents preferred not to provide information about their income.

To understand how respondents perceive SO_2 in wine, the study asked them several questions. First, question asked “*Do you have allergies to sulphur-contained foods and beverages such as wine?*”, followed by the question “*Do you know, or have you heard of, someone who suffers from sulphite allergies in wine?*”. The final and the key question was “*Do you believe that drinking even moderate amounts of wine give you a headache?*”. About 25% of respondents reported being allergic to SO_2 in foods and beverages; 61% claimed to know someone who suffers from SO_2 effects. About 68% believed that drinking even a moderate volume of some type of wine may result in a headache. The study named this group as ‘**headache**’, while the remaining respondents constitute the ‘**no-headache**’ group.

About 15% of the respondents drink wine almost daily, 19% drink wine several times a week, 27% and 22% drink wine at least once a week or a fortnight, and only 5% drink wine rarely. When analysing observed preference, the study named ‘heavy drinkers’ as those who drink wine almost daily or several times a week, and ‘light drinkers’ as those who drink wine once a month or less often (61% of the sample). ‘Heavy’ wine drinkers’ and ‘light’ wine drinkers constitute approximately 34%, and 17%, of the sample size, respectively.

When making their choice, the survey participants had in their mind a wine with a price of about 195 Rand (std=116) for a (750 ml) bottle, with a minimum at 35 Rand and a maximum at 900 Rand. In euro equivalents, the respondents, on average, typically buy a bottle of wine for €11.5(std=6.85), with €2.07 and €53 for the cheapest and the most expensive wine, respectively. This price also set the cost of the status-quo wine to which a price premium is added for the alternative wines.

Table 4.1. Socio-demographic characteristics of the sample (n = 611).

Variable	Percent
Gender	
Males	42%
Females	51%
Age	
18-20	4%
21-30	32%
31-40	24%
41-50	22%
51-60	15%
61-70	3%
Education	
High (secondary) school	12%
Some technical certificate/diploma	19%
Bachelor's degree	22%
Honours degree	18%
Professional/Master degree	16%
Doctorate degree	11%
Income	
R50,000 and less (€3,125 and less)	12%
R50,000 to R100,000 (€3,125 - €6,250)	5%
R100,000 to R150,000 (€6,250 - €9,375)	5%
R150,000 to R200,000 (€9,375 - €12,500)	5%
R200,000 to R350,000 (€12,500 - €21,875)	7%
R350,000 to R500,000 (€21,875 – €31,250)	9%
R500,000 to R750,000 (€31,250 – €46,875)	8%
R750,000 to R1,000,000 (€46,875 - €62,500)	5%
R1,000,000 to R2,000,000 (€62,500 - €125,000)	5%
R2,000,000 and more (€125,000 and more)	4%
I prefer not to answer	33%
Wine Consumption	

Almost daily	15%
Several times a week	19%
Once a week	27%
Once a fortnight	22%
Once a month	12%
Very rarely	5%
Headache	68%

4.3.2 Experimental design

Designing a DCE involves the selection and combination of the attributes and their levels to construct the alternatives included in hypothetical choice situations presented to respondents (Hoyos, 2010). Respondents are then asked to think about the situation in which they would be making their choices. Identification of the attributes in the experiment was facilitated by the literature review addressing particularly recent studies (Amato et al., 2017; Costanigro et al., 2014; D’Amico et al., 2016; Grogan, 2015). In line with the state-of-the-art recommendations for stated preference studies (Boyle, 2017; Johnston et al., 2017), the design of the study was also based on findings from qualitative pre-testing that the study conducted in focus groups with wine consumers from the Cape Town area. The qualitative pre-testing confirmed the suitability of the survey design and ensured the relevance and understanding of the attributes.

For the study, the alternatives were described using a pre-defined set of attributes with levels that were experimentally varied around the level expected by the respondents. The study used four attributes: *Wine preservative* (SO_2 -based vs. Rooibos & Honeybush), *Type of viticulture production* (conventional vs. organic), *Wine quality score*, and *Price* (see, Table 4.2).

Table 4.2. Attributes and levels of the discrete choice experiment

Attribute	No. of levels	Levels
Preservatives	2	SO ₂ -based, Rooibos & Honeybush
Type of viticulture production	2	Conventional, Organic
Wine quality score	6	60, 75, 82, 88, 92, 100
Price (increase compared to what you usually buy)	5	Rands: 0, 30,45,60,75 (EUR equivalent: 0, 1.77, 2.66, 3.54, 4.43)

There are two types of wine *preservatives* in the choice experiment: Rooibos & Honeybush and SO₂ -based preservative. *Type of viticulture production* may either be organic (wine produced using organically grown grapes) or conventional (wine produced using grapes grown with added chemicals, i.e., fertiliser, pesticide). The two viticulture types were included to allow a direct comparison of the valuation of conventional wines preserved with SO₂ versus conventional wines preserved with *Rooibos & Honeybush*, and again organic wines preserved with SO₂ versus organic wines preserved with *Rooibos & Honeybush*. This distinction allows the assessment of the influence of *Rooibos & Honeybush* in both viticulture production types.

Wine *quality score* is defined according to the Wine Spectator (Wine Spectator, 2020) scores, whose expert ratings are recognised globally. Specifically, these scores are defined accordingly as 95–100, classic: a great wine; 90–94, outstanding: a wine of superior character and style; 85–89, very good: a wine with special qualities; 80–84, good: a solid, well-made wine; 75–79, mediocre: a drinkable wine that may have minor flaws; and not recommended wine graded by 50–74 points. Quality levels also represent the proxy for a wide range of attributes, i.e., brand name, taste, origin, which would otherwise make evaluation bulky had the study included them in the experiment. The study used the point-values of the quality score to avoid uncertainty, as described in Table 4.2.

Lastly, *price* was defined as the extra cost (premium) respondents are asked to pay in addition to the price they usually pay for a 750ml bottle of wine. While the decision to pay a premium price for using *Rooibos & Honeybush* and other attributes in wine is essentially driven by the cost and benefits derived from its consumption, the individual choice is difficult to anticipate because of

such reasons as information deficit and perceived or experienced health effects. The wine price was shown as an increment of what a consumer typically pays for a bottle of wine, and the premium included nominal Rand values: 30, 45, 60, and 75, and Euro equivalents are also shown on the cards in brackets.¹⁶ In relative terms, the offered bids represented 15% to 38% of the average price of the status-quo wine. Since the bids were offered in absolute values, wine price premiums ranged between 3.3% and 214%, with the mean at 37%.

The choice task included three alternatives, with one referred to as wine that is typically purchased (i.e., the status quo). The status quo option described a typical wine sold on the South African market (in the Western Cape province); that is, a 750ml bottle of conventional wine with SO_2 -based preservatives, graded by a 75-point quality score, whilst the price in the status quo was respondent-specific. Specifically, before the valuation part, the study asked each respondent to state “*What is the average price for which you typically buy a bottle of wine most often?*”. The study found that respondents typically paid approximately R195 (std=116) for a bottle of wine, with a minimum at R35 and a maximum at R900. An example of a choice card as presented to the respondents is shown in Figure 4.1. The study then asked “Which of the three alternatives do you prefer?”, and then the study repeated this valuation question four times for each different choice situation.

Since preference for red wine and white wine may differ, the study elicited consumers’ preferences for red and white wines in two separate choice tasks. The order in which consumers’ preferences for red or white wine were elicited was assigned to each respondent at random.¹⁷

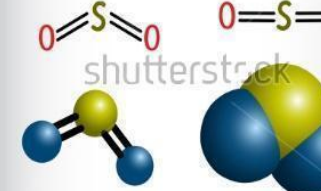
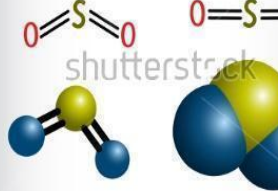
Using NGEN software, the study generates a Bayesian-efficient design. The Bayesian approach for optimal experimental design has become more prominent in the literature (Amzal et al., 2006; Bliemer et al., 2008; Bliemer & Collins, 2016; Dias et al., 2016; Ferrini & Scarpa, 2007; C. Han & Chaloner, 2004; Huan & Marzouk, 2013; Johnston et al., 2017; Müller et al., 2006) due to its ability to improve the design criteria that are functions of the posterior distribution and can simply be tailored to the experiments’ objectives. Further, the framework provides a formal approach for

16. I used the exchange rate 0.059 Euro per Rand, based on the South Africa Reserve Bank prevailing rate at the time. www.resbank.co.za

17. The experiment contained another split-sample treatment in which I expressed price either in Rand or as a percentage change from the status quo level. In this paper, I use only responses with the price in Rand.

including parameter uncertainties and prior information into the design process through prior distributions, and provides a fused approach for joining these quantities with the model and design standard (Ryan et al., 2016). The design contains twelve unique choice combinations grouped into three, giving us four choice cards per each respondent. In total, the study obtained 2,444 responses (from 611 respondents) for both choice tasks, one for white wine and another for the red wine experiment.

Figure 4.1. Example of a choice situation

	Red Wine A	Red Wine B	Wine you usually buy
Preservatives	Rooibos & Honeybush 	Sulfur dioxide SO_2 	Sulfur dioxide SO_2 
Viticulture production	Conventional 	Organic 	Conventional 
Wine quality Score	100 (great top wine)	60 (not recommended)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	R45 (€2.8) more	R60 (€3.75) more	as you usually pay
Which option do you prefer?	☐	☐	☐

4.3.3 Econometric framework

The discrete choice experiments (DCE) technique has grown in popularity since its introduction by Batsell and Lodish (1981) and Louviere and Hensher (1982). The use of the technique has been extended to many disciplines such as transportation, agriculture and environment, telecommunications, marketing and human health (Alberini et al., 2018; Amato et al., 2017; Barreiro-Hurlé et al., 2008; Blackie & Cozzolino, 2011; Boncinelli et al., 2019; Contini et al., 2018; de Magistris et al., 2014; Lockshin et al., 2006; Simone Mueller et al., 2010; Poveda et al., 2005; Rose & Bliemer, 2009; Verneau et al., 2016). Applications also include conservation of wine varieties or valuation of wild crop conservation (Tyack & Scasny, 2020; Tyack & Ščasný, 2018). While DCE has limitations on hypothetical bias (Lusk, Jayson L; Schroeder, 2004), it allows the study of products that are not yet available on the market (Ščasný et al., 2018) or policies that are not yet implemented (Alberini & Ščasný, 2018; Ščasný et al., 2017). Experimental designs not only allow researchers to control for exogenous factors that may otherwise weaken the results, but also ensure that the effects of each attribute on preferences are identified (Kroes & Sheldon, 1988).

The choice model relies on the random utility theory (McFadden and Zarembka, 1974), which assumes that individual n chooses the alternative j in choice situation t with regard to the highest utility:

$$U_{njt} = X_{njt}\alpha_n + \beta_n \cdot (Y_n - PRICE_{njt}) + \varepsilon_{njt} \quad (4.1)$$

where X represents a vector of alternative specific attributes (PRESERVATIVES, VITICULTURE PRODUCTION, QUALITY SCORE), Y is income, $PRICE$ is the price of wine, the vector of coefficients α and coefficient β are estimated and ε_{njt} is a stochastic component identically and independently distributed with a constant variance $k_n^2 (\pi^2 / 6)$, with k_n^2 , being an individual-specific scale parameter. Instead of separately estimating the parameters for each respondent, the study follows a common practice and assumes that the parameters follow specific distributions, which leads to the mixed logit model (Revelt & Train, 1998).

Note that the coefficients are indexed by individuals' n , allowing for (unobserved) preference heterogeneity. In fact, as a consequence of taste and people's concerns, consumers may respond differently to different wine attributes, leading in turn to heterogeneity with respect to individuals' expected net benefit and hence WTP for 'no sulphite added' wine. The study accommodate such heterogeneity by employing econometric models that accommodate both the observable and unobservable component of individual utility from offered alternatives.

Mixed logit with all factors random, freely and fully correlated is estimated using maximum simulated likelihood technique (Revelt & Train, 1998) in STATA 16. An individual will choose alternative j if $U_{njt} > U_{nkt}$, for all $k \neq j$, and the probability that alternative j is chosen from a set of C alternatives is given by:

$$P(j|C) = \frac{\exp(X_{njt}\alpha_n + \beta_n \cdot (Y_n - PRICE_{njt}))}{\sum_{k=1}^C \exp(X_{nkt}\alpha_n + \beta_n \cdot (Y_n - PRICE_{nkt}))} \quad (4.2)$$

The usual procedure is to estimate the distribution of the utility coefficients (i.e., the model in preference-space) and then to estimate the willingness-to-pay as a ratio of two utility parameter estimates, as $-\frac{\hat{\alpha}}{\hat{\beta}}$.

In the alternative specification, the interest was to know whether preference for specific consumer segments differ. For this purpose, the study fit the random utility model, additive in parameters, as follows:

$$U_{njt} = X_{njt}\alpha_{1n} + S \times X_{njt}\alpha_2 + (\beta_{1n} + \beta_2 \cdot S) \cdot (Y_n - PRICE_{njt}) + \varepsilon_{njt} \quad (4.3)$$

where S is a vector of dummies to describe specific segments such as: people who believe that drinking even moderate amount of wine causes headache ('headache', see Table 4.4), race (African, Caucasian) and gender (female); see Table 4.5 and for frequency of wine consumption (heavy drinker, light drinker); see Table 4.6 to control for observed preference heterogeneity. The study assumes the coefficient for the interaction terms to be fixed, which allows us to measure the

difference in preference for the respective consumer segment and given attribute from the random mean.¹⁸ Assuming the indirect utility function is additive in its attributes, the final WTP estimate for segments S in the specification is given as $-\left(\frac{\widehat{\alpha}_1 + \widehat{\alpha}_1 \cdot S}{\widehat{\beta}_1 + \widehat{\beta}_2 \cdot S}\right)$.

The study also assumes this specification to explore preference heterogeneity in wine colour, pooling the data from the two sub-samples. Since the study do not find preference for the attributes to differ between red and white wines, see Appendix 4A Table 4A.1, the study estimates all mixed logit models with pooled data. WTP are estimated by the delta method, using the *nlcom* STATA command.¹⁹

4.4 Estimation Results

Table 4.3 presents the results for the mixed logit model estimated in the preference space with all factors random and freely correlated. The study pooled the data, without distinguishing wine colour. All coefficients are statistically significant at any convenient level and have expected signs, conforming to a priori expectations. It implies that respondents are willing to pay a premium for each of the three wine attributes, and the likelihood of purchasing a bottle of wine is decreasing with the increase in price. The study also discover large unobserved preference heterogeneity for each of the four random attributes, indicated by the large and strong statistically significant standard deviations of the means (See parameter distribution and the robustness of the model used in Appendix 4A).

WTP estimates are presented in Table 4.4, column (1). For *Rooibos & Honeybush* natural-based preservatives, respondents are willing to pay R60.40 per bottle, while the marginal price for organic winemaking is R19.46, a finding consistent with the idea that organic and SO_2 added' wines are differentiated attributes, though *Rooibos & Honeybush* evokes a richer and more

18. I note that the main (random) effect in these MXL models represent the utility of consumers in the baseline group, while fixed coefficients for all interactions between the wine attribute and consumer characteristics measures the differences in the utility of given segments from the utility of the baseline group.

19. STATA command *nlcom* applies the delta method to compute the variance, standard error, Wald test statistic, etc., of the transformations. It is built for functions of the parameters and takes nonlinear transformations of the computed parameter vector from some fitted model.

complex set of values. These findings are consistent with a study by Costanigro et al. (2014), who find that headache sufferers are willing to pay more for wines without added sulphites than for organic wines. WTP for each point of the Quality Score is at R1.55 per 750ml bottle of wine. It is significant to highlight that prior research did not employ actual preservatives like in this case because they were based on a hypothetical SO_2 -free alternative (i.e., using natural the preservatives of *Rooibos & Honeybush*). The increased WTP values for this case study may also be due to this as a factor. Comparing the average price of wine that respondents had in mind when stating values, i.e., 200 Rand or €11.85, the premium comprises 30% of the wine price for a Rooibos & Honeybush-based preservative, and 10% for organic wine, about 0.8% per each point in the Quality Score.). Further, the rank order of importance of attributes and importance scores indicates *Honeybush* to be the most important attribute, followed by organic, price and quality, respectively.

When comparing the difference between wine colour, the study finds no difference in preferences for the quality attributes between red and white wine (see MXL estimates in Appendix 4A Table 4A.1 in Appendix). WTP estimates are reported in Appendix 4A Table 4A.1, Panel B. Although quality and organic production seem to be valued slightly more for red wine, clearly, neither of the two WTP estimates are statistically different.²⁰

20. WTP for Rooibos and honey bush preservatives is R62.34 for white and R81.33 for red wine (Wald statistics is 0.19, and $p=0.6670$); WTP for organic attribute is R18.45 and R28.81, respectively (Wald=0.16, $p=0.6889$); and WTP for 1-point at Quality Score is R1.46 for white and R2.25 for red wine (Wald=0.16, $p=0.6880$).

Table 4.3. Parameter estimates, MXL, pooled

	<i>Means</i>	<i>Standard deviations</i>
	<i>(s.e)</i>	<i>(s.e)</i>
rooibos	2.4618*** (0.2137)	3.3372*** (0.3045)
organic	1.0489*** (0.1463)	1.7835*** (0.2792)
quality	0.0723*** (0.0079)	0.0920*** (0.0117)
price	-0.0447*** (0.0040)	0.0546*** (0.0052)
<i>likelihood</i>	-1839.9323	
<i>LR Chi2</i>	1117.94	
<i>No. obs.</i>	7,332	
<i>r(respondents)</i>	611	
<i>k(parameters)</i>	14	

Notes: *, **, and *** indicate the significance of the WTP mean estimates at 10%, 5%, and 1%. Standard errors are provided in parentheses. All random parameters are fully correlated, with 1000 draws for simulations.

When the study controlled for differences in preferences for consumers who believe that SO_2 in wine causes headaches (see MXL parameter estimate in Table 4A.2 in Appendix 4A), it finds willingness to pay for natural preservatives (Rooibos & honey bush) as well as for wine quality is at least three-times larger than for consumers who do not believe so, compare R96.08 vs. R30.82 for rooibos, and R2.55 vs. R0.76 for Quality score in Table 4.4, whilst their WTP for organic wines do not statistically differ from the other R25.93 vs. R15.76, with Wald=1.28 and p-value=.2572), see Table 4.4, column (2) for ‘headache’ consumers and column (3) for the reference group with ‘no headache’ consumers. The study conclude that, at the margins, individuals who believe their health may be affected by SO_2 in wine are also more sensitive to wine additives and are ready to pay a higher premium for wines perceived to be healthier and of a higher quality.

Table 4.4. WTP estimates per bottle of wine, means in Rands.

	Pooled data	Headache	No 'Headache'
	(1)	(2)	(3)
rooibos	60.3992*** (6.2265)	96.0820*** (15.6792)	30.8219*** (5.0479)
organic	19.4582*** (4.4825)	25.9356*** (8.2914)	15.7607*** (4.3161)
quality (per QS point)	1.5497*** (0.2132)	2.5526*** (0.4661)	0.7614*** (0.1742)

Notes: *, **, and *** indicate the significance of the WTP mean estimates at 10%, 5%, and 1%. Standard errors are provided in parentheses. Wald statistics for the quality test of the WTP means for headache vs. no headache segment is 15.79 ($p = 0.0001$) for rooibos; 1.28 ($p=0.2572$) for organic; and 13.92 ($p=0.0002$) for quality.

The study estimated several mixed models, following eq. (4.3), to explore observed preference heterogeneity with respect to gender, race, and wine consumption frequency²¹. Table 4.5 presents the WTP estimates based on MXL model with the interactions with gender (female) and race (being African, and Caucasian), with non-female, Asian and Coloured as the reference category. As a reminder, since the study assumes the additive specification of the MXL model, the fixed coefficients for the interaction terms measure the difference in the utility from the random mean (see MXL result in Table 4A.3 in the Appendix 4A).

The study finds that females value organic wines more than males, Africans value *Rooibos* & *Honeybush* preservatives less than Caucasians, while the preferences of Caucasians do not differ from other races (those included in the reference category). This is expected considering that, on average, Caucasians and Africans in South Africa are at opposite ends of wealth and income distribution, with *other race* placed in between. WTP estimates reported in Table 4.5 show that non-African males will pay approximately R82.45 for rooibos-based preservatives, while non-African females are willing to pay R64.35 to avoid SO_2 added to wine.

21. Parameter estimates and tests are compiled in the Appendix 5B. Controlling for other socio-economic variables (e.g., income, education, and other wine-measuring preferences) resulted in no significant differences in preferences and are not reported here. These results are available upon request.

African males and females are willing to pay much less: R45.37 and R37.40, respectively. Interestingly, only females are willing to pay for organic attributes; about R36.05 and R21.33 for Caucasians and Africans, respectively, while WTP for organic wines for males is not statistically distinguishable from zero, with the exception of male Caucasians, who are willing to pay a similar amount as African or other race females, but this estimate is only weakly significant. Males are, however, ready to pay more than females for wines with higher a Quality Score: R1.08 compared to R0.94 for Africans, and R1.60 compared to R1.34 for the other race), except for Caucasian males and females, who are actually willing to pay the same premium of R2.59.

Table 4.5: WTP estimates per bottle of wine, by gender and race, means in Rands

	male + other race	male + Caucasian	male + African	female + other race	female +Caucasian	female +African
rooibos	80.54*** (15.9719)	82.45*** (20.2608)	45.37*** (9.7452)	63.64*** (11.3654)	64.35*** (13.55)	37.40*** (7.3758)
organic	5.25 (8.9413)	21.67* (11.4536)	9.30 (7.3142)	20.84** (7.6826)	36.05*** (10.4129)	21.33*** (6.1414)
quality <i>(QS point)</i>	1.60*** (0.4185)	2.59*** (0.6302)	1.08*** (0.3181)	1.34*** (0.3356)	2.59*** (0.4494)	0.94*** (0.2493)

Notes: *, **, and *** indicate the significance of the WTP mean estimates at 10%, 5%, and 1%. Standard errors are provided in parentheses.

Last, the study analyses the differences in preferences for consumers who differ in their wine consumption frequency (see MXL results in Table 4A.4 in the Appendix 4). It finds that heavy drinkers would pay more for natural preservatives than light drinkers: (R90.66 vs R54.22, organic attributes R33.24 vs R12.15, and quality score R2.40 vs R1.72. Heavy drinkers seem to care more about wine additives and are willing to pay a premium for natural preservatives, organic attributes and high quality score for wine. Light wine drinkers care less about organic attributes which are statistically not significant. See WTP estimates in Table 4.6.

Table 4.6. WTP estimates per bottle Heavy vs Light wine drinkers, means in Rands.

	Heavy drinkers	Light drinkers
natural	90.6633*** (19.4492)	54.2270*** (12.9566)
organic	33.2490** (11.1105)	12.1523 (8.8627)
quality (QS point)	2.4026*** (0.5735)	1.7253*** (0.4394)

Notes: 'Heavy drinker' is a consumer who drinks wine at least several times a week, and 'light drinkers' is a consumer who drinks wine once a month or less often. *, **, and *** indicate the significance of the WTP mean estimates at 10%, 5%, and 1%. Standard errors are provided in parentheses. Wald statistics for the quality test of the WTP means for heavy vs. light segment is 2.46 ($p = 0.1166$) for rooibos; 2.40 ($p=0.1213$) for organic; and 1.00 ($p=0.3166$) for quality.

4.5 Discussion and Conclusion

The study answers the research question: “*Are wine consumers (local & international) willing to pay a premium for natural preservatives in wine?*” More than half of the sample of 611 wine respondents from South Africa believes that drinking even moderate amounts of some type of wine causes headaches. A discrete choice experiment was conducted to explore the preferences of consumers in the Cape Town area for natural preservatives, organic wine, and quality measured by a 100-point Quality Score, and price attributes. This study is novel in that it estimates the premium price for not having added SO_2 in wine by substituting the conventional wine preservative with *Rooibos & Honeybush* – a natural preservative. This is the first analysis of its kind. The study find that consumers from the Cape Town area are willing to pay about R19.45 per bottle for organic winemaking. Only Caucasian males are willing to pay for the organic quality and, on average, they are willing to pay as much as non-Caucasian females R21.33, while Caucasian females are willing to pay R36.05 per bottle of wine for organic winemaking. Wine quality matters as well: on average, consumers are ready to pay R1.54 per each point on the Quality Score.

With regard to the key attribute – *Rooibos & Honeybush* preservatives – consumers are willing to pay even more, on average R60.40, though males are willing to pay slightly more than females.

Caucasian males will pay R82.45, which is almost double what African males will pay R45.37. Caucasian females will pay R64.35 compared to African females who are ready to pay R37.40.

With regard to other studies, Amato et al. (2017) find that Italian and Spanish wine drinkers will pay R19.04 (€1.19) and R25.12 (€1.57), respectively, to avoid added SO_2 . Similarly, Costanigro et al. (2014) find that US wine consumers are willing to pay approximately R19.04 (€1.19) per bottle of wine. It is important to note that the previous studies relied on a hypothetical SO_2 -free alternative and hence they did not use real preservatives as in this case (i.e., using natural the preservatives of *Rooibos & Honeybush*). The higher WTP values (compared to the cited above) for this case study may also be due to this fact.

Since using SO_2 as a wine preservative is very likely associated with adverse health effects, the study investigated whether those who believe in these effects are also ready to pay higher premiums for healthier wines. It finds that these consumers are indeed willing to pay at least three times more for SO_2 -free natural preservative and quality scoring than those who do not believe so. They are also ready to pay for organic winemaking, but their premium is only two thirds higher. The importance of these differences is even more significant if we consider the high percent (68%) of respondents who believe SO_2 causes headaches in the sample.

The study finds no difference in preferences between the colour of wine (red or white); however, willingness to pay for the three wine attributes differ between red and white wines. Heavy drinkers would pay more for natural preservatives in wine than light drinkers. This is a good message for winemakers since the high investment cost induced by introducing the new natural preservative may be recovered faster.

The findings confirm that consumers' decisions to purchase a bottle of wine in South Africa are more influenced by natural preservatives and organic attributes rather than a higher quality score. These findings present a significant contribution, at least in the South African context, to understanding preference and hence a niche for the natural preservative market. The share of respondents who believe SO_2 causes headaches is astonishingly large and their preference for wine with less adverse health effects is also strong. These consumers represent an apparent and potentially important market segment for the wine industry and wine producers interested in wine

product differentiation. Although this study targets South African wine consumers, these findings are useful for other wine-producing countries and regions. Further research could investigate whether the findings for South African consumers also hold in other regions.

Based on the findings, the study recommends that the wine industry should provide greater clarity regarding organic winemaking standards. In particular, it should clarify what constitutes organic wine, perhaps by emulating the US standard that regards organic wine as wine made without added sulphur. It is clear, though, that respondents are aware about natural preservatives and are in tune with the natural/organic movement for healthier living. As there is no strong scientific consensus on whether SO_2 in wine causes headaches, investigations in medical research seeking to establish the root cause of headaches promises significant rewards for the wine industry. Before embarking on investment, wineries should consider the additional costs involved with *Rooibos & Honeybush* alternatives and compare them with the expected premium for 'no sulphite added' wines. The empirical study provides the industry with the first evidence of consumers' acceptance of a novel natural wine preservative and, more specifically, how wine consumers may respond.

To fully understand consumer behaviour in relation to natural preservatives, more effort should be put into determining the factors that impact wine-consumer choice. Understanding these factors can provide a better targeted marketing strategy suitable for capturing consumer preference for natural preservatives in wine. Needless to say, the preferences of a wider sample should be investigated. In this sense, the relatively small sample size (≈ 600) and narrow geographic extent (the Cape Town metropolitan area) are the main limitations of the study. A broader sample and a more robust methodology will show an accurate and deep understanding of consumer preferences and on what attributes influence their purchasing behaviour. Another study limitation would be a potential framing bias by asking about SO_2 prior to the DCE. Nevertheless, the results are in line with previous literature on "no sulphite added" but are silent about sulphur alternatives as in the case study. The study also supports the Wine Industry Strategic Exercise (WISE) 2025 Strategy, particularly on the theme of "Technological and innovation".²² The discovery of natural

22. The WISE strategy was launched by the South African Wine and Brandy Company in 2015 to create a comprehensive industry-wide strategic exercise that would help transform the wine industry to become more competitive internationally by 2025.

preservatives in wine making has the potential to further boost the South African wine industry's competitiveness locally and abroad.

5 Does ‘price framing’ influence empirical estimates in Discrete Choice

Experiments: The case study for the South African wine industry.

Abstract

The approach and survey used to examine non-market value in a stated preference study can influence the outcomes and impact the validity and reliability of value estimates. While prior research has investigated the impact of ‘price framing’ on decision-making in other disciplines, (i.e. marketing & psychology), little is known about its validity and reliability in Discrete Choice Experiments (DCEs) and environmental valuation. The study explores the effect of ‘price framing’ on DCE measurements. The tests are carried out using data from a choice experiment on preferences for natural preservatives in wine. The same respondents completed a nearly identical DCE survey, one with a *real price* and another with a *percentage price change* as cost attribute. 611 respondents completed the survey, and a panel mixed logit model was used for the analysis. Results demonstrate that ‘price framing’ remarkably influenced respondents WTP changes in attributes. The data reveals that while the rank order of importance of attributes, signs, and significance levels are similar for the two samples, they differ in the parameter magnitudes. The study sheds light on the establishment of guidelines for developing valid cost attributes in DCEs studies.

Keywords: ‘price framing’, Discrete Choice Experiment, Mixed Logit Model

Note: An extract of this chapter has been published as a working paper at Economics Research Southern Africa (ERSA) Working Paper series. *Chikumbi, L. and Scasny, M. (2022). Does 'Price Framing' in Discrete Choice Experiments influence empirical estimates in Environmental Valuation? The case study for the South African wine industry, ERSA 878.*

5.1 Introduction

Discrete choice experiments (DCEs) are increasingly being used to estimate value for environmental goods and services. The theory behind choice experiments (CE) is that participants derive utility from valued goods or services. Participants' choices determine the amount or quality of multiple attributes that describe the characteristics of that good or service (Kragt and Bennett, 2010). Central to choice experiments is using surveys in which alternative (hypothetical) scenarios are defined by varying levels of non-market attributes and cost. Participants in the survey are then asked to pick their preferred option across the range of alternatives. Choice Experiments technique has been widely used since its introduction by Batsell and Lodish (1981) and Louviere and Woodworth (1983). In addition, the use of the technique has been extended to many disciplines such as transportation and services (e.g. Hensher and Rose, 2007; Rose and Bliemer 2009; Alberini and Ščasný 2018), human health (e.g. O'Hara, 2016; Ryan and Wordsworth, 2000) and environmental valuations (Chikumbi et al. 2021, Gibson et al., 2016; Hanley et al., 2006).

How the CEs are designed and how attributes are described to respondents play a key role in DCEs studies, considering that the contextual information provided in stated preference surveys can affect both the validity and reliability of value estimates (Samples et al. 1986; Bergstrom et al. 1990; Ajzen et al. 1996; Schlapfer 2008). Furthermore, since the results of choice experiments studies are increasingly being used to aid policy development, it is vital to assess the validity of the method and the reliability of value estimates (Kragt and Bennett (2012).

Many studies have investigated the validity of different stated preference techniques. Even though most studies have shown that the way cost information is presented, termed 'price framing', often significantly influence perceptions of value (Guha, et al., 2018; Anderson and Simester 2003; Gourville 1998; Heath, Chatterjee, and France 1995; Russo 1977; Bertini & Wathieu, 2006) little is known about their validity and reliability in DCE and environmental valuations. The close attempts on DCE studies (Veldwijk et al. (2016; Determann et al., 2017; Norman et al., 2016; Cornelsen et al., 2020; Howard and Salkeld, 2009; Kragt and Bennett, 2010; Murwirapachena and Dikgang, 2019) has shown that changes in attribute framing have unintended influences on obtained estimates which might result in biased conclusions. To the author's knowledge, no study has investigated the effects of 'price framing' on DCE measurements. The study answers the

research question, "does 'price framing' influence empirical estimates in DCEs?" and contributes to the literature by explicitly assessing whether or not the use of either *real price* or *percentage price* affects empirical estimates in DCEs concerning parameter' magnitude; sign; significance level; rank order of attribute importance; and the willingness to pay (WTP) estimates. The study hypothesizes that since the cost attribute values are similar and only differ when presented as either *real price* or *percentage price*, they should give similar outcomes since the cost attribute values are similar and only differ when presented as either real price or percentage price.

The study uses choice experiment data on preferences for natural preservatives in wine from a South African wine industry case study. A split sample survey was administered to 611 respondents and only differed on whether the cost attribute was presented as *real price* or *percentage price*. Using a mixed logit model, results demonstrated that 'price framing' significantly influenced respondents WTP changes in attributes. In addition, the findings suggest that while the attribute's rank order of importance, sign and significance level are similar for the two samples, there were differences in their parameter magnitude.

The following section, 5.2, provides a theoretical and empirical literature review. Then, section 5.3 presents the modelling framework, and section 5.4 presents the case study. Finally, section 5.5 shows the results, and concludes with a discussion of the findings in section 5.6.

5.2 Literature Review

Framing refers to the setting in which choices are made (Rolfe et al., 2002). There is significant proof that framing questions and the information provided in a survey influences participants' responses (Ajzen et al., 1996). When using choice experiments to value non-market goods and services, it is always important to know how participants' choices are sensitive to the survey setting. Not all participants of a survey have pre-existing preferences for the non-market goods presented in a choice experiment survey but that preferences are constructed based on the information provided in the survey, for example, see Tversky and Simonson (1993), Bateman et al. (2004) or Braga and Starmer (2005) on setting-dependent preferences. In this case, preferences are likely to change with the information provided and with the context described in the

questionnaire rather than with the nature of the good or service. Therefore, it is safe to argue that framing effects are inherent to stated-preference techniques, as they depend on the information supplied in the survey.

Attribute framing occurs when choices are influenced by how attributes are described to survey participants (Levin and Gaeth, 1988). Minor changes in the presentation or framing of attributes can influence the choices made. For example, Kahneman and Tversky (1979) found that adjusting the presentation of probabilities and results changes individuals' information translation and subsequent decision-making behaviour. By changing the naming of outcomes, as described in their famous "Asian disease" example, they found the more appealing choice was reliant upon whether outcomes were framed as lives saved or lives lost (Tversky and Kahneman, 1981). Thus, the choices varied distinctly in how the problem was framed.

Similar framing effects have been shown in other fields, including environmental policy, public policy, contract negotiations, taxation, health, and political preferences (Frederickson and Waller, 2005; Ovaskainen and Kniivila, 2005; McCaffery and Baron, 2004; Druckman, 2004; Rege and Telle, 2004; Park, 2000; Miller, 2000; Sonnemans, Schram and Offerman, 1998; Johannesson and Johannsson, 1997). Thus, there is suggestive evidence that attribute framing does influence the choices made by respondents.

A few DCE studies have tested the effects of attribute framing on empirical estimates (e.g., Veldwijk et al., 2016; Determann et al., 2017; Murwirapachena and Dikgang, 2019; Norman et al., 2016; Cornelsen et al., 2020; Howard and Salkeld, 2009; Kragt and Bennett, 2010). They found that changes in attribute framing have undesired influences on obtained estimates, which might result in biased conclusions.

Veldwijk et al. (2016) used a survey in the Netherlands to see if attribute framing in a discrete choice experiment influences respondents' decision-making behavior and preferences. The DCE included four factors to consider when deciding whether or not to participate in genetic screening for colorectal cancer. The risk factor was framed in two ways: positively as the likelihood of surviving cancer and negatively as the likelihood of dying from cancer. The relative values were calculated using mixed-logit models. The majority of respondents (56 percent) ranked survival as

the most significant feature in the positively framed DCE, but only roughly 8% ranked mortality as the most important attribute in the negatively framed DCE. They discovered that how a risk is framed has an impact on how people value it (Veldwijk et al., 2016).

Determann et al. (2017) investigated whether paper or electronic administration causes measurement effects. Participants were selected from the same sample frame (an Internet panel) and were asked to complete a virtually identical DCE survey on the web or on paper at the same time. They used mixed logit models and a DCE on preferences for basic health insurance as a case study. They received a total of 898 respondents from both modes. There were no significant differences in sociodemographic variables between the participants in both samples. The median response time for the paper sample was greater than for the web sample, and a smaller proportion of web participants were satisfied with the quantity of choice combinations. Despite the fact that some WTP estimates for the web sample were higher, the elicited preferences for essential health insurance criteria were identical in both modes of delivery.

Murwirapachena and Dikgang (2019) investigated the effects of three presentation formats, namely text, visuals and a combination of the two formats using data collected from a household survey in Gauteng province, South Africa. They found that visual presentations generate more efficient estimates than the other two formats using the mixed logit model.

Norman et al. (2016) investigated the possibility of using a discrete choice experiment (DCE) to value health wellbeing in the QLU-C10D, a utility instrument derived from the QLQC30, and to assess clarity, difficulty, and participants' preference between two presentation formats. They employed an online survey in which participants replied to 16 choice pairs; half of these had variations between dimensions highlighted, while the other half had standard dimensions explained in the text and differences in attributes were calculated. They utilized a conditional logit model to evaluate the DCE data by format, and Chi-squared tests to compare other responses by format. Respondents' cognitive approaches to the valuation task were investigated through semi-structured telephone interviews. The findings revealed that participants considered 10 domains challenging but workable, with many using simplifying heuristics.

Cornelsen et al. (2020) studied whether signalling and framing a sugar-sweetened beverage (SSB) tax increase explicitly as a health-related, designated action reduces demand SSB more than an equivalent price increase. Many nations have imposed SSB taxes to prevent obesity, with evidence that they are effective in reducing SSB purchases. A discrete choice experiment (DCE) was administered online to a randomly selected set of 603 families with children in the Great Britain who routinely purchase SSB. They found compelling evidence that when a price rise is signalled as a tax and framed as a health-related and earmarked policy, it leads to a greater reduction in the likelihood of choosing SSBs. Furthermore, individuals who did not support an SSB tax, who were also more inclined to use SSBs in the first place, were on average more receptive to a price rise framed as an allocated tax than those who supported the tax. The findings suggest that a well-publicized and earmarked tax on SSBs could be more effective at reducing demand.

Howard and Salkeld (2009) conducted a methodological exploration of the impact of attribute framing on marginal rates of substitution and the WTP from a discrete choice experiment within the context of colorectal cancer screening preferences. They used a survey and interviewed 1157 respondents in NSW, Australia. Respondents were randomized to one of four alternatives "frames" of information. A mixed logit model was used to estimate preferences. Results indicate that attribute framing significantly influenced estimates of WTP.

Kragt and Bennett (2012) examined the impacts of two attribute level descriptions. They first described non-market attributes as absolute or relative terms, with positive versus negative contextual descriptions of the attribute levels. The experiment was carried out using data from an Australian choice experiment on catchment management. Unlike derived expectations, revealed preferences are not affected by stated preferences. However, data reveals considerable discrepancies in value assessments when attribute levels are described as a 'loss' versus a 'presence,

Hess et al. (2006) investigated whether positive and negative changes in travel time attribute levels from a pre-specified reference option of a "current trip" were balanced. They found that increments and reductions in attribute levels were valued unevenly, demonstrating that gains and losses from a pre-specified reference point was not valued the same.

The focus of this chapter is ‘price framing’. The two commonly used ‘price framing’ in DCE studies are *real price* and *percentage price* as cost attribute (see Regier et al., 2015; Michaud, 2012; Chau et al., 2010; Masiero et al., 2015; Balogh et al., 2016; Fecke et al. 2018). While prior research has investigated the impact of ‘price framing’ on decision-making in other disciplines, i.e. marketing and psychology (e.g., Bertini & Wathieu, 2006; Anderson and Simester 2003; Gourville 1998; Heath, Chatterjee, and France 1995; Russo 1977), little is known about their validity and reliability in DCEs and environmental valuation studies. The study contributes to literature by exploring whether *real* or *percentage price change* as a cost attribute in DCE studies affects empirical estimates. This decision is critical since the contextual information provided in stated preference surveys affect results that ultimately influence policy development. Further, the study sheds light on establishing guidelines for developing valid cost attributes in DCE evaluations.

5.3 Modelling Framework

The theory of Choice Experiment is vested in the random utility theory and Lancaster's characteristics theory of value (Lancaster, 1966). It assumes the utility that individuals derived from choice situations are a function of a vector of attributes in the choice set and individual characteristics and an unobserved stochastic component:

$$U_{njt} = X_{njt}\alpha_n + \beta_n \cdot (Y_n - PRICE_{njt}) + \varepsilon_{njt} \quad (5.1)$$

where X represents a vector of alternative specific attributes (PRESERVATIVES, VITICULTURE PRODUCTION, QUALITY SCORE), Y is income, and $PRICE$ is the price of wine, the vector of coefficients α and coefficient β is estimated and is a stochastic component identically and independently distributed with a constant variance $k_n^2 (\pi^2 / 6)$, with k_n^2 , being an individual-specific scale parameter. An individual will choose alternative j if $U_{njt} > U_{nkt}$, **for all** $k \neq j$, and the probability that a particular alternative j is chosen from a set of C alternatives is given and can be estimated using different econometric models (Louviere et al. 2000; Alpízar et al. 2001; Bennett and Adamowicz, 2001):

$$P(j|C) = \frac{\exp(X_{njt}\alpha_n + \beta_n \cdot (Y_n - PRICE_{njt}))}{\sum_{k=1}^C \exp(X_{nkt}\alpha_n + \beta_n \cdot (Y_n - PRICE_{nkt}))} \quad (5.2)$$

Like the previous chapter, the study uses a mixed logit model specification with random, freely and fully correlated factors to account for unobserved heterogeneity across respondents (Revelt and Train 1998). Because the mixed logit probability does not have a closed-form solution, the model is estimated using the simulated maximum likelihood technique in STATA 16. The advantage of using a mixed logit model is that the specification of an individual specific error term allows for correlations across the sequence of choices made by individual n . The conditional probability of observing a sequence of individual choices t from the choice sets is the product of the conditional probabilities (Carlsson et al., 2003). Per procedure is to estimate the utility coefficients' distribution and then estimate the willingness-to-pay as a ratio of two utility parameter estimates, as $-\frac{\hat{\alpha}}{\hat{\beta}}$.

5.4 Case Study: Measuring premium price for natural preservatives in wine.

A Discrete Choice Experiment

The effects of 'price framing' on DCE measurements was tested using data from a choice experiment on preferences for natural preservatives in wine in the South African (SA) wine industry. SA wines have been successful globally, achieving significant production and export sales growth since 1994 (VinPro, 2018). However, since 2005, the industry has undergone major setbacks that have negatively impacted growth. As a survival mechanism, industry policy-makers are increasingly exploring ways to mitigate the negative trends.

One such way is through product innovation. Innovation is widely accepted as a driving force for agricultural development, and scientists recognize innovative farmers' key role (Chambers and Thrupp, 1994; Klerkx and Leeuwis, 2008; Reij and Waters-Bayer, 2014). In the same context, SA wines could explore product innovation as a potential revenue source to support itself and enhance competition.

In 2014 the South African wine industry launched the world first 'no sulphite added' wine made from indigenous Rooibos & Honeybush toasted wood chips. This wood chip contains anti-oxidants properties known to protect the wine from oxidation. On the other hand, as a wine preservative, sulphur dioxide (SO_2) is often perceived by wine consumers as causing headaches. Drawing attention to consumer behaviour in the marketplace has highlighted the trend of consumers choosing healthy food products. Most consumers, particularly in recent times, are attentive to artificial additives and prefer to buy organic foods (Hoffman et al., 2014). Since 'no sulphite added' wines seem attractive to health-conscious consumers, it is interesting to explore this potential niche market in-depth to gauge consumers' perceptions of the importance of these wines. Determining whether consumers choose such wines is essential, as it would reveal whether wine players can exploit this source of avenue to save the struggling industry. Key indicators that would inform wine players are how valuable 'no sulphite added' wine is to consumers and what consumers would consider such a trait necessary in their purchasing decisions.

5.4.1 Experiment design and randomized treatment

Designing a DCE involves selecting and combining the attributes and their levels to construct the alternatives in hypothetical choice situations presented to respondents (Hoyos, 2010). Respondents are then asked to think about the situation in which they would be making their choices. The identification of the attributes and levels (see Table 5.1) in the experiment was facilitated by the literature review of the findings from qualitative pre-testing conducted in focus groups with wine consumers from the Cape Town area.

Table 5.1. Attributes and levels of the discrete choice experiment

Attributes	No. levels	Levels
Preservatives	2	SO ₂ -based, Rooibos & Honeybush
Type of viticulture production	2	Conventional, Organic
Wine quality score	6	60, 75, 82, 88, 92, 100
Real Price	5	Rands: 0, 30,45,60,75 (Euro:0, 1.77, 2.66, 3.54, 4.43)
Percentage Price	5	0, 20%, 30%, 40, 50%

The same respondents completed a nearly identical DCE survey, one presented a *real price*, and another presented a *percentage price* as a cost attribute. The study I uses four price increase levels in the DCE design in both options, with zero in the Status Quo. While in the former case, the price increase was given by design, the levels in percentage value were respondent-specific in the latter variant. Thus, each respondent was presented with eight (8) choice situations where half the cards cost attribute was presented as *real price*, and the other half was presented as *percentage price*. An example of a choice card presented to respondents is shown in Figures 5.1 and 5.2, respectively. The wine price was shown as an increment of what a consumer typically pays for a bottle of wine, and the premium included *real price*: 30, 45, 60, and 75, and Euro equivalents are also shown on the cards in brackets. In *percentage price*, the offered bids represented 0, 20%, 30%, 40% and 50% of the average price of the status-quo wine.

The choice task included three alternatives, one referred to as wine typically purchased (i.e., the status quo). The status quo option described a typical wine sold on the South African market (in the Western Cape Province): a 750ml bottle of conventional wine with SO₂-based preservatives, graded by a 75-point quality score, whilst the price in the status quo was respondent-specific. Specifically, before the valuation part, the study asked each respondent the question, "What is the average price for which you typically buy a bottle of wine most often?". As a result, approximately respondents typically paid on average R184 for a bottle of wine, with a minimum at R33.60 and a maximum at R848. It then asked, "Which of the three alternatives do you prefer?" and repeated the valuation question four times for each different choice situation.

Using NGEN software, a Bayesian-efficient design was generated. The Bayesian approach for optimal experimental design has become more prominent in the literature (e.g., Muller, 1999; Han and Chaloner, 2004; Amzal et al., 2006; Muller et al., 2006; Collins and Rose, 2006; Ferrini and Scarpa, 2007; Scarpa and Rose, 2008; Cook et al., 2008; Huan and Marzouk, 2013) due to its ability to optimize design criteria that are functions of the posterior distribution and can easily be tailored to the experiments' objectives. The design contains twenty-four (24) unique choice combinations grouped into three, giving us eight choice cards per respondent. In total, the study obtained 4,888 responses (from 611 respondents) for both choice tasks, one presented with *real price* and another with *percentage price change*.

Figure 5.1. Real Price choice scenario

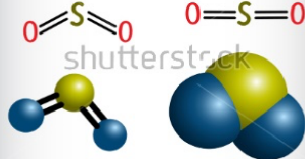
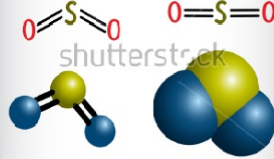
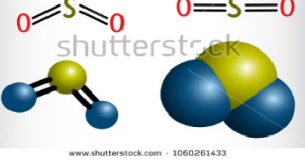
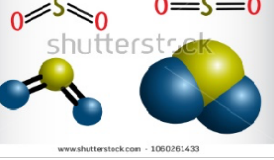
	Red Wine A	Red Wine B	Wine you usually buy
Preservatives	Rooibos & honeybush 	Sulfur dioxide SO_2 	Sulfur dioxide SO_2 
Viticulture production	Conventional 	Organic 	Conventional 
Wine quality Score	100 (great top wine)	60 (not recommended)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	R45 (€2.8) more	R60 (€3.75) more	as you usually pay
Which option do you prefer?	☐	☐	☐

Figure 5.2. Percentage Price choice scenario

	Red Wine A	Red Wine B	Wine you usually buy
Preservatives	Rooibos & honeybush 	Sulfur dioxide SO_2 	Sulfur dioxide SO_2 
Viticulture production	Conventional 	Organic 	Conventional 
Wine quality Score	100 (great top wine)	60 (not recommended)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	30% more	40% more	as you usually pay
Which option do you prefer?	☐	☐	☐

5.4.2 Experimental data

Multistage sampling was used to select areas and places to conduct the interviews. No incentive was offered to the survey participants. The interview was conducted in English, and the enumerators used a pen-and-paper mode of interviewing. Prior to the final survey, the questionnaire was comprehensively pre-tested in two waves of testing, and the survey instrument was modified to improve its readability and comprehension. The questionnaire consisted four sections. The first section contained a brief explanation of the purpose of the study without getting into details about what the study was all about to minimize a potential framing bias. The second section dealt with consumer information and knowledge about SO_2 content in wine, perceived health effects, cultivar production types and quality score of wine. The discrete choice experiment was presented in the third section. If respondents choose no change (status quo), they were asked to provide their main reason to identify protest responses. The final section collected socio-economic and other relevant information about the respondents. Visual information was included to facilitate understanding and make the survey more pleasant to respondents (see Figures 5.1 and 5.2).

The primary survey was conducted between July 8–22, 2019, and 611 participants completed the survey. While the sample may not represent the South Africa population, the recruiting strategy successfully targeted respondents in areas where most wine consumers reside. Almost everyone was buying at least a bottle of wine in a typical month. The majority of respondents (78%) are between the age of 21–50 years. There are 42% males and 51% females, while 7% choose not to provide information about their gender.

The majority of the respondents reside in Africa (80%), some in Europe (10%), 4% and 3% came from Northern America and Asia, respectively, and the rest (3%) come from other parts of the world. Regarding race, our sample included 33% Caucasian, 31% African, 23% coloured (mixed race), and the minority being Indian and Asian (5% each). In addition, over 66% held a university degree. The median net annual household income is between R200,000 and R350,000 (€12,500–€21,875), coinciding with the average annual household income for South Africa at R270,000 (StatsSA, 2019). However, one-third of the respondents preferred not to provide information about their income.

In order to understand how respondents perceive SO_2 in wine, the study asked several questions. First, question asked, "*do you have allergies on sulphur contained foods and beverages such as wine?*" followed by a question "*, do you know, or have you heard of someone who suffers from sulphite allergies in wine?*" Final and the key question was, "*do you believe that drinking even moderate amounts of wine give you a headache?*" About 25% of respondents reported being allergic to SO_2 in foods and beverages; 61% claim to know someone who suffers from SO_2 effects. In addition, about 68% believed that drinking even a moderate volume of some type of wine may result in headaches.

5.5 Estimation results

Results for the mixed logit model estimated in the preference space with all factors random and freely correlated are presented in Table 5.2. The study estimates the utility function and WTP estimates for the experiment. The rationale of these two fundamental analyses is to compare estimates of the experiments and see if there are variations in terms of the rank order of importance of the attributes; statistical level of significance; sign; the magnitude of parameters; and the WTP estimates. Results from pooled data (see column) show all coefficients are statistically significant at any convenient level and have expected signs, conforming to a priori expectations. It implies that respondents are willing to pay a premium for each of the three wine attributes, and the likelihood of purchasing a wine bottle decreases with a price increase. It also discovered large unobserved preference heterogeneity for each of the four random attributes, indicated by the means' extensive and robust statistically significant standard deviations.

Table 5.2. Parameter estimates for all MXL models

	Total sample (1)		Real price (2)		Percentage change price(3)	
<i>Variable</i>	<i>mean</i>	<i>(s.e)</i>	<i>mean</i>	<i>(s.e)</i>	<i>mean</i>	<i>(s.e)</i>
<i>Random parameter mean</i>						
Rooibos	1.9691***	(0.1538)	2.5102***	(0.1643)	1.8155***	(0.1471)
Organic	0.6175***	(0.1139)	0.8794***	(0.1224)	0.5454***	(0.1281)
Quality	0.0553***	(0.0054)	0.0697***	(0.0066)	0.0598***	(0.0069)
Price	-0.022***	(0.0022)	-0.640***	(0.0557)	-0.202***	(0.0340)
<i>Random parameter standard deviation</i>						
Rooibos	2.9365***	(0.1745)	2.5915***	(0.3045)	-2.765***	(0.1799)
Organic	1.7764***	(0.1340)	1.2092***	(0.2792)	-1.401***	(0.1404)
Quality	0.0784***	(0.0061)	0.0536***	(0.0117)	0.0770***	(0.0090)
Price	0.0391***	(0.0027)	0.7361***	(0.0052)	0.2415***	(0.0389)
<i>likelihood</i>	-3415.14941		-3377.1879		-3377.1879	
<i>LR Chi2</i>	2973.51		2969.83		2969.83	
<i>n(observations)</i>	14,640		14,664		14,664	
<i>r(respondents)</i>	611		611		611	
<i>k(parameters)</i>	14		48		48	

Notes: *, **, and *** represent coefficients significantly different from zero at 0.1, 0.05, and 0.01 significance level, respectively. Standard errors are provided in parentheses. All parameters are freely correlated, with 1000 draws for simulations.

When the sample was split between *real price* and *percentage price change*, (also using a joint mixlogit model) the test statistics indicate significant differences in the coefficient means for the two samples, 12.39 ($p = 0.0004$) for Rooibos; 4.91 ($p = 0.0267$) for organic; and 1.17 ($p = 0.2801$) for quality, implying that the two samples give different estimates (see, column 2 & 3 of Table 5.2).

While the signs and significance levels are similar for the two samples, the study finds differences in the parameter magnitudes. *For example, real price* had a higher likelihood of choosing all its attributes (Rooibos, organic, and quality score) than *percentage price*, whilst the likelihood of choosing the cost attribute was lower for the *real price* than *percentage price*, an indication that the model fit for *real price* sample was slightly better than that of *percentage price* sample. Furthermore, the statistically significant estimates for derived SD for all parameters suggest the existence of heterogeneity around the mean parameter over the two samples.

There is strong evidence that willingness to pay (WTP) estimates are different for the two samples. WTP for natural preservatives as well as that for quality is at least two times larger for *percentage price* sample, R143.89 vs R62.73 for Rooibos; whilst their WTP for organic attribute is statistically different with R43.22 vs 21.97, and R4.74 vs R1.74 for quality. Further, the rank order of importance of attributes and importance scores were similar across both samples. *Rooibos & Honeybush* was considered the most important attribute, followed by organic, price and quality, respectively.

Table 5.3. WTP estimates in Rands per 750ml wine bottle.

	Total sample (1)		Real price (2)		Percentage change price (3)	
Rooibos	88.3248***	(11.1016)	62.7351***	(6.2265)	143.8989***	(20.551)
Organic	27.6996***	(5.6485)	21.9776***	(4.4825)	43.2294***	(9.9298)
Quality	2.4845***	(0.3256)	1.7435***	(0.2132)	4.74097***	(0.6929)

Notes: *, **, and *** indicate the significance of the WTP mean estimates at 10%, 5%, and 1%. Standard errors are provided in parentheses. Wald statistics for the quality test of the WTP means for real price vs percentage price is 13.56 ($p = 0.0002$) for Rooibos; 3.87 ($p=0.0491$) for organic; and 12.70 ($p=0.0004$) for quality.

5.6 Discussion and Conclusion

The study answers the research question: “***Does ‘price framing’ influence empirical estimates in Discrete Choice Experiments?***” There is enough evidence that the way information is framed in choice experiment surveys can impact respondents' decision behaviour. Therefore, if choice experiment surveys are to be used and trusted to value environmental goods and services, it is crucial to determine how sensitive value estimates are to 'price framing'. This chapter contributes to the literature by investigating the impacts of 'price framing' on respondents' choices and welfare estimates using data from a DCE survey on preferences for natural preservatives in wine in the South African wine industry.

The effect examined was the impact of 'price framing' on DCE empirical estimates, presenting the cost attribute to respondents as either *real price* or *percentage price change*. A split sample survey was administered to the same respondent who answered 8 choice scenarios - half of the cards were

assigned in *real price*, and another half was presented in *percentage price*. The study hypothesized that since the cost attribute values were similar and only presented to respondents as either *real price* or *percentage price*, they should give similar outcomes. However, the mixed logit model results show that estimated parameters were significantly different in the split sample. The test statistics indicates significant differences in the coefficient means for the two samples, 12.39 ($p = 0.0004$) for Rooibos; 4.91 ($p = 0.0267$) for organic; and 1.17 ($p = 0.2801$) for quality, implying that the two samples give different estimates.

Data also indicates that while the signs and significance levels are similar for the two samples, it reveals differences in the parameter magnitudes. *For example, real price* had a higher likelihood of choosing all its attributes (Rooibos, organic, and quality score) than *percentage price*, whilst the likelihood of choosing the price attribute was lower for *real price* than *percentage price*, an indication that the model fit for *real price* sample was slightly better than that of *percentage price* sample. Additionally, the statistically significant estimates for derived SD for all parameters suggest heterogeneity around the mean parameter over the two samples.

There is strong evidence that WTP estimates are different for the two samples. WTP for natural preservatives and quality is at least two times larger for *percentage price*, whilst their WTP for organic attribute does not statistically differ from the other. Additionally, the rank order of importance of attributes was similar across both samples. *Rooibos & Honeybush* was considered most important, followed by organic, price and quality scores, respectively.

These findings suggest that presenting the cost attribute in *real price* will give better results than the *percentage price change*. Because this study is rare, there is limited literature to compare these findings with. However, similar experimental studies on the effects of framing on empirical estimates in DCEs have shown that changes in attribute framing have unintended influences on obtained estimates, resulting in biased conclusions. This study confirms these findings, and DCE practitioners need to be cautious when designing experimental tools. There is a need for well-defined instruments that match individuals' decision environments when making the actual policy choice considered in the CE studies.

DCE practitioners need to have a clear understanding of individual decision behaviour and the scientific settings of the study in order to reveal people's valid preferences for the resources under consideration. Not only should the cost attribute in a CE questionnaire suit the decision context, but it should also be communicated in a manner that is relevant and interpretable to participants. CE practitioners should be aware that alternative presentation of cost attributes, i.e. *real price* vs *percentage price*, may affect how respondents understand the survey information. Focus group discussions and pilot studies are recommended beforehand to gauge participants' prior beliefs and assess how the cost attribute framing may influence participants' choices.

There are no clear guidelines on how to present cost attributes in a DCE setting and how decisions about 'price framing' affect study outcomes. Therefore, further research is recommended on the effects of 'price framing' in other DCE settings. This will ascertain the existence of these effects in other decision contexts, and ongoing research on appropriate designs will allow further quantification of the magnitude of the influence of 'price framing' in DCE studies.

The study's main limitation is that it used a DCE on preferences for natural preservatives in the South Africa context as a case study for this methodological research. In addition, this DCE was administered on a sample representative of the generalized adult wine consumer population in Cape Town, South Africa. This generalization and a small population sample may be limiting. More research is needed to test the generalizability of the findings to other populations and other environmental valuation settings. The next stage of research can categorise respondents into age groups at the same time increase the population sample to cover a wider area. The impact of picture presentation is yet another possible study limitation. Due to the possibility that natural preservatives shown as plants and sulfur as atoms may influence consumers and have their own framing effects. Furthermore, asking respondents on their knowledge about SO_2 prior to the DCE could also cause framing bias. Nevertheless, the results provide insight into the validity and reliability of 'price framing' effects in DCE and environmental valuations. DCE practitioners need to be cautious when designing experimental tools considering that the contextual information provided in stated preference surveys affect results that ultimately influence policy development.

6 Volatility linkages between energy and wine prices in South Africa

Abstract

This chapter investigates whether energy price volatility influences South African wine prices. It contributes to knowledge by examining the volatility behaviours of energy (fuel and electricity) and wine prices and establishing the extent to which energy price uncertainty affects prices in the wine sector. Although energy cost is one of the major contributors to the wine industry's poor performance, no research has been conducted to quantify the effect and provide countermeasures. Using a Multivariate Generalized Autoregressive Conditional Heteroscedasticity (MGARCH) model, the chapter estimates own- and cross-volatility spillovers and persistence between the South African energy and wine markets using monthly data from 2002 to 2018. The results from the Constant Conditional Correlation MGARCH model indicate positive and significant volatility effects, with a strong spillover from the energy market to the wine market. The persistence indicator is close to unity, implying that the impact of energy price shocks on the wine market takes a long time to decay. The outcomes additionally demonstrate that only fuel and wine prices move together in the long run. The implication of the findings is that a chart of dependence and risk between energy and wine markets could be designed to protect the wine industry from spillovers and foster wine market stability. Notably, the higher spillover transmission from fuel should be internalized for better hedging.

Keywords: Energy, Wine, Price Volatility, MGARCH

Note: An extract of this chapter has been published as a working paper (Chikumbi, L., Muchapondwa, E., and Thiam, D., 2020. Volatility linkages between Energy and Wine Prices in South Africa. Environment for Development P 20-07).

6.1 Introduction

Energy is a necessary input in the agricultural sector as it is needed for growing, harvesting, processing, and transporting food from farms to different locations across the world. This creates a connection between the two sectors and raises the question of how the prices in one market affect those in the other. Especially given high energy price volatility and its effects on food prices, the transmission of energy price to agricultural commodity output prices is of considerable economic interest. More significant is the increase in price volatility, which has far more severe consequences than level price increases. Price volatility indicates the rate at which price changes over successive periods and is determined by the speed, magnitude, and change in the direction of the variation in prices (FAO, IFAD, IMF, OECD, UNCTAD, 2011). An increase in price volatility implies more significant uncertainty about future prices because the range in which prices lie in the future becomes broader. Therefore, consumers and producers can be affected by an increase in price volatility because it augments the uncertainty and risk in the market. For example, a volatility increase in price exposes consumers and producers to additional risk by reducing the accuracy of future agricultural commodity prices predictions, thereby causing welfare losses to both producers and consumers of agricultural products (Sahn and Delgado, 1989).

The South African agricultural sector uses liquid petroleum fuels for approximately two-thirds (69%) of its energy, while electricity contributes 30% and coal just 1% (DAFF, 2015). The South African wine industry relies heavily on energy inputs to grow grapes and wine processing and distribution to different sites in the country and abroad. In recent years, a sharp increase in input production cost has reached levels at which over a thousand farmers shut down operations (VinPro, 2018). Although energy cost has been highlighted as one of the contributors to the industry's difficulties, no empirical study has been conducted to evaluate the claim. This study aims to estimate the conditional correlations in the returns on energy and wine prices using an MGARCH model. The correlations will enable a determination of whether energy prices and wine prices are related. Knowledge about the degree of price volatility is key to the ability of wine stakeholders and policy-makers to implement appropriate hedging strategies. In addition, it will provide helpful information in relation to, for example, pricing efficiency, assimilation of market signals, and the structural rigidity of prices.

Price volatility measures have been analysed extensively in the field of finance, and the approach is also widely used in assessing agricultural commodity prices (Bergmann et al., 2016; Daki et al., 2017; Deb et al., 1996; Gardebroek and Hernandez, 2013; Gilbert and Mugera, 2014; Nazlioglu et al., 2013; Trujillo-Barrera et al., 2012). However, few studies have focused on the impact of energy price volatility on wine prices (Azzi, 2013; Bouri, 2013, 2014; Cevik and Sedik, 2014; Kwon, 2014). This chapter examines the relative uncertainty of prices in the energy (fuel and electricity) and wine markets and measures the degree to which price uncertainty in one market influences price uncertainty in the other market.

It contributes to the literature by establishing the extent to which price uncertainty in the fuel and electricity market affects prices in the wine market. The study opted to model the domestic prices for energy and wine because the consumer price index (CPI), used here as a price proxy for fuel, electricity, and wine reflects the true domestic values and plays a role as a major input in the production of grapes, the processing of wine, and the distribution of wine to end-users in the supply chain. Moreover, given that energy is a key input in wine production, it is interesting to uncover the extent to which changes in energy prices influence wine price and vice versa. Thus, the study contributes to a better understanding of input price volatility effects and identifies tools and approaches that could assist farmers to reduce the uncertainty related to price volatility. The findings indicate significant and positive effects were imposed on wine prices by the volatility of energy prices. The findings also confirm a clear correlation between fuel and wine prices, implying that the two markets are positively dependent to the extent that a change in fuel prices influences a change in wine prices.

The remainder of the chapter is arranged as follows. Section 6.2 looks at past studies on the linkages between energy and agricultural commodity prices. Section 6.3 describes the empirical framework and data sources. Section 6.4 discusses the empirical results of the analysis. Finally, section 6.5 concludes the study and discusses the implications for the wine industry. All computations are carried out in STATA 16.

6.2 Literature Review

The connection between energy and agricultural commodity prices has been addressed by many researchers using econometric techniques. However, the majority of the literature has concentrated on price level interdependencies. Until now, only a few studies have examined volatilities and their transmission between markets (Ameur and Le Fur, 2020; Bergmann et al., 2016; Deb et al., 1996; Gilbert, 2010; Haniotis and Baffes, 2010; Ji and Fan, 2016; Kang et al., 2017; Nwoko et al., 2016; Roman et al., 2020; Serra et al., 2011; Tyner, 2010; Vo et al., 2019). Whilst many studies show a positive connection between energy and agricultural commodity prices (Bergmann et al., 2016; Gardebroek and Hernandez, 2013; Nwoko et al., 2016a; Serra et al., 2011; Trujillo-Barrera et al., 2012; Zhang et al., 2010), others found mixed results (Campiche et al., 2007; Ciaian, 2011; Natanelov et al., 2011), and base their conclusions on different factors such as (1) the time period of the data sample, (2) country specifics, (3) a particular agricultural commodity and (4) the magnitude of oil price changes. Some empirical results suggest a neutral position (Nazlioglu et al., 2013; Qiu et al., 2012; Zhang et al., 2010) and claim no link between energy price and agricultural commodities.

The following studies investigate the linkages between commodity and crude oil prices: Ameur and Le Fur (2020) examines volatility transmission from various markets (for example, commodities, credit, financial, real estate, and art) to the fine wine market during 2007–2017 period. They used monthly wine data from Liv-ex for the analysis. The results reveal that, in the short term, volatility is transmitted with a negative effect through the commodity and financial markets and with a positive effect through the residential real estate, art, and credit default markets. However, the study shows that the wine market is influenced by all other markets in the long term.

Roman et al. (2020) investigate the linkages between crude oil prices and selected CPI food prices (cereal, dairy, meat, oils, and sugar) and provide an empirical specification for the direction of the impact. They used monthly real crude oil price and food price indexes for the period 1990-2020. They employed several methods for the analysis, including the Granger causality test, the Augmented Dickey-Fuller test, the Cointegration test, the Vector Autoregression model, and the Vector Error Correction model. Results indicate a long-term relationship between crude oil and

meat prices. In the short term, crude oil prices are linked with food, cereal, and oil prices. The study also found that the linkages between the variables increased during the period 2006–2020.

Vo et al. (2019) investigate the causal link between agricultural products and oil markets from 2000–2018. They used impulse response functions, a structural vector autoregressive (SVAR) model, and a variance decomposition technique to examine how shocks to agricultural markets contribute to differences in crude oil prices. Using month-to-month spot prices of 15 commodities, including crude oil, biofuel-related agricultural commodities, and other agricultural commodities, their results show that not all oil shocks contribute to agricultural price fluctuations in the same way, and for the same applies to the effects of aggregate demand shocks on the agricultural market. Findings reveal that the crude oil market plays a vital role in explaining fluctuations in agricultural commodities prices and the associated volatility.

Ji and Fan (2016) examine the contemporary causality between China's oil markets and other commodities markets. They used the error correction model blended with a coordinated acyclic graph technique. Their findings show that China's oil markets are integrated with other commodity markets locally and globally. Furthermore, the impact of China's fuel oil futures market on other local commodity markets is excellent when oil prices are high, though the impact is comparatively weak when oil prices are lower. Results also show that the crude oil market has little impact on other commodity markets due to China's lack of futures markets.

Another study by Ji and Fan (2012) investigates the impact of the crude oil market on non-energy commodity markets before and after the 2008 financial crisis. Using a bivariate EGARCH model with time-varying correlation construction, the results show that the crude oil market has significant volatility spillover effects on non-energy commodity markets, revealing its core position among commodity markets. Furthermore, they found that the overall degree of correlation was reinforced after the crisis, demonstrating that the economic recession influenced the consistency of market price trends. In addition, the study found that the influence of the US dollar index on commodity markets had weakened since the crisis.

Kang et al. (2017) assess the spillover effects among six commodity futures markets, crude oil, gold, silver, corn, rice, and wheat, using a multivariate DECO-GARCH approach and the spillover

index. The dynamics of return and volatility spillover indices reveal the intensity and direction of transmission of the global financial crisis and the European sovereign debt crisis. The results show significant correlations between commodity futures market returns that went up during the crises. There were more striking patterns in the bidirectional return and volatility spillovers across commodity futures markets during the study period, indicating a strong impact of the shocks. They also found that both silver and gold were information transmitters for other commodity futures markets, while the remainder of the commodities were receivers of spillover during the financial crises.

Bergmann et al. (2016) used the Vector auto-regression (VAR) models and a multivariate GARCH model to capture the price transmission impacts of the palm oil, butter, and crude oil markets. They used monthly data from January 1995 to December 2005 to test the transmission effects before the full implementation of the CAP Luxembourg agreement, and bi-weekly data from January 2006 to December 2015 was used to test for transmission after the implementation of the agreement. The findings demonstrate a strong price and volatility transmission impact between EU and World butter prices. Furthermore, the European Union butter shocks further spillover to palm oil volatility. In addition, there was proof that oil prices spill over to World butter prices and volatility.

Gilbert (2010) employed Granger-causality tests to examine the connection between crude oil prices and the IMF's agricultural food price index and crude oil prices and the grains sub-index. The analysis is based on monthly data from March 2006 to June 2009. In both cases, the results showed a negative Granger-causal impact in the two decades up to 1989 and a positive Granger-causal impact in the two more recent decades. The pre-1989 results may reveal that, over that period, the developed economies lacked a clear monetary solution, and hence a rise in oil prices would likely be met by a strict anti-inflationary monetary tightening. The production function pass-through-impact of higher oil prices became apparent once the validity of inflation targeting had been established.

Thompson et al. (2009) evaluate how shocks to the corn and oil markets affect the price and use of ethanol. By conducting forward-looking analysis, they used the findings of partially stochastic simulations to evaluate the correlations of key market indicators. The findings show that market

developments and policy changes determined the intensity of linkages between the energy and agricultural markets and changed the nature of these connections (Thompson et al., 2009).

Deb et al. (1996) discovered weak proof of excess co-movement using univariate and multivariate GARCH models. They offer a few explanations for this excessive co-movement, for example, the presence of a speculator's liquidity restrictions on financial markets, herding behaviour, or the likelihood that agents interpret supply shocks explicit to a market as macroeconomic shocks. Other reasonable alternative causes include the connection between energy markets, such as oil and other commodities. This last point has produced several studies that helped highlight the impact of oil prices on commodity prices and the transmission components between the energy and other commodity markets.

A study by Nwoko et al. (2016) investigates the oil - agriculture relationship. They used a GARCH approach to examine the dynamic relationships between food prices and crude oil prices. The results reveal no significant effects in the long run but a positive and significant effect in the short run. Another study by Gardebroek and Hernandez (2013) employs a multivariate GARCH model for 1997-2011 and finds a very high interaction between ethanol and the corn market. Similarly, a study by Todsadee et al. (2014) measured the volatility of food commodity prices using a multivariate GARCH approach. The findings show that lagged conditional variance and lagged square distribution had significantly influenced the conditional variance and discovered that the ARCH effects had less impact than the GARCH effects.

Whether a relationship exists between the energy and wine markets remains a charged issue for academics and wine stakeholders, including governments. Only a few studies specifically look at the energy-wine relationship (Azzi, 2013; Bouri, 2013, 2014; Cevik and Sedik, 2014; Kwon, 2014). Bouri (2013) applies an MGARCH approach to examine the mean price and volatility transmission dynamics between crude oil and fine wine prices. Bouri used daily observations of financial data from January 2004 to December 2011. The findings suggest that the mean price of crude oil strongly influences wine market prices. Bouri also found that the volatility persistence was high and significant in each series and noted that innovations in each market predict volatility in other markets. In the course of the financial crisis of 2008, the conditional volatilities of oil and wine rose but then returned to their pre-crisis levels. Another study by Bouri (2014) examines fine

wine's safe-haven status concerning the US equity movements. The study used a GARCH model and its variant to examine the asymmetric reaction to the positive and negative shocks. The results indicate inverted asymmetric volatility in the wine market and that positive shocks increased the conditional volatility more than the adverse shocks. This indicates that an opposite reaction in the volatility of equity returns happened in the wine market. The study proposed that the safe-haven effect was a leverage effect, and the volatility feedback was not clearly explained.

Azzi (2013) investigates the dynamic interactions of return and volatility transmission between crude oil and fine wine prices using a multivariate framework with monthly data for 1988-2012. Results show that the mean return on crude oil dominates that of the wine market. The effects of adverse shocks are asymmetric between the oil and wine markets. Azzi also found that the linkages between the two markets were affected by global industrial production levels.

On the other hand, Cevik et al. (2014) investigate the causes of extreme fluctuations in commodity prices using monthly data from 1990 to 2010. The crude oil and fine wine analysis show that macroeconomic factors are the primary determinant of commodity prices. The empirical results show that, while advanced economies account for more than half of worldwide consumption, emerging economies make up the bulk of the increased changes in demand and thereby have a more significant effect on commodity price formation. The findings also indicate that the shift in the composition of aggregate commodity demand was a new phenomenon.

A study by Kwon (2014) used Vector autoregression and cointegration analysis to investigate if monthly fine wine prices co-move excessively with other commodity prices and found that there was no excess co-movement between fine wine and other commodity prices in either the short or long term, strengthening fine wine's status as a financial asset. However, from the studies highlighted, it is clear that few studies examine the linkages between energy and wine prices. This study seeks to fill this gap by examining the volatility behaviours of energy (fuel and electricity) and wine prices and establishing the extent to which energy price uncertainty affects wine prices in the South African wine industry.

6.3 Methodology and Data

6.3.1 Approach

The study runs unit-root and heteroscedasticity tests for the monthly data series and then test for the Autoregression Conditional Heteroscedasticity (ARCH) effect. The study examined several versions of parametrised GARCH models and chose the Constant Conditional Correlation Multivariate General Autoregression Conditional Heteroscedasticity (ccc MGARCH) model for the final analysis as the model that best fits the data.

Unit Root Test

Unit root tests were carried out to establish whether each series is stationary. It is important to test for a unit root in the time series to avoid the problem of spurious regression, as described by Granger et al. (1974). If a unit root is found, then the conditions of stationarity are violated. The most commonly used tests are the Augmented Dickey-Fuller (ADF) and Phillips and Perron (1988). For the ADF test, the study chose the optimal lag length using the Schwarz information criterion. For the Phillips and Perron (PP) tests, the study selected the optimal bandwidth using the Newey–West criterion. The null hypothesis of the ADF and PP tests is that the time series contains a unit root.

Co-Integration Test

According to Engle and Granger (1987), co-integrated series are those integrated in the same order $I(q)$, and their linear combination generates a stationary series. A non-stationary series that is co-integrated may diverge in the short run but must be linked together in the long run. For example, price series are co-integrated if they move together in the long run; even though they may experience shocks that cause them to deviate for a short while, they will always return to their long-run relationship (Koop and Quinlivan, 2005). Although there are different ways to test for co-integration, the Johansen (1988) test approach is used to analyse the long-run relationship between energy and wine prices. The Johansen test is known to have desirable statistical properties and can determine the number of co-integrating relationships among variables (Nwoko et al., 2016). Its weakness, however, is that it relies heavily on asymptotic properties, making it sensitive

to the specifications used. The Johansen co-integration test is a vector autoregression (VAR)-based test and has a general VAR of order p :

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + B X_{t-i} + \varepsilon_t \quad (3.1)$$

where y_t is a k -vector of non-stationary variables that are, for instance, integrated of order 1 and denoted as $I(1)$. In this study, y_t consists of wine, fuel, and electricity prices respectively. X_t is a d -vector of deterministic or exogenous variables which are optional, and ε_t is a vector of random shocks. The VAR is then rewritten as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + B X_t + \varepsilon_t \quad (3.2)$$

$$\text{where } \Pi = \sum_{i=1}^p A_i - I, \quad \Gamma_i = -\sum_{j=i+1}^p A_j \quad (3.3)$$

Granger's representation asserts that, if the coefficient matrix Π has reduced rank $r < k$, then there exist matrices α and β each with a rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is $I(0)$. r is the number of co-integrating relationships (i.e., the co-integrating rank) and each column of β is the co-integrating vector. The elements of α are known as the adjustment parameters in the Vector Error Correction (VEC) model. Johansen's method is to estimate the Π matrix from an unrestricted VAR and to test whether the study can reject the restrictions implied by the reduced rank of Π . It can be shown that, for a given r , the maximum likelihood estimator of β defines the combination of y_{t-1} that yields the r largest canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences and deterministic variables when present. For this study, deterministic or exogenous variables such as seasonal dummies or time trends are not included. Johansen (1988) proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace test and the maximum eigenvalue test. The trace test tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of k co-integrating vectors. The maximum eigenvalue test, on the other hand, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of $r+1$ co-integrating vectors. Once the study identified that the series are integrated of the same order, i.e., $I(1)$, a vector autoregression (VAR) model is postulated to obtain a long-run relationship.

Heteroscedasticity and ARCH Effect

The study used the Breusch-Pagan test and Engle's La Grange-multiplier test (1982) to test for the presence of heteroscedasticity and ARCH effect respectively. The presence of the ARCH effect is tested for using the following conditional variance:

$$h_2 = Var\left(\frac{u_t}{\Omega_{t-1}}\right) \quad (3.4)$$

$$h_2 = \rho_0 + \rho_1 u_{t-1}^2 + \rho_2 u_{t-2}^2 + \cdots \dots + \rho_q u_{t-q}^2 \quad (3.5)$$

where u_t^2 is the squared residual in period t , and p represents the parameters to be tested.

The confirmation of the presence of the ARCH effect indicates that the volatility in the prices of the series is time variant; as such, the GARCH approach can be used (McAleer et al., 2008).

The GARCH Framework

The Autoregressive Conditional Heteroscedasticity (ARCH) process was first introduced by Engle (2002) to allow conditional variance to vary as a function of past shocks while maintaining the unconditional variance constant. The generalised ARCH (GARCH) process is the most popular volatility model, introduced by Bollerslev et al. (1988). GARCH allows a more flexible and parsimonious representation of the variance (scedastic) process. GARCH models specify an Autoregressive Moving Average (ARMA) process for the scedastic process followed by a time series to produce an estimate of the conditional variance of the process at each date in the sample.

The study follows the standard practice of adopting a GARCH (1,1) specification that includes a single lagged squared error (ARCH) and a single lag on the lagged conditional variance (GARCH). Accordingly, the study defines GARCH (1,1) as follows:

$$\begin{aligned} r_t | r_{t-1}, r_{t-2}, \dots &\sim N(\mu, h_t) \\ h_t &= \omega + \alpha(r_{t-1} - \mu)^2 + \beta h_{t-1} \end{aligned} \quad (3.6)$$

where $\omega > 0$ and $\alpha, \beta \geq 0$, with ω , α , and β parameters to be estimated, $(r_{t-1} - \mu)^2$ represents the ARCH effects (or the short-run persistence of shocks to return), that capture the short-term

deviations in price as a result of short-term supply and demand fluctuations. (h_{t-1}) represents the GARCH effects (or the contribution of the shocks to return to long-run persistence), that reflect any permanent changes in long-term prices as a result of changes in the market, and $\alpha + \beta$ denotes the long-run persistence.

Multivariate GARCH Models

Bollerslev et al. (1988) introduced a framework for multivariate GARCH (MGARCH) analysis. Generally, MGARCH employs four commonly-used methods of parameterization: the diagonal VEC (dvech) model, the constant conditional correlation (ccc) model, the dynamic conditional correlation (dcc) model, and the time-varying conditional correlation (vcc) model (Amado et al., 2019; Bauwens et al., 2006; Bollerslev et al., 1988, 1994; Engle, 2002). The multivariate framework allows one to estimate jointly volatility measures of different series. Generally, an MGARCH (1,1) model for an m -dimensional vector r of returns is given as:

$$\begin{aligned}
 r_t | r_t, r_t, \dots &\sim N(\mu, H_t) \\
 h_{jit} &= \omega_{ji} + \sum_{k=1}^m \sum_{l=1}^k \alpha_{jik} (r_{k,t-1} - \mu_k)(r_{l,t-1} - \mu_l) + \sum_{k=1}^m \sum_{l=1}^k \beta_{jik} h_{kl,t-1} \\
 h_{ijt} &= h_{jit} \quad (j = 1, \dots, m; i = 1, \dots, j) \\
 &\quad (j = 1, \dots, m; i = 1, \dots, j-1)
 \end{aligned} \tag{3.7}$$

The presentation of equation (3.7) is problematic if the dimensionality m of the return vector exceeds two. This is because, in the first place, the model becomes highly parameterized - the number of parameters is $2m + 1/2m^2(m+1)^2$ - and, in the second place, because it is difficult to impose positive definiteness of the conditional variance matrix H_t at every date in the sample. For these reasons, many studies use simplified versions of the general MGARCH model (i.e. dvech, ccc, dcc and vcc). The study examined several versions of parametrised MGARCH models and chose ccc MGARCH as it fit the data best. The ccc MGARCH is known to be flexible enough to account for own- and cross-volatility spillovers and persistence between markets. In the diagonal case the ccc MGARCH has the structure :

$$r_t | r_{t-1}, r_{t-2}, \dots \sim N(\mu, H_t)$$

$$\begin{aligned}
h_{j|t} &= \omega_{jj} + \alpha(r_{j,t-1} - \mu)^2 + \beta_{jj}h_{jj,t-1} & (j = 1, \dots, m) \\
h_{jit} &= \rho \sqrt{h_{j|t}h_{i|t}} \\
(j = 1, \dots, m; i = 1, \dots, j) & & h_{ijt} = h_{jit} \\
(j = 1, \dots, m; i = 1, \dots, j-1) & &
\end{aligned} \tag{3.8}$$

The scedastic equation (3.8) may be written more compactly as follows:

$$H_t = D_t R D_t \tag{3.9}$$

where $D_t = \text{diag}\left(h_{11t}^{-\frac{1}{2}}, \dots, h_{mmt}^{-\frac{1}{2}}\right)'$ is a $n \times n$ diagonal matrix of time-varying standard deviation from the univariate GARCH model, and $R = (\rho_{ij})$ is a constant positive definite correlation matrix that measures the long-term relationship of the series.

The conditional variances and covariances (correlation) matrices are estimated in a multivariate GARCH model using quasi-maximum likelihood (QML) by maximizing the Gaussian log-likelihood function. In estimating ARCH/GARCH models, the study uses the maximum likelihood technique, which is based on finding the most likely values of the parameters. This technique works by specifying a log-likelihood function and maximizing the values of the parameters. The maximum likelihood method can be utilized in both linear and non-linear models. First, considering mean and variance equations, a log-likelihood function should be formed to maximize the values of the parameters. Then, parameter values and their standard errors should be obtained.

6.3.2 Data and Descriptive Analysis

The empirical analysis uses the monthly Consumer Price Index (CPI) from 2002: Q1 to 2020: Q4 for fuel, electricity, and wine. This provides a total of 228 observations. All prices are expressed in Rands (ZAR). The data were obtained from Statistics South Africa (StatsSA, 2020). Even though the data used for the analysis is not extensive, the study could draw out some conclusions that have vital policy implications. Needless to say, the preferences of a broader sample should be investigated. In this sense, the relatively small sample size is the main limitation of this study.

However, the approach and indicators align with previous literature on the "fuel-food" interrelationship.

Prices show a constant increase in the real price of wine from about R43.17 in 2002 to a high of about R137.9 in 2020. Fuel prices increased from R31 in 2002 to a high of R83 in 2008. This dropped in 2009 to about R46, started increasing in 2010, and peaked at R112 in 2014. As of 2020, it stood at R136.2. Electricity prices increased from R20.87 in 2002 to R130.9 in 2020. The selected variables measure the variability in the prices of wine, fuel, and electricity. The CPI indicators of each variable give the average increase in real price over the years. Each variable exhibits some levels of volatility. Following Roman et al. (2020) that employed crude oil and CPI for selected foods, the study uses the South African CPI as a "price proxy" for fuel, electricity, and wine. Table 6.1 shows the three series' descriptive statistics for price levels and the logarithmic price changes (returns). The Jarque-Bera test rejects normality for both price levels. The returns have similar kurtosis, though the price level has a higher skewness.

Table 6.1: Descriptive Statistics for Data

Price levels	Max	Min	Mean	s.d	Skewness	Kurtosis	p-value	Obs
Wine	137.9	43.17	79.73	24.14	0.0031	0.00	0.000	228
Fuel	134.9	31.35	78.01	30.60	0.9685	0.00	0.000	228
Electricity	130.9	20.88	63.40	34.68	0.0675	0.00	0.000	228
Ln price returns								
Wine	0.0870	-0.0174	0.0051	0.0116	0.000	0.00	0.000	227
Fuel	0.1435	-0.1902	0.0066	0.0467	0.000	0.00	0.000	227
Electricity	0.1962	-0.0327	0.0084	0.0282	0.000	0.00	0.000	227

Source: own elaboration

6.4 Estimation Results

Unit Root Test

The augmented Dickey and Fuller (ADF) and Philips–Perron (PP) unit root tests were used to check for stationarity or non-stationarity of variables, as described in the methodology section. Table 6.2 provides the results of the unit root tests based on ADF and PP methods. The test results indicate that all variables have a unit root and therefore are non-stationary in levels. However, for all three variables, the null hypothesis is rejected at the 1% level when I difference the equations by first order.

Table 6.2: ADF and PP Test Results

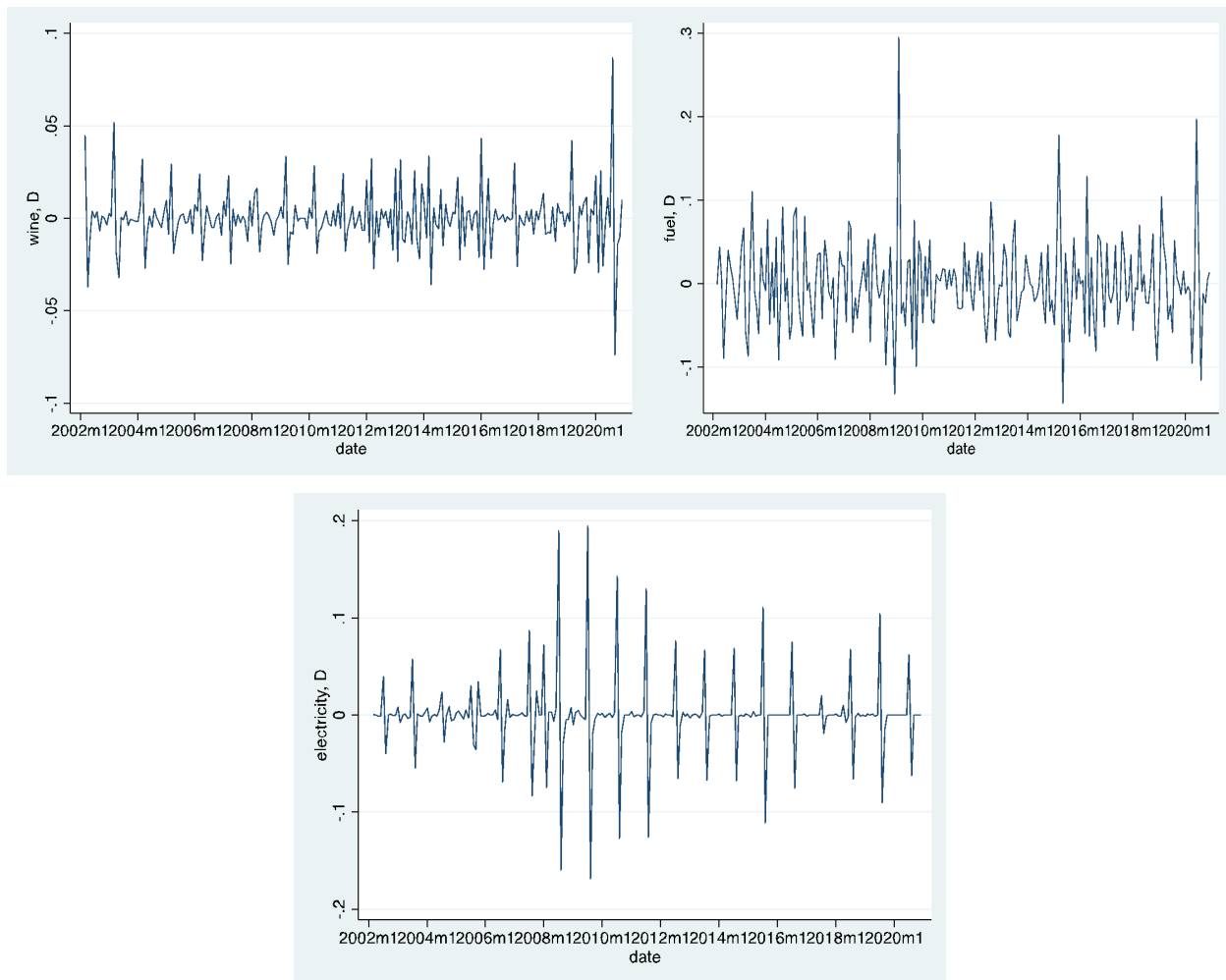
Variables	t-statistics	crit-value	t-statistics	crit-value	
	ADF level		ADF Difference		
Wine	3.890	-3.469	-6.567***	-3.469	I(1)
Fuel	-1.028	-3.469	-8.474***	-3.469	I(1)
Electricity	1.697	-3.469	-8.224***	-3.469	I(1)
	PP level		PP Difference		
Wine	2.632	-3.468	-14.569***	-3.468	I(1)
Fuel	-1.242	-3.468	-9.599***	-3.468	I(1)
Electricity	1.465	-3.468	-14.969***	-3.468	I(1)

*Notes: This table provides the results of the unit root tests. Asterisks *, ** and *** denote rejections of the null hypothesis at 10%, 5% and 1% significance levels, respectively.*

Heteroscedasticity Test

The Breusch-Pagan test results confirm the presence of heteroscedasticity at the 1% significance level. This is also shown in Figure 6.1, which presents the cluster volatility for wine, fuel, and electricity. For each series, large changes tend to be followed by further large changes, and small changes tend to be followed by further small changes.

Figure 6.1: Volatility Clustering for Wine, Fuel, and Electricity



Source: Own elaboration

ARCH Effect Test

The Ljung-Box test was carried out to test for the Autoregressive Conditional Heteroscedasticity (ARCH) effects. The tests for autocorrelation in the residuals, and the null hypothesis is such that all q lags of the squared residual have values equal to zero. The rejection of the null hypothesis at the 1% significance level confirms the presence of the ARCH effect. This implies that the volatility in the prices of energy and wine are time-variant, and therefore it is suggested that the GARCH approach is to be used (McAleer et al., 2008).

Multivariate GARCH

Before assessing the ccc MGARCH(1,1) model, the GARCH (1,1) model was estimated. The significance levels of the ARCH and GARCH effects at 1% indicate that lagged conditional variance and lagged square distribution have an impact on the conditional variance, implying that a change of price in one market influences changes in price in the other. Furthermore, GARCH effects exhibit a high level of variability, whereas low values of ARCH effects suggest that market shocks induce relatively small revision in future volatility for wine. The ccc MGARCH estimates are given in Table 6.4 and the associated correlation matrices in Table 6.5. The coefficients intercept at (ω), ARCH effect (α) and GARCH (β) with (standard errors in parentheses) in the wine, fuel, and electricity markets. All coefficients are statistically significant at the 1% level in all series. Furthermore, the magnitudes of the coefficients β s are especially high for all series, with 1.01, .86, and .99 for wine, fuel and electricity respectively, exhibiting a high level of variability. The ARCH effect, on the other hand, has negative and smaller coefficients, indicating that a shock in the series decreases the current volatility. This is consistent with the findings of Bouri (2014) and Todsadee et al. (2014), whose GARCH coefficients are larger than the ARCH effects for the series. The overall effect indicates a strong volatility spillover from energy to the wine market.

Table 6.3: Preliminary Results for Conditional Variance Estimations

	Wine	Fuel	Electricity
Intercept (ω)	5.9600*** (1.0400)	0.0004* (0.0002)	0.0002*** (6.6700)
ARCH (α)	-0.0629*** (0.0039)	-0.0559*** (0.0134)	-0.0283*** (0.0023)
GARCH (β)	1.0193*** (0.0059)	0.8556*** (0.1035)	0.9990*** (0.0173)
$\alpha+\beta$ (persistence measure)	0.97	0.80	0.97
Log-likelihood	1583.546		
no: observations	227		

Notes: This table provides the final results for the ccc MGARCH model. The standard errors (in parentheses) are calculated using the quasi-maximum likelihood method, which is robust to the distribution

of the underlying residuals. Asterisks *, ** and *** denote rejections of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

The long-run persistence (The study fail to reject the restriction $\alpha + \beta = 1$) was generally close to one, implying that a shock in the volatility series impacts future volatility over a long horizon. This means that the impact of the shock takes a long time to decay. The study present covariance estimates for the constant condition correlation MGARCH in Table 6.5. Results indicate a positive and statistically significant long-run relationship between fuel and wine prices at the 1% level, while the long-run relationship between electricity and wine is positive but statistically insignificant. This suggests that only the prices for fuel and wine move together in the long run, implying that changes in fuel prices are likely to influence changes in wine prices.

Table 6.4: Covariance estimates for ccc MGARCH

	Wine
Fuel	0.2701*** (0.0622)
Electricity	0.0816 (0.0657)

*Notes: This table provides the covariance results for the ccc MGARCH model. The standard errors (in parentheses) are calculated using the quasi-maximum likelihood method, which is robust to the distribution of the underlying residuals. Asterisks *, ** and *** denote rejections of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.*

6.5 Discussion and Conclusion

The study answers the research question: “***To what extent does energy price volatility influence wine prices?***” The findings from the analysis lead to the following conclusions. First, concerning the increase in volatility, it emerged that commodity prices for the three series are relatively volatile across the study period. Notably, the analysis of the univariate GARCH(1,1) model, in order to identify the source and magnitude of the mean innovation and volatility spillovers of each market, gave a 1% significance level for both the ARCH and GARCH effects, which indicates that the means and own-mean volatility have had an impact on the current volatility in the series.

The analysis of the ccc MGARCH model showed positive and statistically significant volatility effects between the series. All three markets exhibit a significant own-mean (GARCH) spillover. On the other hand, the ARCH effect has negative and smaller coefficients, indicating that a shock in the series decreases the current volatility. These results are consistent with the findings by Bouri (2014) and Todsadee et al. (2014), who found that GARCH coefficients were more extensive than the ARCH effects of agricultural commodities. The overall analysis indicates a strong volatility spillover from energy to the wine market. The analysis also shows that the persistence measure ($\alpha + \beta$) is close to one (1), indicating that a shock in the volatility series impacts future volatility over a long horizon, implying that the impact of the shock takes a long time to decay.

When the study measured covariance (conditional correlation) between the series, the results indicated that only fuel and wine prices move together in the long run. This suggests that the two markets are positively dependent to such a degree that a change in fuel prices influences wine prices.

The volatility of fuel and electricity prices on wine prices is potentially significant because it can render wine prices unstable, increasing market uncertainty and risk for consumers and wine producers. It can also impact negatively the government's revenue and the South African economy at large. The study results have some important implications for agriculture and specifically for policymaking in the wine industry. The degree of dependence and risk between energy and agricultural markets can be presented to assist in protecting against spillover risk effects and fostering market stability. Policy-makers must clarify whether spillover risks to agricultural commodities and specifically the wine market, are driven by global economic activity or other factors specific to the energy market. Higher spillover transmissions from the fuel market should be considered as a means of building better hedging strategies that may protect wine and other agricultural producers against adverse contingencies.

To this end, policy-makers should formulate income and farm price programmes and establish appropriate hedging facilities to mitigate the associated risks of energy price volatility. For example, policy-makers should promote alternative energy sources, such as solar and wind energy. These measures might alleviate the risks associated with price volatility. Although energy cost is one of the significant contributors to the South African wine industry's poor performance, no

research has been conducted prior to this study to quantify the effects and provide countermeasures. The findings of this study make a significant contribution to the literature by estimating the volatility of the energy market using a multivariate technique that has not been previously applied in the South African context. Estimating the prices and the volatility between the energy and wine markets allows for a better understanding of the extent to which the markets influence each other.

The study also has some limitations. The results from the study are measured using aggregate time-series data at the macro-level. The model does not consider the quality of wine production and assumes homogenous goods, which may not be the case. Additional research is required to understand the dynamic interaction of the series better, especially using firm-level data that considers wine quality. The eighteen years' time series may not be extensive enough to offer robust output. However, the study was able to draw out some conclusions that give vital policy implications. Future research with a larger sample size should be investigated. In this sense, the relatively small sample size is the main limitation of this study. However, the approach and indicators are in line with previous literature on "fuel-food" interrelationship. Future research is recommended. The next stage of research would be useful where we assume the wine is not homogeneous, and what might be the effect on the model. Perhaps investigating firm level data with wine quality included.

7 Study Conclusions

South African (SA) wines have been increasingly competitive globally, with a likely and favourable trend since 1994. Despite its many benefits, the wine industry has faced major challenges since 2006. Among them are fluctuating input production costs, an unreliable energy supply and high energy costs, climate change and its associated droughts, a fragmented wine industry, labour costs, poor wine quality and low prices, subpar technological adaptation, a lack of innovation and development, and lack of global competitiveness. Due to these unfavourable circumstances, just 25% of wine farmers are now producing at profitable levels. Grape growers decreased from 4,185 in 2006 to 2,778 in 2019 due to many farmers closing their doors. The reduction in wine production led to job losses, poor pay for farmworkers, low levels of investment and the use of technologies with low production levels, to mention a few.

While most of the difficulties wine producers face have been extensively studied and discussed within the sector, global competition, innovation, and fluctuating input production costs stand out as the critical factors in improving competitiveness and sustainability. The study reveals how the South African wine sector competes globally (chapter 3). Competition can be mitigated through (i) innovation that could potentially improve the quality of wine and attract higher profits and (ii) reducing production input costs. Chapter 4 shows how innovation and its associated costs could be covered in the industry. Chapter 5 then tests the robustness of the findings in chapter four by estimating the validity and reliability of DCE estimates in environmental valuation. In the last chapter, 6, the study uses one input cost (e.g., energy) to show how such costs negatively impact productivity in the wine industry over time. Finally, the suggestion is made for future research to explore more significant input costs, i.e., labour. The following research questions are answered in the thesis, *What is the degree of South Africa's competitiveness against rivals in SHNW and what factors determine specialisation in these economies?; Are wine consumers willing to pay a premium for natural preservatives in wine?; Does 'price framing' influence empirical estimates in Discrete Choice Experiments?; and To what extent does energy price volatility influence wine prices?* With the primary goal of enhancing South Africa's wine competitiveness, the thesis addresses these research questions as follows:

In **chapter three**, the degree of competition between the South African wine industry and its counterparts in the Southern Hemisphere New World (Australia, Argentina, New Zealand, and Chile) was determined, and factors affecting specialisation in the area were examined. The objective was to determine the top areas to concentrate on to increase South Africa's competitiveness and sustainability. The Global Wine Markets panel data covering 1990 to 2018 was used. Trade specialisation and its determinants were calculated using (i) the Revealed Comparative Advantage, (ii) estimation of the Galtonian regression model and (iii) estimation of the panel regression model. The findings of the analysis lead to the following conclusions.

Firstly, the study examined trade specialisation (RSCA). It was evident that South African wines are comparatively less competitive than their SHNW competitors. Other SHNW producers considerably improved over the study period, between 1990 and 2018, with New Zealand, Chile, Argentina, and Australia (in that order) receiving higher scores than South Africa. The popularity of South African wines peaked in 2005 and has since declined. The following strategies and programs, according to a review of the critical success factors and lessons learnt from the analysis in 3.4.1, could improve South Africa's competitiveness: i) build strong institutions within the industry that can advance the growth agenda across the value chain; (ii) draw in and increase foreign direct investment; (iii) boost export sales; (iv) develop a well-coordinated wine sector; (v) lower input production costs; (vi) boost export sales of bottles and packaged wine; (vii) effectively market the SA brand and; (viii) build strong relationships between government and the wine industry.

Second, all SHNW producers reported high stability in specialisation patterns when the study estimated the Galtonian regression model to analyse the stability, magnitude, and specialisation patterns in SHNW countries. New Zealand and Argentina reported the highest coefficients at 0.91 and 0.87, respectively. South Africa came fourth with 0.78, barely behind Australia (0.79). However, despite having stable specialisation patterns over time, all SHNW producers reported a reduction (convergence) in specialisation patterns for the study period. An indication that there is not enough innovation to attract divergent patterns in the region.

Thirdly, the panel model estimation of the factors influencing specialisation in SHNW discovered that the regression findings supported the in-depth study's hypotheses. Results indicated that

specialisation in SHNW was positively impacted by real GDP, real exchange rate, grapevine area per capita, wine export volume, and wine export value. Contrarily, wine imports' quantity/volume and value negatively affect trade specialisation. The results imply that South Africa can increase its competitiveness by emulating rivals' strategies and programs and developing a vibrant, inventive business climate. Increased grapevine per capita and higher wine quality and value would help accomplish this.

Another way is by encouraging local wine drinkers to switch from other alcoholic beverages to wine. In South Africa, wine makes up just 10% of the total beverage market, with alcohol accounting for 75%. At 11 litres, the current per capita wine consumption is low when compared to nations like Portugal (59 litres), France (51 litres), Italy (44 litres), Argentina (27 litres), and Namibia (20 litres). Switching beer drinkers to wine would significantly increase SA wine competitiveness.

Other measures to increase South Africa's competitiveness include strengthening industrial institutions and expanding service export capabilities. These organisations would bring together all the parties involved in the wine industry to develop reputable quality brands and boost packaged wine exports. Exporting more packaged wine from the current 60:40 ratio to 40:60 by 2025 is one of the initiatives of the Wine Industry Strategic Exercise (WISE) 2025. Additionally, innovators should provide incentives, and businesses within the industry should be encouraged to compete locally and internationally at trade events. Thanks to innovation and technological improvement, the sector should lower production costs using more efficient machinery, including mechanical grape harvesters, fertiliser spreaders, rotary mowers, and row tractors. Additionally, a purposeful FDI promotion strategy could assist in providing the industry with the necessary funding. According to Van Rooyen et al. (2011), a lack of confidence between the government and the industry may have prevented the industry from growing. To develop and expand the industry, the sector may gain significantly if it can establish strong cooperation with the government.

The skill level and wine quality are directly related. It is well known that South African wines lack the experienced staff needed to raise their rate to the levels demanded by the global market (Ewert, 2005). The predicted 2.23% global export value share in 2018 (figure 3.1) proves that South African wine needs to improve to compete internationally. Human resource improvements can be

made in cooperation with colleges to increase capacity and strengthen industrial competition. The industry can boost productivity and create high-quality products and wine brands that can be successfully marketed by developing a skilled labour force.

The study also has some limitations. The results from the study were measured at the macro level and did not consider the quality of the wine product. The models assume that wine products across SHNW are homogenous goods which may not be the case. Additional research is required to better understand the drivers of competitiveness, especially at a firm level that considers the quality of the wine. Historical data for the South African wine industry and rivals in SHNW are available from 1835 to 2018; however, the study only prioritised data from 1990-2018. Despite these drawbacks, the study sheds light on South Africa's competitiveness. It guides the steps to take to encourage an improvement in the competitive performance of the industry. It draws lessons on what actions to take to drive an upward trend in the competitive performance of the industry. Furthermore, the study's conclusions and strategic proposals could be applied in future research and used by wine players to increase competitiveness. Further research in the industry and using micro-level data for the analysis would provide insight into South Africa's competitiveness.

The **fourth chapter** examined how wine consumers perceived product innovation in the South African wine business and their willingness to pay for it. The survey aimed to learn whether customers would be willing to pay more for wines produced using natural preservatives (Rooibos and Honeybush), organic farming practices, and higher quality ratings. Determining whether customers favour these wines is crucial because it shows whether the industry can use the findings' results to improve its competitiveness. A more significant finding would be how helpful "no sulphite added" wine is to consumers and whether or not consumers would regard such a trait as essential in their purchasing decisions. The study used the stated preference approach and Discrete Choice Experiment (DCE) to understand consumers' perceptions and, in particular, how consumers would value a wine produced using *Rooibos & Honeybush* as a preservative for both conventional and organic production. The Mixed logit method was used for the analysis. The analysis's findings support the following judgments.

First, the study discovered that natural preservatives and organic qualities significantly influenced South African customers' decisions to buy a bottle of wine with a higher quality rating. Second,

the study discovered no differences in preferences for red or white wines, but there were differences in the willingness to pay for the three wine attributes. Third, wine with natural preservatives would cost more to heavy drinkers than light drinkers. Since the high investment cost of adopting the new natural preservative may be repaid more quickly, this is a favourable message for winemakers.

Since using SO_2 as a wine preservative is likely associated with adverse health effects, the study examined if those who believe in these effects are ready to pay higher premiums for healthier wines. The study found that these consumers are willing to spend at least three times more for SO_2 -free natural preservatives and quality scoring than those who do not believe so. They are also ready to pay for organic winemaking, but their premium is only two-thirds higher. When we consider the high proportion of respondents in the sample who believe SO_2 causes headaches (68%), these disparities become much more apparent.

When the study examined whether the preferences varied based on different consumer factors like gender and race, it discovered that, on average, consumers are willing to pay about R19.45 per bottle for organic winemaking. However, only Caucasian men are willing to pay for organic quality. On average, they are eager to pay R21.33 more per bottle of wine for organic winemaking than Caucasian women. Additionally, wine quality counts because consumers are willing to pay R1.54 for each point of Quality Score. Concerning the key attribute – *Rooibos & Honeybush* preservatives – on average, consumers are willing to pay R60, though men are marginally more inclined to do so than women. For instance, Caucasian men will spend R82.45, almost twice as much as African men, who will pay R45.37. Caucasian women will pay R64.35, more than twice as much as African women, who are prepared to pay R37.40. The findings present a significant contribution, at least in the South African context, to understanding preference and hence a niche for the natural preservative market. The share of respondents who believe SO_2 causes headaches is astonishingly large, and their preference for wine with less adverse health effects is also vital. These customers appear to be a significant market group for the wine business and wine producers interested in differentiating their wine products. The results of this study are relevant to other wine-producing nations and areas even though it is aimed at South African wine consumers. Further research could investigate whether the findings for South African consumers also hold in other regions.

Based on the findings, the study suggests that the wine industry clarifies the requirements for producing organic wine. It should specifically define what organic wine is, perhaps by adopting the US standard that defines organic wine as wine made without the use of sulphur. As the survey shows, respondents are aware of natural preservatives and supportive of the natural/organic movement for healthier living. The wine business stands to gain significantly from medical research that aims to identify the source of headaches because there is no clear scientific consensus on whether SO_2 in wine causes headaches. Wineries should weigh the increased costs of Rooibos & Honeybush alternatives against the anticipated premium for "no sulphite added" wines before investing. According to the empirical study, the industry now has the first concrete proof of consumers' acceptance of a revolutionary natural wine preservative and, more particularly, how wine consumers may react.

To properly understand consumer behaviour about natural preservatives, more effort should be put into determining the variables that affect wine consumers' choices. Understanding these factors can provide a better-targeted marketing strategy that captures consumer preference for natural preservatives in wine. Additionally, a larger sample size should be examined. In this sense, the study's main limitation is the small sample size and a constrained geographic scope (the Cape Town metropolitan area). However, the results align with previous literature on "no sulphite added" but are silent regarding sulphur substitutes, as the case for this study. This chapter supports the WISE 2025 Strategy, particularly the "Technology and innovation" topic. The discovery of natural preservatives in winemaking can increase the competitiveness of the South African wine industry domestically and internationally. Further studies are recommended where a broader sample is used.

Chapter five investigated the robustness of DCE estimates obtained in chapter four. The approach and survey used to examine non-market value in a stated preference study can influence the outcomes and affect the validity and reliability of value estimates. This chapter uses data from a choice experiment on preferences for natural preservatives in wine to address the research issue, "Does 'price framing' influence empirical estimates in Discrete Choice Experiments?" The same respondents completed a nearly identical DCE survey, one presented with a *real price* and another with a *percentage price change*. The survey received 611 responses, and a panel mixed logit model

was employed for the analysis. The empirical estimations were predicted to be the same because the cost attribute values were comparable and reported as *real price* or *percentage price*. The findings lead to the following conclusions.

According to the mixed logit model's findings, the estimated parameters in the split sample had significantly different values. The test statistics revealed significant differences in the coefficient means for the two samples, with the Rooibos coefficient mean being 4.23 ($p = 0.0398$) organic coefficient mean being 5.23 ($p = 0.0211$). Quality coefficient mean being 5.32 ($p = 0.0147$).

The data also showed that, although the two samples' signs and significance levels are comparable, the parameter magnitudes differ. . *For example, the real price* had a higher likelihood of choosing all its attributes (Rooibos, organic, and quality score) than *percentage price*, whilst the possibility of selecting the price attribute was lower for the *real price* than *percentage price*, an indication that the model fit for *real price* sample was slightly better than that of *percentage price* sample. In addition, the statistically significant estimates for derived SD for all parameters suggest heterogeneity around the mean parameter over the two samples. Strong evidence indicated that the WTP estimations for the two samples were different. While their WTP for the organic attribute does not statistically differ from the other, it is at least two times larger for the *percentage price* for natural preservatives and quality. Furthermore, both samples shared a comparable rank order of attribute importance. In that order, the most significant factors were rated as Rooibos & Honeybush, organic, price, and quality.

These results suggested that presenting the cost attribute in *real price* gives better results than the *percentage price change*. Because this study is rare, there is limited literature to compare these findings. However, similar experimental studies on the impact of framing on empirical estimates in DCEs have demonstrated that altering the attribute framing might have unanticipated implications on obtained estimates, leading to skewed results. The study supports these conclusions, and DCE practitioners should use caution when designing experimental instruments. When making the policy choice considered in the CE studies, there is a need for well-defined instruments matching individuals' decision environments.

To uncover people's legitimate preferences for the resources under consideration, DCE practitioners need a thorough understanding of individual decision behaviour and the scientific context of the study. In addition to fitting the decision context, the cost characteristic in a CE questionnaire should also be expressed in a way that is pertinent and understandable to participants. CE practitioners should be mindful that how respondents understand the survey results may vary depending on how cost attributes are presented, such as *real price* vs *percentage price*. Using focus groups and pilot research, it is advised to gauge participants' preconceptions and determine how the cost attribute framing may affect participants' decisions beforehand.

There are no clear guidelines on presenting cost attributes in a DCE setting and how decisions about 'price framing' impact study results. Therefore, further research is recommended on the effects of 'price framing' in other DCE settings. This will ascertain the existence of these effects in different decision contexts, and ongoing research on appropriate designs will allow further quantification of the magnitude of the influence of 'price framing' in DCE studies.

The study's primary shortcoming is that it employed a DCE on preferences for natural preservatives in South Africa as a case study for this methodological investigation. A broader setting would be ideal for investigating the preferences for *Rooibos* and *Honeybush* preservatives. Additionally, this DCE was administered on a sample representative of the generalised adult wine consumer population in Cape Town, South Africa. A small population sample and this generalisation can be restricting. More studies must determine whether the results are generalisable to different people and environmental valuing contexts. Nevertheless, the results provide insight into the validity and reliability of 'price framing' effects in DCE and environmental valuations. DCE practitioners must exercise caution when developing experimental instruments, considering that the contextual information provided in stated preference surveys affects results that ultimately influence policy development.

Chapter six investigated the relationship between fuel, electricity, and wine prices. The objective was to determine how much the South African wine industry's wine prices are impacted by energy price volatility. According to the results, a chart of dependence and risk between energy and wine markets could be designed to protect the wine industry from spillovers and foster wine market stability. The study employed monthly CPI prices from 2002 to 2018 to derive own- and cross-

volatility spillovers and persistence between markets using the MGARCH technique. The analysis's findings support the following conclusions.

The study first determined if recent price volatility has increased for both energy and wine. Second, commodity prices for the three series were relatively volatile across the study period. Notably, when the study analysed the univariate GARCH(1,1) model to identify the source and magnitude of the mean innovation and volatility spillovers of each market, the significance of the ARCH and GARCH effects at a 1% significance level indicates that the means and own-mean volatility has had an impact on the current volatility in the series.

Secondly, the study analysed the relationship between fuel, electricity, and wine prices. In particular, it aimed at establishing the extent to which energy price uncertainty affects wine prices in the South African wine industry. When the study analysed the ccc MGARCH model, it found positive and statistically significant volatility effects between the series. All three markets showed a significant own-mean (GARCH) spillover. On the other hand, the ARCH effect had negative and smaller coefficients, which shows that a shock in the series decreases the current volatility. These findings align with those of Bouri (2014) and Todsadee et al. (2014), who found that GARCH coefficients were more significant than the ARCH effects on agricultural commodities. The overall findings of the analysis indicate a substantial volatility spillover from energy to the wine market. The study also shows that the persistence measure ($\alpha + \beta$) is near to one (1), suggesting that a shock in the volatility series has a long-lasting impact on future volatility and that it takes a long time for that impact to subside. When the study measured covariance (conditional correlation) between the series, the results indicated that only fuel and wine prices showed a long-term association. This implies that the two markets are positively correlated to such a degree that a change in fuel prices impacts wine prices.

The volatility of fuel and electricity prices on wine prices is potentially significant because it can render wine prices unstable, enlarging market uncertainty and risk for consumers and wine producers. It may also harm government revenue and the overall South African economy. The study's findings have significant ramifications for agriculture, particularly for policymaking decisions about the wine industry. To prevent risk effects from having a spillover effect and to promote market stability, the degree of reliance and risk between the energy and agriculture

markets can first be given. Second, decision-makers need to be clear about what factors—other than a global economic activity—drive spillover risks to agricultural commodities, particularly the wine market. Third, improved hedging techniques that could shield wine and other agricultural producers from unfavourable contingencies should be built using higher spillover transmissions from the fuel market.

This shows that to reduce the risks associated with energy price volatility, policymakers should develop income and farm price programs and set up suitable hedging facilities. For instance, policymakers should support renewable energy sources like solar and wind power. These steps could reduce the dangers brought on by price volatility. Although the high cost of electricity is a significant factor in the South African wine industry's poor performance, no previous research has been done to quantify the consequences and offer solutions. The findings of this study constitute a substantial contribution to the literature. Estimating the prices and the volatility between the energy and wine markets allows for a better understanding of the extent to which the markets influence each other.

Additionally, the study contains some limitations. The results from the study are measured using aggregate time-series data at the macro-level. The model does not consider the quality of wine production and assumes homogenous goods, which may not be the case. Additional research is required to understand the dynamic interaction of the series better, especially using firm-level data that considers wine quality. The eighteen years time series may not be extensive enough to offer robust output. However, the study could draw some conclusions that give vital policy implications. Future research with a larger sample size should be investigated. In this regard, the primary constraint on this study is the small sample size. However, the approach and indicators are consistent with previous literature on "fuel-food" relationships.

In summary, the thesis investigates South Africa's wine competitiveness against rivals in the New World, examines consumers' preferences and willingness to pay for product innovation in the industry and investigates the impact of input costs on wine productivity. There is strong evidence that the wine industry lags in many aspects compared to its rivals. There is also empirical evidence that innovation could mitigate some of the challenges faced in the industry. The study suggests the industry could enhance its competitiveness by emulating some of the rival's strategies and

programs, such as (i) creation of solid institutions within the industry that can advance the growth agenda across the value chain; (ii) attracting and increasing foreign direct investment; (iii) increase export sales; (iv) create a well-coordinated wine industry; (v) reduce input production costs (vi) increase the number of packaged export sales; (vii) promote SA brand through effective marketing and; (viii) build strong relationships between government and the wine industry. Evidence shows that improvement in Real GDP, real exchange rate, grapevine area per capita, and improved value of exports can positively influence wine trade specialisation.

On the other hand, the volume of wine imports and the value of wine imports negatively impact trade specialisation. Different approaches can be used to improve the industrys' competitiveness i.e., upgrading the quality and value of wine produced, stimulating local demand for wine, developing the service export capacities, and improving human resource skills. It is up to the South African wine industry to experiment on these findings and develop mechanisms to enhance its competitiveness and sustainability.

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Appendix 2. Chapter 2

2A: KWV & governance

The primary role of KWV was subsequently to settle and manage the industry through price and quantity control and to protect local farmers from unfavourable trading conditions. This protectionism and guidelines implied that there were little motivations for farmers to put resources into improving the quality of grapes and wine. The sanctions also meant that the industry was distant from advancements in the global wine market and only started to catch up since re-entering the global wine market after 1994. Another significant part of the historical backdrop of the South African wine industry, which identifies with its present quality dilemma, is the historical background of unskilled cheap labour. It is the history of paternalism where farmworkers were treated as property by their proprietors.

In contrast to the money system, which characterises the connection between management and workers in the present-day industry, paternalism on the wine farms associated the lives of workers with farm owners, workers being treated like children under close control of the proprietor with negligible rights (A. Du Toit, 1993). Farmworkers on these vineyards were exposed to poor working and living conditions marked by outrageous destitution, misuse and deplorable living conditions. This was worsened by the "tot system", a framework in which the owner gave farmworkers wine at specific intervals during the working day in lieu of wages. A survey led by Dop-stop Association in 1998 found that 76% of men and 34% of women were viewed as alcoholics (London et al., 1998). Albeit the tot system has since been prohibited, many of the results of this framework, liquor addiction, domestic violence, child abuse, absenteeism and low productivity, persist on wine farms today. Contrasted with other New World's producers, South Africa has the least labour productivity (Ewert et al., 1998). This is not surprising considering the wine industry's experiences of poor labour relations.

2B: Fragmentation of wine players and leadership vacuum

Another significant component of the historical backdrop of the South African wine industry, which identifies with its present quality and price predicament, is the fragmentation of wine players. In this situation, we have many small players vying for fewer spots on the market (SAWIS, 2020a). The industry now has more wineries and brands competing against each other for sale.

Because of coordination failure, the industry cannot supply the quality large quantities and brands demanded internationally. This is because, after the dissolution of KWV and the subsequent resolution of SAWIC²³, the industry has lost direction and lacks the leadership necessary to coordinate the many players and brings out the dilemma currently being experienced.

When political changes started in South Africa in the mid-1990s, the KWV system was challenged by its members on numerous fronts – for instance, on planting quotas, fixed rates, minimum price etc. Many of these rules were suspended, and shortly after, international trade sanctions were cancelled soon after South African democratic elections in 1994 (Vink, N., Williams, G. and Kirsten, 2004). The dismantling of the statutory powers of the KWV post-apartheid transformed the South African wine industry and made it more sensitive to the forces of supply and demand in the global sense. The wine players have been presented with numerous opportunities and challenges during this time. For example, the South African industry experienced exceptional export growth over the last three decades, from approximately 6% in 1994 to close to 52% in 2016 (SAWIS, 2020a). The industry's strength lies in having a great variety of terroirs²⁴ due to its unique location and is perceived internationally to be less fruity than other New Worlds such as Australian wines (DAFF, 2015). It has the opportunity to capitalise on the above to foster both the domestic and the export market. Having a coordinated team with a solid leadership process will advance the industrial agenda and focus on resolving some of the challenges faced.

2C: Cooperatives and quality/price dilemma

Cooperatives and ex-coop (producer cellars/wineries) produce roughly 80% of industrial yield. In 2016 there were 50 functioning wineries in the South African wine industry, the more significant part of which were set up before the 1950s. This group of wine producers are a marvel of the past,

23. The South African Wine Industry Trust (SAWIT) was set up in 1999, after the resolution of KWV to administer the assets from KWV. Two non-profit organizations were institutionalised: The Wine Industry Business Support Company (Busco) and the Wine Industry Development Company (Devco). Busco accepted accountability for financing the Wine Industry Network of Expertise and Technology. Devco on the other hand, laid out cutting edge plans for thriving and global competitiveness of the wine industry, in view of industry-wide discussions (SAWB, 2003). In 1999, Winetech started the vision 2020 Agenda whose role was to coordinate designs that provide leadership to the industry. The introduction of South Africa Wine and Brandy Company (SAWB) was created to assume that purpose in 2002 (Ponte and Ewert, 2007). In 2006, SAWB was rebuilt into South Africa Wine Industry Council (SAWIC) to augment players' representation. SAWIC's body electorate included arising agribusiness, wine producers, workers, cellars, traders and wholesalers, and civil society. Tragically in 2008 SAWIC was suddenly disbanded because of industrial politics (Ratcliffe, 2011) leaving a leadership vacuum.

24. Terroir also known as character, describes the environmental factor that affects wine phenotype i.e. unique environment contexts, farming practices and crop specific growth habitats.

huge present power and will affect the future. Overall, these cooperatives have a member base of around 61 groups, with the smallest (Stettyn Cellar) having 4 individuals and the biggest (Orange River Cellar) having 890 members (SAWIS, 2020a). Typically, a cooperative is structured with a Manager (Chief Executive Officer) and three winemakers (production manager and aide winemaker). The Chief Executive Officer (CEO) reports to the Board of Directors comprising of elected individual members. The chief accountant deals with the financial aspects of a cooperative, including the pool system, while the production manager administers winemaking and viticulture. Responsibilities often over-laps, and the production process is complex and not easily separated. In many cases, the CEO would be an ex-winemaker with a few years of industrial experience. All productions, wine and vineyard related processes would be split between these individuals. In some cases, a viticulturist would be employed or otherwise sub-contracted from specialists like "VinPro" from within the industry (SAWIS, 2020)

Quality in the vineyard is dictated by an evaluating framework used across the board for all members. Generally, the evaluation of grape quality starts during the beginning phases of berry production and at the late phase of ageing. Numerous variables that determine wine quality, such as pruning style, shoot positioning, covering control, suckering, harvest control, pest control, irrigation system, size of the crop and the overall vineyard upkeep, are considered. Typically, the grading system will be organised as follows: Grade A, – is said to be extraordinary quality wine; Grade B – good quality vineyard and quality wine expected; Grade C – normal vineyard and average wine is expected; Grade D – red grapes not used for red wine; and Grade E – Rebate wine/juice/grape juice concentrate (SAWIS, 2020).

After the vineyard grading, a final assessment is done where minimum sugar levels and ripeness are tested. For instance, the testing of pH, TA, Balling, temperature and a visual examination are conducted on arrival at the winery. Cooperative members are then paid out according to the quality and cultivar grading. The challenge with this pool system, however, is that it tends to be easily abused. It lacks control over which grapes go into which wines; as a result, members who supply good quality grapes end up earning the same money as those who supply poor quality grapes. The opposite is also possible where low-quality wine is enhanced by mixing with better quality wine to improve pricing on the market. Eventually, the pool system does not incentivise members to produce and deliver quality. The circumstance is also worsened by a lack of knowledge on the

most proficient method to produce quality. Most members are not fully aware of the "best practice" in producing quality wine.

In addition, the cooperative wine manager has too much power to manipulate the winemaking process measure for his benefit. Another illustration of maltreatment of this pool system is conflicting interests. The executives of the cooperative are also growers with personal interests. They are more likely to grant themselves better prices/earnings for their produce, creating mistrust among members. Consequently, members would sell their high-quality grapes outside the pool system for better profit. The other dilemma with the pool system is that bulk sales do not attract reasonable prices compared with packaged wine sales. The bulk wine is sold cheaply for quick money, then paid to members for their contributions. Another illustration of this pool system maltreatment is its utilisation as a "bank" by the growers. The assumption from individual members is that they should be paid for the delivery at specific times, whether or not the wine is sold. This necessity forces cooperative managers to secure funds from other sources, such as banks and other financial institutions, to meet the commitments as they emerge. As expected, it limits cooperatives to operate as a viable businesses.

2D: Institutions and governance

Even though the wine industry does not have a specific body that governs it, it has a number of bodies and institutions that influence its operations. The Wine Industry Directory of 2021 has 54 different organisations and education bodies' listed (Wineland, 2021). Each of them plays an important role (though sometimes confusing) in its own right. Table 2A.1. highlights some of the institutions (according to early years) and their roles as specified from its websites.

Table 2A.1: List of organisations and industrial bodies in the SA Wine Industry

Name of organisation	Est	Goal
South Africa Vine improvement Association	1960	The group members are registered nurseries under the South Africa Plant Certification Scheme for Wine Grapes and table and drying grape nursery vines under the Deciduous Fruit Plant Certification Scheme as publicised in the Plant Improvement Act (Act No. 53 of 1976).
Wine and Spirit Board	1973	Administers the Wine of Origin Scheme introduced that was introduced in 1973 and estate brandy and the Integrated Production of Wine Scheme.
South Africa Society for Ecology and Viticulture (SASEV)	1977	It serves as a forum for dispensing the latest scientific information to the wine industry to improve the quality of South African wines and products and make the technology & innovation available internationally.
The South Africa Brandy Foundation	1984	was created to facilitate long-term growth and protect the integrity and heritage of the South African brandy industry.
Industry Association for Responsible Alcohol Use (ARA)	1989	The association goal was to reduce alcohol-related harm via combating the abuse of alcoholic beverages and supporting responsible drinking.
ARC Infuitem-Nietvoorbij	1997	Committed to providing sustainable technologies to the developing and commercial agricultural sectors in South Africa through leading and dynamic research. Technology development and transfer, enhancing food security, competitiveness and wealth creation
Integrated Production of Wine (IPW)	1998	It is a voluntary environmental sustainability scheme that falls under the Wine and Spirit Board (WSB).
Wines of South Africa (WOSA)	1999	The organisation represents wine producers that trade globally. The company's mandate is to support and promote the growth value of the industry through the marketing of exports of all South African wines in key global markets.

South Africa Wine Industry Information & Systems (SAWIS)	1999	Serves as a business intelligence centre for the South Africa Wine Industry
Black Association of the Wine and Spirits industry (BAWSI)	1999	the goal is to marshal groups of people and interested parties from historically disadvantaged South African communities. They aim to uplift farmworkers by implementing fair labour practices and empowering them to become owners of the means of production within the industry.
The Wine Industry Ethical Trade Association (WIETA)	2002	An organisation is a non-profit voluntary association that advances ethical trade in the wine industry's value chain through training, specialised appraisal and evaluations to assess members' compliance with its code of good practice.
VinPro (was once part of KWV, 1918-2003)	2003	An independent organisation for both the wine producer and cellar member, rendering professional consultations in viticulture, soil science, oenology, agro-economy and general management.
South Africa Liquor Brand Owners Association (SALBA)	2005	This non-profit organisation represents producers and distributors of liquor products within the industry on issues of common interest.
Fairtrade Southern Africa Network	2008	The mission is to promote the interest of African Fairtrade-certified producer organisations within the broader Fairtrade system to help improve socio-economic conditions
Wine Industry Network for Expertise and Technology (Winetech)	2009	Provides the wine industry with viable solutions on innovation and Human Resources to strengthen the local and international competitiveness and profitability
Cape Vintner Classification (CVC)	2013	The organisation oversees issues of accreditation, representation, governance and promotion of peculiar regional site-specific Cape wines

Institute for Grape and Wine Sciences (IGWS)	-	The organisation provides training in viticulture and oenology, promotes R & D and the transfer of technology to the industry.
Sustainable Wine South Africa (SWSA)	-	This is a union of the Wine and Spirit Board (WSB), the Integrated Production of Wine (IPW) scheme, the Biodiversity & Wine Initiative (BWI) and Wines of South Africa (WOSA).
Tasting Room Association of South Africa	2019	TRASA was established to provide the SA wines with a central association that provides support and information to tasting rooms across all regions. Support services include setting industry-wide service standards, annual audits of the tasting rooms, and basic training materials. In addition, information on all facets of tasting rooms and wine tourism (including pricing, offerings and tourism information) will be available in a centralised database, allowing wineries easy access to evaluate and compare.

Source: Authors compilation

After the disbanding of KVV post-apartheid, a leadership vacuum was ensured, and most of the highlighted organisations were set up to fill the gap. Each of these organisations benefits the wine industry in one way, although some of the roles conflict with each other. However, the major challenge is the time needed by wine players to comply with the required standards and certifications from these institutions, which often is bureaucratic and not well communicated.

Appendix 3. Chapter 3

3A. Trade Performance for South African wines

Methodology

The study measures South Africa's trade performance in wine using four performance indices, namely (i) Trade Specialisation Index, (ii) Export Propensity Index, (iii) Import Penetration Index, and (iv) Export/Import Ratio.

Trade Specialisation Index

A country's trade advantage in a specific industry is measured by computing the Trade Specialisation Index (TSI) (Balassa, 1965). The TSI index compares the net flow of commodities (exports minus imports) to the total flow of commodities (exports plus imports). Thus, it measures the degree of specialisation of a country in exporting a particular product. According to UNCTAD (2013), the index removes bias of high export values due to significant re-export activities, thus is more suitable to identify real producers than any intermediate traders. The values of TSI range between minus one (-1) and positive one (+1). A positive value of the TSI signifies a country that specialises in the production of a commodity and hence a net-exporter of that commodity. As a result, the country has a comparative advantage in the trade of that good. In contrast, a negative value of the TSI indicates that the country has a comparative disadvantage in the trade of the commodity, and it is a net-importer of that commodity. Therefore, TSI applied to the South Africa wine industry is defined as:

$$TSI_{SA} = \frac{(X_{SA} - M_{SA})}{(X_{SA} + M_{SA})} \quad (3A.1)$$

where TSI_{SA} is the trade specialisation index of South Africa's wines; X_{SA} and M_{SA} are South Africa's exports and imports of wine, respectively.

Export Propensity Index

Export Propensity Index (EPI) for an industry is a proportion of exports over the domestic production of that industry. A higher ratio of the EPI in a specific good indicates that a country has a higher degree of specialisation and comparative advantage in that good. In this case, the EPI for the South African wine industry is the percentage ratio of South Africa's wine exports divided by its domestic production of wines:

$$EPI_{SA} = \left(\frac{X_{SA}}{D_{SA}} \right) \times 100 \quad (3A.2)$$

where EPI_{SA} is the Export Propensity Index of South Africa's wines; X_{SA} and D_{SA} are South Africa's exports and domestic production of wine, respectively.

Import Penetration Index

Import Penetration Index (MPI) is the degree to which the international market threatens the South African market. MPI measures the percentage share of imports to the total domestic sales of wine. The MPI for the South African wine industry is defined as the percentage ratio of wine imports divided by total domestic wine sales in South Africa as follows:

$$MPI_{SA} = \left(\frac{M_{SA}}{D_{SA}} \right) \times 100 \quad (3A.3)$$

where MPI_{SA} is the Import Penetration Index of South Africa's wines; M_{SA} and D_{SA} are South Africa's import and domestic sales of wines, respectively.

As an alternative MPI_{SA} can also be calculated as the percentage ratio of imports M_{SA} to domestic production DP_{SA} of wine (Athukorala & Hazari, 1988). Cleveland (1985) argues that when exports and imports increase, the degree of measured imports deteriorates because total domestic sales depend heavily on the extent of both imports and exports. To resolve this problem, the study measures the MPI for S.A. wines as a percentage ratio of imports to domestic production:

$$MPI_{SA} = \left(\frac{M_{SA}}{P_{SA}} \right) \times 100 \quad (3A.4)$$

where MPI_{SA} is the import penetration index of South Africa's wines; M_{SA} and P_{SA} are South Africa's import and domestic production of wines, respectively. A higher MPI ratio indicates that a country has a high comparative disadvantage in a particular industry.

Export to Import Ratio

The Exports to Imports Ratio (EMR) is used to measure a countries trade competitiveness (Verdoorn, 1960). For example, South Africa's export/import ratio is defined as follows:

$$EMR_{SA} = \left(\frac{X_{SA}}{M_{SA}} \right) \times 100 \quad (3A.5)$$

where, EMR_{SA} is the export/import ratio for South Africa's wines; X_{SA} is the export of wines; and M_{SA} is the imports of wine in South Africa. The higher the ratio value, the more a country has international trade competitiveness in a particular industry.

When the study takes a natural logarithm (ln) to the ratio, equation (3.5) becomes:

$$\ln EMR_{SA} = \ln \left(\frac{X_{SA}}{M_{SA}} \right) \times 100 \quad (3A.6)$$

The negative values imply that the industry does not have international competitiveness.

Estimation Results (S.A. Trade performance)

Measuring the national wine industry performance is vital in establishing how South Africa is fairing locally in the wine industry. This is important because the study assesses and monitors local wine export performance evolution before analysing competitiveness with rivals. Therefore, the study uses four indicators (defined in the methodology section) to measure the performance of the South Africa wine industry. Table 3A.1 shows South African's overall trade performance in wine for the period 1990-2018. According to the Trade Specialisation index (TSI) eqn.1, South Africa wine scores a positive average point of 0.9, close to 1, indicating that the industry is a net-exporter of wine and has a comparative advantage for the study period.

Table 3A.1: South Africa trade Performance in wine 1990-2018

	TSI	EPI	MPI-sales	MPI-pdt	lnEMr
1990	0.91	1.76	0.08	0.08	307.046
1991	0.93	2.10	0.07	0.07	336.841
1992	0.96	3.11	0.07	0.07	380.783
1993	0.94	3.03	0.09	0.09	356.359
1994	0.97	6.55	0.12	0.11	408.346
1995	0.93	15.33	0.61	0.52	338.700
1996	0.76	11.85	1.85	1.63	198.361
1997	0.68	11.59	2.53	2.24	164.567
1998	0.81	13.20	1.61	1.40	224.650
1999	0.76	8.89	1.32	1.20	199.952
2000	0.91	20.31	1.16	0.93	308.566
2001	0.95	22.12	0.74	0.58	364.324
2002	0.95	25.23	0.85	0.64	367.675
2003	0.94	24.36	0.93	0.71	353.984
2004	0.99	25.73	0.22	0.16	508.220
2005	0.94	38.58	1.88	1.16	350.847
2006	0.94	26.89	1.18	0.87	343.566
2007	0.99	40.30	0.30	0.18	542.366
2008	0.99	39.74	0.28	0.17	547.637
2009	0.99	41.54	0.34	0.20	535.215
2010	0.99	40.34	0.27	0.16	551.157
2011	0.99	37.21	0.34	0.21	516.373
2012	0.99	40.75	0.40	0.23	515.631
2013	0.99	45.43	0.38	0.21	538.949
2014	0.99	36.88	0.30	0.19	527.586
2015	0.99	37.40	0.41	0.26	497.141
2016	0.99	40.68	0.43	0.26	507.014
2017	0.99	49.10	0.45	0.23	537.729
2018	0.99	44.21	0.47	0.26	512.396

Source: Calculations based on data obtained from Global Wine Markets, 1860 to 2018: A statistical compendium, Adelaide: University of Adelaide Press, 2019. It is freely downloadable as an e-book at www.adelaide.edu.au/press/titles/global-wine

The degree of the export propensity of the South African wines has increased steadily since the removal of sanctions in 1994 (post-apartheid era). In 1990, the industry was only able to export 1.76% of the domestic wine production. After independence, the number increased to 15.33% in

1995. By 2005 the number went up to 38.58% and reached the highest at 49.10% in 2017 (SAWIS, 2020).

The low values of the import penetration index indicate a low degree of international competitiveness. South Africa imports less wine than it exports, making it very strong and competitive with its rivals. The importation of wine before 1994 only average 0.7% on domestic wine sales and 0.5% on domestic wine production. Between 1996 and 2000, wine imports slightly increased between 1.6% to 2.5%. The increased imports resulted because of the opening of international markets. During the time, there were many investments (Goldrush), and the wine industry could not sustain the demands that came with it. It had to look outside to meet the shortfall. Similarly, between 2005 and 2006, wine imports went up due to demands of S.A. wines by the international market. Overall, the per cent increase in wine imports is still low in South Africa, indicating that wine imports do not threaten the industry.

According to results in Table 3A.1, the export-import ratio has been positive and high throughout the study period, even though between 1996-2000 the values reduced due to increased imports for the reasons indicated earlier. Since the international market opening after 1994, South Africa has had a comparative advantage in wine. These results are consistent with the findings by (Van Rooyen et al., 2011). As a country, South Africa's trade performance in wine is outstanding. The wine industry has gained a trade advantage and has become a net-exporter since post-apartheid.

3B. Export value proposition

Methodology

The share of world wine export value is measured as follows:

$$XWV_{ij} = \left(\frac{XValue_{ij}}{XValue_{iw}} \right) \times 100 \quad (3A.7)$$

where XWV is the percentage share of world wine value, $XValue$ is the export value, i is a given country, and j is wine. w denotes the world value of wine. The estimates are absolute values for

the study period. A higher value indicates that a country has a high degree of comparative advantage in wine.

3C. Diagnostic Tests

Multicollinearity test

The multicollinearity test was run using a correlation matrix of coefficients. The cut-off level of severe multicollinearity was 0.8 (Gujarati and Porter, 2009; Hensher et al., 2012). A higher level of correlation between the study variables would produce undetermined coefficients and infinite standard errors, which would subsequently reduce the accuracy of the null hypothesis, affecting the decision to either reject or accept the hypothesis (Gujarati and Porter, 2009). The results of the multicollinearity test are presented in Table 3A.2. It is evident that correlation coefficients are below 0.80 (Hensher et al., 2012).

Table 3A.2: Correlation Coefficients between variables

	GVPcapit	VWXs	VWMs	UVXs	UVMs	BeerCsup	RGDP	REXCH
GVPcapit	1							
VWXs	-0.5492	1						
VWMs	0.4852	-0.3614	1					
UVXs	-0.2035	-0.176	-0.5499	1				
UVMs	0.2374	-0.3072	0.4367	-0.2776	1			
BeerCsup	0.3023	0.2758	-0.0098	-0.1167	-0.301	1		
RGDP	-0.5963	0.0895	-0.6419	0.595	-0.3846	-0.5019	1	
REXCH	0.2673	-0.5798	0.3029	0.2905	0.1635	-0.5336	0.1959	1

Source: Author's own calculations.

Panel Unit Root test

The test for a unit root in the series uses Levin et al. (2002). Test results indicate that none of the variables has unit roots and is stationary with individual effects and individual specifications (Table 3A.3).

Table 3A.3: Panel unit root results for the model variables

Variables	Adjusted t-statistics	P-value
-----------	-----------------------	---------

GVPcapit	-2.5574	0.0053
VMXs	-8.4946	0.0000
VWMs	-6.0758	0.0000
UVXs	-7.1847	0.0000
UVMs	-6.6716	0.0000
BeerCsup	-5.0261	0.0000
RGDP	-2.2870	0.0111
REXCH	-1.3255	0.0000

Source: Author's own calculations based on Levin et al.'s(2002).

Cross-sectional dependence test

The third test examines the hypothesis that the series does not have a cross-sectional dependence using the Pesaran (2004) test. The rejection of the null hypothesis confirms the cross-sectional dependence of the panel data (p=0.000) output.

Autocorrelation test

The study examined the hypothesis that the error term is not serially correlated. This is because serial correlation in linear panel-data models biases the standard errors and causes inefficient results (Gujarati and Porter, 2009). The study identifies serial correlation in the idiosyncratic error term using Woodridge (2002). The test confirms the presence of autocorrelation. The F-statistic with one and eleven degrees of freedom was 116.849. The computed p-value for the F-test was 0.0248, indicating that the F-test is statistically significant at the 5% level. The results are presented in Table 3A.4.

Table 3A.4: Woodridge results for autocorrelation

Ho: no serial correlation
$F(1, 4) = 11.261$
Prob > F = 0.0284

Source: Authors own calculations

Heteroscedasticity test

Lastly, the test for heteroscedasticity was performed. This is important because its presence could lead to incorrect inferences that need to be corrected (Gujarati and Porter, 2009). The test results

for the Lagrange Multiplier L.M., Likelihood Ratio L.R. and Wald tests reject the null hypothesis of no heteroscedasticity ($p=0.000$) and confirms the presence of heteroscedasticity (see Table 3A.5).

Table 3A.5: Group-wise Heteroscedasticity test results

Ho: Panel Homoscedasticity - Ha: Panel Group-wise Heteroscedasticity		
Lagrange Multiplier Test	=1730.0333	P-value > Chi2(4) 0.0000
Likelihood Ratio LR Test	=30.4902	P-value > Chi2(4) 0.0000
Wald Test	=9170.8821	P-value > Chi2(4) 0.0000

Source: Authors own calculations

Hausman Test

A number of methods are used to estimate panel data, such as constant effects, random effects and fixed effects. The pooled-effect model assumes that the variables are constant across observations. The pooled ordinary least squares (OLS) method ignores the unobserved cross-country heterogeneity, thereby giving biased results. The fixed-effects model assumes that each of the intercepts associated with the cross-sections is not different across time. Finally, the random effects method is appropriate if the coefficients are randomly characterised given the panel data. The Hausman test determined which of the three models was appropriate. Table 3A.6. presents the Hausman test results.

Table 3A.6: Hausman Test Results

	Coefficients			sqrt(V _b -V _B)
	(b)fe	(B)re	(b-B)difference	S.E.
GVPcapit	0.066	0.3213	-0.2552	0.0719
Pxed	0.0072	0.0051	0.0021	0.001
VWMs	0.00E+00	0.00E+00	0.00E+00	0.00E+00
UVXpt	0.1727	0.1236	0.0491	0.0118
UVMs	-0.0013	-0.0109	0.0096	0
BeerCsup	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RGDP	0.00E+00	0.00E+00	0.00E+00	0.00E+00
REXCH	0.0469	0.0486	-0.0017	0.0078

b = consistent under H₀ and H_a; obtained from xtreg

B = inconsistent under H_a, efficient under H₀; obtained from xtreg

Test: H₀: difference in coefficients not systematic

$$\begin{aligned}\text{chi2}(5) &= (b-B)'[(V_b-V_B)^{-1}](b-B) \\ &= 101.06\end{aligned}$$

$$\text{Prob}>\text{chi2} = 0.0000$$

(V_b-V_B is not positive definite)

Source: Authors own calculations

The null hypothesis for the Hausman test means that the random-effects model is preferred to the fixed-effects model. However, the Hausman test reports a chi-square of 101.06 with a *p*-value(0.0000), indicating that the chi-square value is statistically significant at the 1% significance level. Therefore, the null hypothesis was rejected and concluded that the fixed-effects model was more appropriate.

Appendix 4. Chapter 4

4A: Natural preservatives valuation questionnaire



AIM OF STUDY: To assess preferences for different types of wine

Introduction and disclaimer:

- My name is Lydia a PhD student at the University of Cape Town.
- You are invited to participate in this study on preferences for different types of wine.
- This research has been approved by Ethics Research Committee at faculty of commerce..
- Your participation in this research is voluntary.
- You can choose to withdraw from the research at any time.
- The survey will take no more than 30 minutes.
- Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate.
- Your information will be coded and will remain confidential.
- If you have questions at any time about the survey or the procedures, you may ask.
 - Yes, I agree to participate
 - No, I do not agree to participate

Screening Question 1: Over the past 6 months have you consumed accumulatively at least a bottle of wine?

- ☐ Yes
- ☐ No

The questions are grouped in 4 sections (A, B, C and D) as follows:

A. Wine acquisition practice

1. How often do you drink wine

- ☐ Almost every day
- ☐ Few times a week
- ☐ Once a week
- ☐ Once a fortnight
- ☐ Once a Month
- ☐ Very rarely

2. How many bottles do you typically buy a month at your household (do not count wine drank at restaurants or bars)?

- ☐ Red wines: _____
- ☐ White wines: _____
- ☐ Rose wines: _____
- ☐ Sparkling wines: _____
- ☐ Champagne wines: _____
- ☐ Special wines (desert, ice, straw, botric, and similar):.....
- ☐ None: reason.....

3. What are some of the factors that determine your purchasing decisions? (Pick all factors that influence your decision to buy).

- ☐ Using sulphur as wine preservative
- ☐ Using Natural preservatives
- ☐ Organic wine
- ☐ Conventional wine
- ☐ Quality score
- ☐ Price of wine

- Taste of wine
 - Vintage
 - Wine Cultivar (Grape variety)
 - Region
 - Winery
4. What is the average price you typically buy a bottle of wine most often?
- Below 50 (3 Euro)
 - 50-100 ZAR (3-6 Euro)
 - 100-150 ZAR (6-9 Euro)
 - 150-200 ZAR (9-13 Euro)
 - 200-250 ZAR (13-16 Euro)
 - 250-300 ZAR (16-19 Euro)
 - 300-400 ZAR (19-25 Euro)
 - 400-500 ZAR (25-32 Euro)
 - 500 ZAR and more (32+ Euro)
5. The last bottle you bought, how much did it cost?
-
6. What is the approximate share of wine bottles you buy a year with organic label?
- %
 - We dont buy organic wine
 - We only buy organic wine
 - We are not sure

B. Consumer information and knowledge about sulphite content in wine, perceived health effects, wine types and the quality score of wine.

The South Africa wine market sells conventional wine and organic wine both produced using either Sulphite or Natural preservatives. For example you can buy conventional and organic wine with sulphite preservatives only or conventional and organic wine with natural preservatives.

Small levels of sulphites occur naturally in all wines. The amount of naturally-occurring sulphites is usually less than 10 milligram per litre (mg/l). Winemakers commonly add sulphites to wine to prevent it from oxidation and to maintain its freshness.

It is estimated that 1 in 100 people have allergies to sulphites. The common health effects include trouble breathing, asthma attack, headaches and migraines attack. However, these perceived health effect claims have not been proved scientifically.

In 2014, the South African wine industry (Audacia Winery) discovered a natural way to preserve wine using Rooibos and Honeybush plant (Natural Preservative). This plant is endemic to the Western Cape and contains high levels of oxidants, no caffeine and low tannin levels making it ideal not only to preserve wine but for flavouring.

Sources: Frey Vineyards Ltd., 2009; Wine Institute, 2011; Slinkard, 2012; Grotheer, Marshall, and Simonne, 2005; Mauskop and Sun-Edelstein 2009, Lyons, 2014

1. Have you heard about these health effects?
 - ☐ Yes
 - ☐ No
2. Do you have allergies on sulphite contained foods and beverages such as wine?
 - ☐ Yes
 - ☐ No
3. Do you know or have you heard of someone who suffers from sulphite allergies in wine?
 - ☐ Yes
 - ☐ No
4. Do you believe that drinking even moderate amounts of some type of wine give you headaches?
 - ☐ Yes
 - ☐ No

Information on wine quality score

There are several institutions that rate the quality of wine. One such rating is regularly provided by the Wine Spectator that uses a 100 point rating scale. The wine scores are defined as follows:

- 60 (not recommended)
- 75 (a drinkable wine that may have minor flaws)
- 82 (good, well-made wine)
- 88 (very good)
- 92 (very good with special qualities)
- 97 (excellent, superior character)
- 100 (great top wine)

5. Have you ever heard about the quality scores?

- ☐ Yes
- ☐ No

C. The next part of the survey will take you through 6 choice sets each with three alternatives.

Each wine option is described by four attributes:

Preservative

- Sulphur (containing SO₂)
- Natural (containing Rooibos and honeybush)

Type of viticulture production

- Conventional viticulture
- Organic viticulture - organic wine is made from grapes produced without adding artificial fertiliser and pesticides

Wine quality

Quality of wine as measured by the Wine Spectator

- 60 (not recommended)
- 75 (a drinkable wine that may have minor flaws)

- 82 (good, well-made wine)
- 88 (very good)
- 92 (very good with special qualities)
- 97 (excellent, superior character)
- 100 (great top wine)

Additional cost

In addition to the price you usually pay for a 750ml bottle of wine. It means **how much extra** are you willing to pay for a wine having different attributes than the wine you usually buy.

- +10 % (for instance, if you usually pay R150 (9.2 Euro), you would pay R15 more (+0.9 Euro), so the final price is R165 (10.1 Euro))
- +20 % (a wine for R200 would cost R40 more, so the final price is R240)
- +40 % (a wine for R100 would cost R40 more, so the final price is R140)

I will ask you **8 times** to choose the option you consider the best for you.

Each choice –card has 3 alternatives Wine A, B and status quo (wine you usually buy). Wine A and B have different attributes with respect to used preservatives, type of viticulture, wine quality, and the costs.

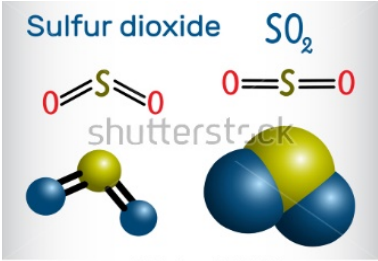
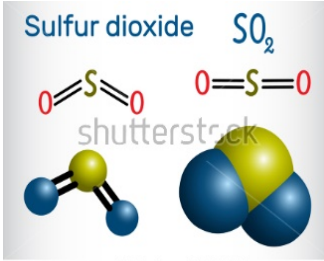
Each choice-card is unique and does not relate to the next. Therefore, the choices you make are independent of each other.

If you agree with chosen option, consider that you will have less money to spend on other goods and services.

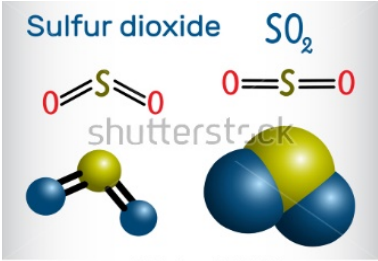
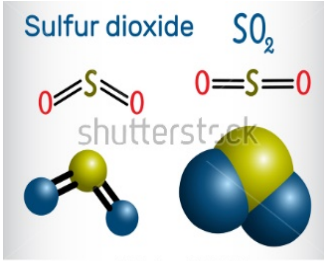
Choice Card 1

	Red Wine A	Red Wine B	Wine you usually buy
Preservatives	NATURAL	SULPHUR	SULPHUR
			
Viticulture production	CONVENTIONAL	ORGANIC	CONVENTIONAL
			
Wine quality Score	100 (great top wine)	60 (not recommended)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	30% more	40% more	as you usually pay
Which option do you prefer?	☐	☐	☐

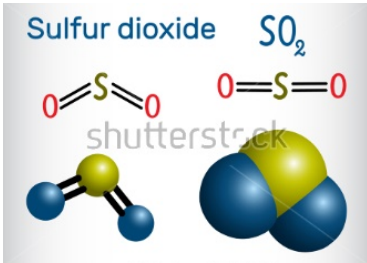
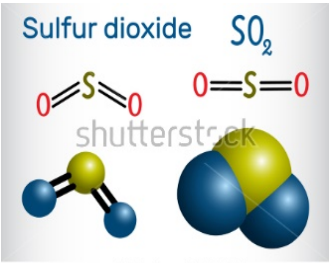
Choice Card 2

	Red Wine A	Red Wine B	Wine you usually buy
Preservative s	SULPHUR 	NATURAL 	SULPHUR 
Viticulture production	ORGANIC 	CONVENTIONAL 	CONVENTIONAL 
Wine quality Score	88 (very good wine)	82 (good wine)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	20 % more	50 % more	as you usually pay
Which option do you prefer?	☐	☐	☐

Choice Card 3

	Red Wine A	Red Wine B	Wine you usually buy
Preservative s	SULPHUR 	NATURAL 	SULPHUR 
Viticulture production	ORGANIC 	CONVENTIONAL 	CONVENTIONAL 
Wine quality Score	82 (good wine)	88 (very good wine)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	50 % more	20 % more	as you usually pay
Which option do you prefer?	☐	☐	☐

Choice Card 4

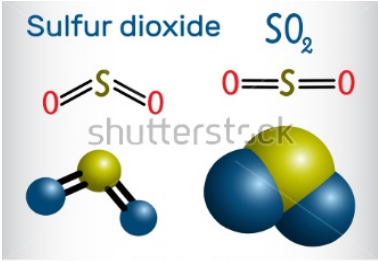
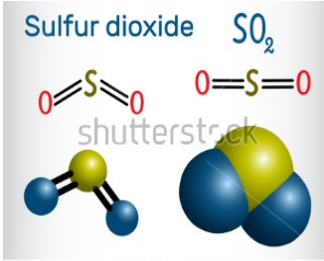
	Red Wine A	Red Wine B	Wine you usually buy
Preservative s	NATURAL 	SULPHUR 	SULPHUR 
Viticulture production	CONVENTIONAL 	ORGANIC 	CONVENTIONAL 
Wine quality Score	100 (great top wine)	60 (not recommended)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	R30 (€1.87) more	R40(€2.5) more	as you usually pay
Which option do you prefer?	☐	☐	☐

Now, I will show you 4 more choice-Cards. This time I'm referring the white wine options.

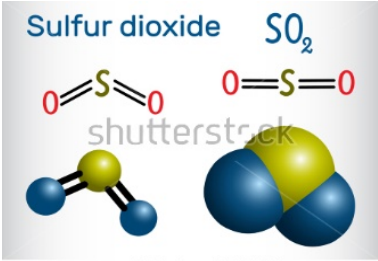
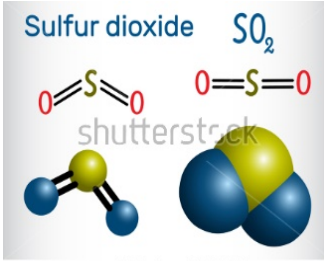
Choice Card 5

	White Wine A	White Wine B	Wine you usually buy
Preservatives	NATURAL	SULPHUR	SULPHUR
			
Viticulture production	CONVENTIONAL	ORGANIC	CONVENTIONAL
			
Wine quality Score	100 (great top wine)	60 (not recommended)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	30% more	40% more	as you usually pay
Which option do you prefer?	☐	☐	☐

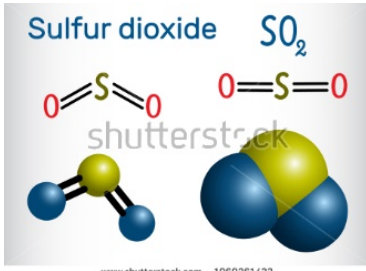
Choice Card 6

	White Wine A	White Wine B	Wine you usually buy
Preservative s	SULPHUR 	NATURAL 	SULPHUR 
Viticulture production	ORGANIC 	CONVENTIONAL 	CONVENTIONAL 
Wine quality Score	88 (very good wine)	82 (good wine)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	20 % more	50 % more	as you usually pay
Which option do you prefer?	☐	☐	☐

Choice Card 7

	White Wine A	White Wine B	Wine you usually buy
Preservative s	SULPHUR 	NATURAL 	SULPHUR 
Viticulture production	ORGANIC 	CONVENTIONAL 	CONVENTIONAL 
Wine quality Score	82 (good wine)	88 (very good wine)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	50 % more	20 % more	as you usually pay
Which option do you prefer?	☐	☐	☐

Choice Card 8

	White Wine A	White Wine B	Wine you usually buy
Preservative	NATURAL	SULPHUR	SULPHUR
s			
Viticulture production	CONVENTIONAL	ORGANIC	CONVENTIONAL
			
Wine quality Score	100 (great top wine)	60 (not recommended)	75 (a drinkable wine that may have minor flaws)
Additional cost per bottle	R30 (€1.87) more	R40(€2.5) more	as you usually pay
Which option do you prefer?	☐	☐	☐

1. What price of a 750ml bottle of wine did you have in mind when making the above choices?

☐

2. If at least one time you choose either option A or option B (not choosing “a wine you usually buy”), what is the main reason:

Please choose all that apply.

☐ The prices I was asked to additionally pay were costly

- The additional costs were negligible
- I valued natural preservatives (using Rooibos)
- I valued wine made from organic grapes
- I valued wine quality

3. If you choose status quo “the wine you usually buy” at least once, what is the main reason:

Please choose all that apply.

- I do not trust the information provided
- Both alternatives were **too expensive** for me
- **I do not trust** wine can be effectively preserved using natural products such as Rooibos and honey bush
- **I do not care** about presented wine characteristics (I care more about price)
- **I never buy wine**
- **I did not understand** the presented experiment
- Other.....

4. How important was each of these characteristics when answering the questions?

Please rate each characteristic on a scale from 1 to 5, where 1=not important at all and 5=very important.

	Not important at all				Very important
	1	2	3	4	5
Preservatives (SO ₂ or Rooibos)	☐	☐	☐	☐	☐
Viticulture production (conventional or organic)	☐	☐	☐	☐	☐
Wine quality (score)	☐	☐	☐	☐	☐
Additional cost in percentage increase	☐	☐	☐	☐	☐
Additional cost in Rand (Euro)	☐	☐	☐	☐	☐

5. Which of these wine attributes did you consider when making your choice?

Please rate each characteristic on a scale from 1 to 5, where 1=not important at all and 5=very important.

	Never consider ed		Considered sometime s		Always considered
	1	2	3	4	5
Preservatives (SO ₂ or Rooibos)	☐	☐	☐	☐	☐
Viticulture production (conventional or organic)	☐	☐	☐	☐	☐
Wine quality (score)	☐	☐	☐	☐	☐
Additional cost in percentage increase	☐	☐	☐	☐	☐
Additional cost in Rand (Euro)	☐	☐	☐	☐	☐

D. Social Demographics questions

1. What is your age?

- ☐ 18-20
- ☐ 21-30
- ☐ 31-40
- ☐ 41-50
- ☐ 51-60
- ☐ 61-70
- ☐ 71 or above

2. What is your gender?

- ☐ Male
- ☐ Female
- ☐ I prefer not to answer

3. Please estimate your net annual household income?

- ☐ R50,000 (€3,125) or below
- ☐ R50,000 to R100,000 (€3,125 - €6,250)
- ☐ R100,000 to R150,000 (€6,250 - €9,375)
- ☐ R150,000 to R200,000 (€9,375 - €12,500)
- ☐ R200,000 to R350,000 (€12,500 - €21,875)

- R350,000 to R500,000 (€21,875 – €31,250)
- R500,000 to R750,000 (€31,250 – €46,875)
- R750,000 to R1,000,000 (€46,875 - €62,500)
- R1,000,000 to R2,000,000 (€62,500 - €125,000)
- above R2,000,000 (€125,000)
- I prefer not to answer

4. What is your highest level of education?

- Primary education
- High (secondary) school
- Some technical certificate/diploma
- Bachelor's degree
- Honor's degree
- Professional/Master's degree
- Doctorate degree
- Others (please specify).....

5. Where do you reside, continent?

- Africa
- Europe
- Northern America
- Latin and South America
- Asia
- Australia, New Zealand, Oceania

6. Indicate your race

- Asian
- African
- Coloured
- Indian
- White / Caucasian

- Other (specify).....
- I prefer not to answer

THANK YOU

Table 4A: Parameter distribution for Rands and Percentage

Cost in mind	Frequency		cum
	Rands	Percentage	
35	24	0	24
40	72	0	72
45	0	24	24
50	144	312	456
51	24	0	24
60	72	192	264
65	24	48	72
70	168	192	360
75	96	120	216
80	144	168	312
85	24	0	24
89	24	0	24
90	24	96	120
95	0	24	24
100	792	864	1,656
110	24	24	48
120	408	360	768
125	24	0	24
130	240	216	456
135	0	24	24
140	72	48	120
145	0	48	48
150	1,176	888	2,064
155	0	24	24
160	144	120	264
165	0	24	24
170	120	144	264
175	24	48	72
180	240	288	528
190	0	72	72
195	0	24	24
200	528	1,128	1,656
210	0	72	72
220	0	96	96
226	24	0	24
229	24	0	24
230	144	24	168

240	72	48	120
250	360	408	768
260	72	24	96
270	48	72	120
280	24	120	144
300	384	384	768
320	0	24	24
330	72	0	72
350	288	288	576
360	48	24	72
370	72	0	72
400	264	144	408
425	24	0	24
429	24	0	24
430	24	24	48
440	24	0	24
450	72	0	72
460	120	48	168
470	24	0	24
484	0	24	24
490	0	24	24
500	144	168	312
560	24	0	24
700	0	48	48
900	0	24	24
Total	7,008	7,608	14,616

Figure 4A: Parameter distribution for Rands and Percentage

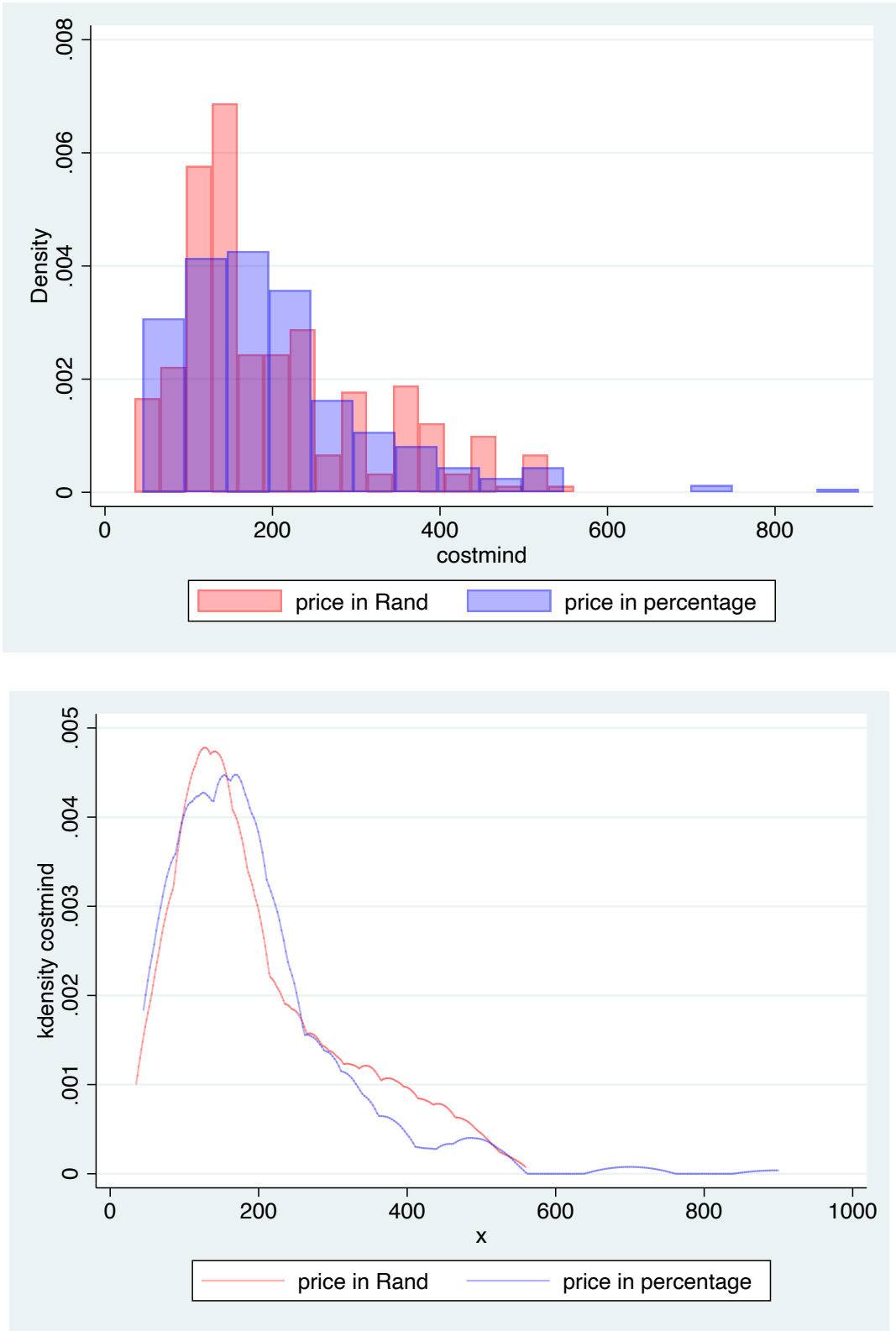
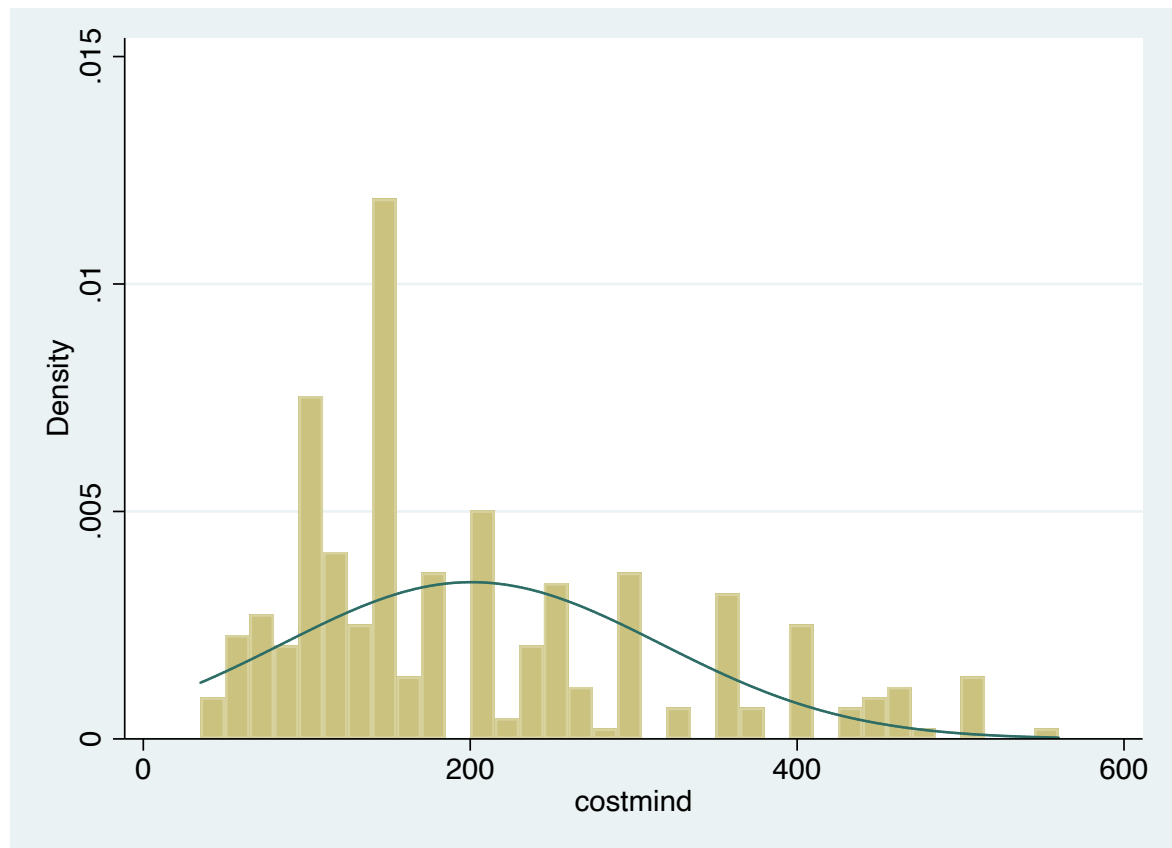


Figure 4A: Parameter distribution for Rands only



T Test for significance

R184 per 0.75 l bottle (11.51 USD), with min at R35 and max at R900

RAND price: mean = R200,84 (11.85 USD) (se 0.082)

PRCT price: mean = R189,75 (11.20 USD) (se 0.079)

mean(RAND)= mean(PRCT) $t=5.778$, $Pr= 0.000$

To test for robustness, we tested two comparable models MNL and ML (by reason ML being an extension of MNL) and found that ML has a few advantages, relative to MNL. Two main advantages are that ML does not exhibit the assumption of independence of irrelevant alternatives (IIA) in contrast to MNL, and that ML accounts for possible correlation over repeated choices made by each individual (Algers et al., 1998). IIA implies that the choice between two options only depends on the characteristics of these two options, and not on the characteristics of other possible options. Therefore, an individual's preference does not change after including or excluding any other option. While in many situations exhibiting the assumption of IIA does not cause any problems, it may be an unrealistic assumption in some cases (Franses and Paap, 2001).

Additionally, ML accounts for possible correlation over repeated choices made by each individual, while for MNL, repeated choices made by an individual are independent.

A study by Ye and Lord (2014) concludes that ML has a better interpretive power than MNL and that ML fits the data significantly better than MNL. Another study by Alfnes (2004), used both MNL and ML to model the choice between several kinds of beef. He concludes that using ML is better to model the choice between different types of beef, than MNL, since ML allows the presence of correlated error terms, similar to our case where we model consumers choice between several wine alternatives. ML is better for identifying substitution patterns and the prediction of consumer shares (Alfnes, 2004).

To test for robustness and to find the best fitting parameters for ML, Maximum Likelihood estimation (MLE) was used. The idea of MLE was to make the desired probability distribution “most likely”, such that the model fits the data as good as possible. This is accomplished by seeking the value of the parameters that optimizes the likelihood function $L(\theta)$ (Myung, 2003).

The most frequently used distributions for the parameters in ML are the normal, log-normal, triangular and uniform distribution (Hensher and Greene, 2003). ML avoid limitations of MNL by allowing for unrestricted substitution patterns, random taste variation, and correlation in unobserved factors over time (Train, 2009).

Table 4A:1. Estimation results, MXL with colour interactions

Panel A – Parameter estimates

	Mean	SD	Interactions with
	(s.e)	(s.e)	red wine
rooibos	2.7543*** (0.3245)	3.3360*** (0.3049)	-0.4281 (0.3755)
organic	0.8150*** (0.2563)	1.7806*** (0.2827)	0.0090 (0.3099)
quality	0.0647*** (0.0119)	0.0915*** (0.0117)	-0.0002 (0.0144)
price (in euro)	-0.04417*** (0.0061)	0.0548*** (0.0052)	0.0727 (0.1191)
Model			
characteristics			
<i>Log likelihood</i>	-1833.7971		
<i>LR Chi2</i>	1126.72		
<i>No. obs.</i>	7,332		
<i>r(respondents)</i>	611		
<i>k(parameters)</i>	18		

Panel B – WTP estimates per bottle of wine, means in Rands

	Red wine	White wine
rooibos	81.3322 (329.8)	62.3477*** (8.5113)
organic	28.8142 (116.78)	18.4497*** (5.8372)
quality	2.2573 (9.2085)	1.4662*** (0.2651)

Notes: *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. Standard errors are provided in parentheses. All random parameters are fully correlated, with 1000 draws for simulations. Wald statistics for the equality test of the WTP means for each attribute between red and white wine is 0.19 ($p = 0.6670$) for rooibos; 0.16 ($p=0.6889$) for organic; and 0.16 ($p=0.6880$) for quality, indicating that mean WTP values are not statistically different for red and white wines at any convenient level.

Table 4A.2: Parameter estimates, MXL with headache interactions

	Mean	SD	Interactions with
	(s.e)	(s.e)	headache
rooibos	1.9341*** (0.3565)	3.3019*** (0.2989)	0.6653 (0.4043)
organic	1.1084*** (0.2596)	1.8310*** (0.2673)	-0.3356 (0.2922)
quality	0.0501*** (0.0115)	0.0895*** (0.0118)	0.0283 (0.0139)
price (in euro)	-0.0675*** (0.0070)	0.8493*** (0.0817)	0.0376 (0.0076)
Model			
characteristics			
<i>Log Likelihood</i>	-1815.5838		
<i>LR Chi2</i>	1047.43		
<i>No. obs.</i>	7,332		
<i>r(respondents)</i>	611		
<i>k(parameters)</i>	18		

Notes: *, **, and *** indicate significance at 10%, 5%, and 1%. Standard errors are provided in parentheses. All random parameters are fully correlated, with 1000 draws for simulations.

Table 4A.3: Parameter estimates, MXL with interactions on gender and race

	Mean	SD	Interaction	Interaction	Interaction
	(s.e)	(s.e)	with	with	with
			female	African	Caucasian
rooibos	2.8528*** (0.3465)	3.2454*** (0.2993)	0.1062 (0.3589)	-1.0174** (0.4575)	-0.4426 (0.4177)
organic	0.4149 (0.2687)	1.8332*** (0.2701)	0.6696** (0.2814)	0.1327 (0.3348)	0.4053 (0.3273)
quality	0.0703*** (0.0128)	0.0913*** (0.0115)	0.0002 (0.0136)	-0.0276 (0.0170)	0.0184 (0.0163)
price	-0.0312*** (0.061)	0.0538*** (0.0049)	-0.0132* (0.0067)	-0.0115 (0.0084)	0.0004 (0.0076)
Model					
Characteristics					
<i>Log likelihood</i>	-1825.5692				
<i>LR Chi2</i>	1083.67				
<i>No.obs</i>	7,332				
<i>r(respondents)</i>	611				
<i>k(parameters)</i>	26				

Notes: *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. Standard errors are provided in parentheses. All parameters are fully correlated, with 1000 draws for simulations.

Table 4A.4: Parameter estimates, MXL with frequency of wine drinking interactions

	Random factors		Fixed interactions	
	Mean (s.e)	SD (s.e)	Interactions with heavy drinkers	Interactions with light drinkers
rooibos	2.3138*** (0.2787)	3.3589*** (0.3043)	0.2541 (0.4208)	-0.1781 (0.5231)
organic	1.0178*** (0.2022)	1.7221*** (0.2880)	0.0772 (0.3459)	-0.4059 (0.4147)
quality	0.0634*** (0.0102)	0.0925*** (0.0119)	0.0095 (0.0166)	0.0101 (0.0200)
Price (in euro)	-0.0484*** (0.0051)	0.0539*** (0.0047)	0.0208* (0.0079)	0.0087 (0.0096)
Model				
characteristics				
<i>Log likelihood</i>	-1827.3224			
<i>LR Chi2</i>	1109.00			
<i>No. obs.</i>	7,332			
<i>r(respondents)</i>	611			
<i>k(parameters)</i>	22			

Notes: *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. Standard errors are provided in parentheses. All random parameters are fully correlated, with 1000 draws for simulations.