Assessing consumer post-response to a food safety scare in South Africa using behavioural game theory

By

Ziyanda P Hadebe

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Supervisor: Dr Cecilia Punt
Co-supervisor: Dr Jan C. Greyling

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Declaration

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Abstract

The consumer response to the *Listeria* outbreak in South Africa (SA) was noticeable and reasonable. However, the post food scare effects are still predicted and it is not certain to what degree the outbreak affected rational decisions of consumers when buying processed meat products, especially the implicated ones. Thus, it is vital to capture and quantify the level of trust that South African consumers have toward processed meat products after the *Listeria* outbreak.

Since the market is consumer-orientated, this study analysed the consumer behaviour towards the implicated product after the *Listeria* outbreak through behavioural economics and game theory. The study used 111 subjects with 50 control and 61 treatment participants from the Cape Wineland District in Western Cape Province. The participants consisted of both student and non-student participants, which enabled broad socio-economic characteristics to investigate the factors that influenced consumer behaviour after the outbreak. The experimental game theory chosen for the study is the Vickrey fourth-price auction used to collect willingness to pay (WTP) data. The Vickrey fourth-price auction consisted of three rounds where each participant was requested to bid for 500g viennas online through an oTree online platform after receiving negative and/or positive information about the *Listeria* outbreak. The winning bidders received food vouchers equivalent to the 500g viennas retail price after the experiment. After the auction, a survey and evaluation were conducted to collect data based on demographic characteristics, shopping habits, knowledge or attitude about food safety, salience, social pressure resulting from the outbreak and the level of trust for the implicated products.

All the data and information that was collected from the auction, survey and evaluation were further analysed using a Tobit regression model, an integrative model of behavioural prediction (IMBP) and partial least squares structural equation modelling (PLS-SEM) to assess the consumer behaviour after the outbreak. Most participants indicated that they stopped consuming or reduced their consumption of the products implicated during the outbreak. Moreover, the negative information had a more significant impact on consumer behaviour than positive information about the outbreak. Negative information caused a major decrease in the consumption of ready-to-eat (RTE) meat products during and after the outbreak. Lastly, real intention of buying the implicated products, trust and shopping habit had the greatest influence on WTP compared to other variables. Real intention mainly increased the WTP of participants whilst trust either decreased or increased the WTP after the recall. Since the purchasing behaviour of consumers changed after the outbreak, shopping habits had the most negative effect on WTP. Thus, one may conclude that most consumers change their choice of purchase and frequency of buying RTE meat products, especially for implicated products after a food scare.

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List of abbreviations

AVE	Average variance extracted
B.C.	Before Christ
BDM	Becker-DeGroot-Marschak
BE	Behavioural economics
BGT	Behavioural game theory
BRCGS	British Retail Consortium Global Standards
CDC	Centres for disease control and prevention
CFA	Common factor analysis
CHM	Cognitive Hierarchy Model
COVID	Coronavirus disease
DAEC	Diffusional adherent *Escherichia coli*
ECDC-EFSA	European Centre for Disease Prevention and Control-European Food Safety Authority
EFA	Exploratory factor analysis
EHEC	Enterohaemorrhagic *Escherichia coli*
EIEC	Entero-invasive *Escherichia coli*
EPEC	Entero-pathogenic *Escherichia coli*
EWA	Experience weighted attraction learning
FAO	Food and Agriculture Organization of the United Nations
FNSE	Fear of negative social evaluation
FSSC	Food Safety Management Certification Scheme
GFSI	Global Food Safety Initiative
GMP	Good Manufacturing Practice
HACCP	Hazard Analysis Critical Control Points
ID	Identification number
IMBP	Integrated model of behavioural prediction
IV	Instrumental variables
KMO-MSA	Kaiser Meyer Olkin measure of sampling adequacy
NICD	National Institute of Communicable Diseases
PCA	Principal component analysis
PLS-SEM	Partial least squares structural equation model
PSM	Propensity score matching
QRE	Quantal Response Equilibrium
RTE	Ready-to-eat
TGT	Traditional game theory
TRA	Theory of reasoned action

TPB	Theory of planned behaviour
SA	South Africa
SEM	Socio-economic measurement
SRMR	Standardised root mean square residual
URL	Uniform resource locator
US	United States
US$	United States dollar
VA	Vickrey auction
WCDOA	Western Cape Department of Agriculture
WHO	World Health Organization
WTA	Willingness to accept
WTP	Willingness to pay

CHAPTER 1

1. Introduction

1.1. Background

Food safety is one of the most important public health issues in the world because when food is unsafe it can be a threat to human life. Both developed and developing countries suffer from food safety threats caused by biological, chemical and physical hazards. According to Manning (2017), food safety refers to both unintentional and intentional contamination of food, either through physical, chemical or biological hazards that may make food a threat to human health and cause foodborne diseases. Foodborne diseases can be defined as diseases commonly transmitted through food and comprise of a broad group of diseases caused by microbial pathogens, parasites, chemical contaminants and bio-toxins (Forsythe, 2010; Hanson *et al.*, 2012; Shonhiwa *et al.,* 2017). According to Manning (2017), the definition of diseases, poisoning or intoxication associated with food can be explicitly defined as being:

"a health disorder with symptoms of either of short [acute] or long [chronic] term duration with a specific onset period that is induced by consuming food that is contaminated by biological organisms or agents that can invade host cells and/or produce toxins once ingested, or food that contains toxic material at the time of consumption, or by consuming an unbalanced diet over a prolonged period, leading to over and under nutrition."

According to Gizaw (2019), unsafe food containing harmful bacteria, viruses, parasites or chemical substances causes more than 200 diseases, ranging from diarrhoea to cancer. The most vulnerable are infants, young children, pregnant women, elderly and those with weak immune systems due to diseases. Globally, it is estimated 600 million people (1 in 10) suffer from foodborne diseases annually due to eating contaminated food; of these, about 420 000 die every year (Gizaw, 2019; Shonhiwa *et al.,* 2017; World Health Organization (WHO), 2019a). Children under five years of age carry 40% of the foodborne disease burden, with 125 000 deaths every year (WHO, 2019a). Diarrheal diseases are the most common illness resulting from consuming contaminated food, causing approximately 550 million people to fall ill and causes more than 230 000 deaths every year globally (Gizaw, 2019; WHO 2019a). South Africa (SA) has a mortality rate from foodborne diseases of 25.84 deaths per 100 000 people, which is relatively high compared to the US and Europe, where it is 0.66 and 0.11 per 100 000 people, respectively (Hanson *et al.*, 2012).

Chemical and biological hazards such as bacterial and viral pathogens are responsible for most of the foodborne diseases worldwide (Bruhn, 1999; Miles *et al.*, 2004) . Chemical hazards are harmful substances that can be found in food naturally and unintentionally or intentionally added during processing. Chemical hazards include all the naturally occurring toxins (mycotoxins, marine biotoxins, cyanogenic glycosides and poisonous toxins from mushrooms), environmental pollutants, added chemicals such as food additives, agricultural products such as pesticides and veterinary drug residues. The symptoms of foodborne diseases due to chemical contamination range

from mild gastroenteritis to fatal cases of hepatic, renal, and neurological syndromes. The most unforgettable chemical contamination outbreak is the Chinese milk scandal that occurred in 2008 due to the intentionally added melamine in raw milk to increase the milk protein content. The infants and young children that consumed milk products (especially infant formula), that were made from the raw milk with melamine, experienced kidney and urinary tract problems. More than 300 000 Chinese infants and young children were affected with about six reported deaths (Gossner *et al.*, 2009).

Microbial contamination exposes and contaminate food with microorganisms such as fungi, bacteria, viruses, and their by-products. If the contaminated food is consumed it may cause diseases and allergens, some of which could possibly result in death. Over 90% of foodborne diseases are caused by species of *Staphylococcus*, *Salmonella*, *Clostridium*, *Campylobacter*, *Listeria*, *Vibrio*, *Bacillus* and *Eschericia coli* (*E. coli*) (Bintsis, 2017). A study conducted by Soon *et al.* (2020), reviewed global food safety incidents and/or recalls with known or suspected causes. They reviewed food recalls in nine official websites and five journal databases from 2008 to 2018. According to this study, the highest number of reported food safety incidents in the world, from 2008 to 2018, were associated with raw fish with the detection of foodborne pathogens, presence of prohibited substances, heavy metals, undeclared or high sulphite content and other allergens as the major cause of the incidents. The second highest number of reported food incidents/recalls in the world were associated with ready-to-eat (RTE) meals. The most common hazards contributed to the incidents associated with RTE meals were *Listeria monocytogenes* (*L. monocytogenes*), *Salmonella* species, *E. coli* and undeclared allergens.

The most recent outbreak in SA was the *Listeria* outbreak. This outbreak was recognised as one of the largest *Listeria* outbreaks in the world, about 216 deaths and several economic losses due to the outbreak. According to Olanya *et al.* (2019), the outbreak was caused by the widely consumed ready-to-eat processed meat product called "polony". From January 2017 to the 4th of March 2018, individuals interviewed indicated that they consumed polony before experiencing symptoms of food poisoning associated with *Listeria monocytogenes* (*L. monocytogenes*). The implicated products were recalled on the 4th of March 2018. The outbreak occurred across the whole country with the most cases and deaths reported in the Gauteng Province (~614 reported cases and 108 deaths), followed by Western Cape Province (~136 reported cases and 32 deaths) and KwaZulu-Natal Province (~83 reported cases and 21 deaths) (National Institute Communicable Diseases (NICD), 2018). The *Listeria* outbreak in SA resulted in an estimated social and economic total cost of approximately US$ 276 million at low-value of human life and about US$ 537 million at high-value of human life[1] (Olanya *et al.*, 2019).

Where there is severe notifiable damage caused by microbial contamination of food to consumers, the implicated products are recalled, which marks the beginning of a food scare[2]. In some countries it takes longer to recall the implicated products due to lack of adequate traceability systems for the implicated products. In SA, the recall of

[1] The value of human life is an economic concept that is used to quantify the benefit of avoiding a fatality.
[2] A food safety scare is the response to a food incident (real or perceived) that causes a sudden disruption to the food supply chain and to food consumption patterns (Whitworth *et al.*, 2017).

the implicated product was delayed due to lack of adequate traceability systems, as a result many deaths were recorded. Recalls are important as they attempt to remove the source of the problem to prevent further diseases but they can also inflict serious damage on an industry through stigmatising similar products, including ones that are safe. As a result, food scares cause economic losses[3], social disruption and also have environmental implications (Hussain and Dawson, 2013; Whitworth *et al.*, 2017). A food safety economic analysis study conducted by Ribera *et al.* (2012) showed that it is much cheaper for a producer to prevent foodborne outbreaks than to face costs associated with unsafe food as a result of the outbreak.

To avoid most of the economic, social and environmental implications as a result of a food safety scare, it is crucial to implement a systematic and proactive food safety approaches such as hygiene management systems to minimise contamination from farm to fork. Food control agents and food retailers require food processors and manufacturers to apply food safety regulations which can be country specific and/or internationally approved. In SA, the food service premises are expected to adhere to the *'Regulations governing general hygiene requirements for food premises, the transport of food and related matters (R638 of 2018)'* (Teffo and Tabit, 2020). This regulation makes provision for health inspectors to ascertain that food services premises comply with the food safety regulations by having the necessary resources, conditions and infrastructure to ensure the safe handling of food. Some food services premises implement the most common hygiene management systems such as Hazard Analysis and Critical Control Points (HACCP) with Good Manufacturing Practice (GMP) to ensure that food safety procedures are followed and in place when processing food. There are also advanced hygiene management systems that are internationally recognised and inspect food manufacturers on the basis of food safety and hygiene. These include all hygiene management systems and certification programmes recognised under the Global Food Safety Initiative (GFSI) to ensure highest standards in food safety which enable food businesses to gain access in the global market (GFSI, 2021). The most common advanced hygiene management systems and certification programmes recognised in GFSI, include the Food Safety System Certification scheme (FSSC 22 000) and the British Retail Consortium Global Standards (BRCGS).

Implementing such food safety systems and certification programmes enables all role players to maintain quality and safety assurance throughout the food value chain until consumption. However, it does not always guarantee that food is completely safe even when proper hygiene procedures are implemented. This is why up to date different foodborne diseases are still faced around the world and if their sources are not efficiently traced it may result in more people getting sick due to the consumption of contaminated food. Lack of efficient traceability systems for foodborne diseases sources in the food supply chain may delay effective communication to inform consumers about consuming the implicated food products. The information that is spread by the media, especially during a food safety scare, is not always accurate and mostly consists of negative information. As a result, food producers, commodity organisations, and policy makers have shifted their interests in consumer responses to food

[3] The estimated cost of food incidents in the United States is approximately US$7 billion per annum which consists of costs for notifying consumers of any outbreaks, removing contaminated food from shelves and paying damages as a result of lawsuits (Hussain and Dawson, 2013).

safety information since it enable them to understand how typical consumers react to food quality, safety, and composition information published by the media. Understanding consumer response helps us to evaluate the effectiveness of food safety information and to assess the potential risks facing firms if consumers alter their behaviour following food safety scares. In most cases, consumer behaviour is significantly changed by negative information concerning the safety of food. Consumers may tend to avoid purchasing food from the entire industry or avoid purchasing a specific product that is declared unsafe for consumption. Thus it is vital to ensure that consumers receive the correct information about the food industry, especially when a food safety scare occur.

This study used applied behavioural and experimental economics to analyse how SA consumers behaved after the *Listeria* outbreak. Behavioural economics (BE) is a specific economic technique used to analyse human behaviour with psychological insights to explain economic decision-making. Psychology has helped economists overcome the narrow concept of the homo economicus, which implies that consumers are regarded as rational, calculating, acting in their self-interest and never making systematic mistakes (Cartwright, 2011; Frey and Stutzer, 2007). Behavioural economics also tests the standard economic model on humans, seeing when it works and when it does not, asking whether it can be tweaked or given an overhaul to better fit what we observe. In short, behavioural economics seeks to explain the reality of marketing using human behaviour and psychology to test and tweak or overhaul the standard economic model (Cartwright, 2011). BE can be applied in different approaches such as game theory, experimental economics, bounded rationality or research on cognitive biases. This study will use experimental economics and game theory.

1.2. Problem statement

We have previously discussed that a food safety scare does not only affect the mortality rate but it also causes social disruption in the market for the implicated products. Consumer behaviour towards the implicated product and the product brand is also severely affected during and after the outbreak. To date, most researchers have focused on consumer's food safety attitudes and perceptions towards different food products, especially implicated products during the outbreak, but very few studies have successfully assessed and quantified consumer behaviour after foodborne disease outbreaks in the world. As a result, we currently lack an understanding of the long-term consequences of foodborne diseases on consumer behaviour after a food safety scare such as outbreaks associated with dangerous pathogens. One study conducted by Talley *et al.* (2021), quantified the impact of consumer behaviour on foodborne diseases using a compartment model. Based on their results, food safety risks increase as the consumer purchasing frequency increases for each food type because of increased exposure to contaminants. Also, with high food safety risks associated with the product or brand, consumers tend to change their purchasing behaviour towards that product or brand.

From July 2017, SA experienced one of the largest *Listeria* outbreaks globally due to the consumption of contaminated polony. The source of the *Listeria* outbreak was identified in March 2018 and the implicated product was recalled and removed from the public after the recall. By the time the implicated product was recalled and removed, SA already had faced a high mortality rate and substantial economic losses. Due to the removal of the

implicated products and consumer awareness of the outbreak, the consumption of the implicated product significantly decreased until the outbreak was no more. In September 2018, it was announced that the outbreak was over. But after the end of the *Listeria* outbreak, the question remained, to what extent did the foodborne disease outbreak change SA consumers' behaviour towards the implicated product, and how did it affect their attitudes, trust and perceptions towards the implicated product after the implicated product was announced safe again to consume and back to the retail market. To date, no studies have been conducted to assess the consumer post response or behaviour after the *Listeria* outbreak in SA.

Currently, South Africa is regaining its reputation towards the safety of processed meat products such as polony, viennas and ham in the global and domestic markets. Since the market is consumer-orientated, the study focused on analysing consumer behaviour through behavioural economics and game theory. The consumer response to the *Listeria* outbreak in SA was noticeable and reasonable. However, the post food scare effects are still predicted and not certain to what degree the outbreak affected rational decisions of consumers when buying processed meat products, especially the implicated ones. According to Hanson *et al.* (2012), the full extent of the burden and cost of unsafe food is currently unknown, but its impact on global health, trade and development is considered to be immense. Thus, it is vital to capture the consumers' response towards the implicated products after the outbreak and quantify South African consumers' level of trust towards processed meat products after the *Listeria* outbreak.

1.3. Research objectives

The main aim of the study is to assess consumer behaviour after the implicated products was announced safe to consume and back in the retail market in South Africa. This will be achieved by analysing the three following objectives:

- **First objective**: Examine possible influences of negative and positive or balanced information about the SA *Listeria* outbreak on consumer's willingness to pay (WTP) for RTE meat products. If the negative information has more significant influence on consumer behaviour then a decrease in WTP is expected, and vice versa.
- **Second objective:** Determine if consumer behaviour towards the implicated products is affected by the 2017/2018 *Listeria* outbreak after the implicated product was safe to consume and back in the market. We expect that rational[4] consumers do not change their behaviour towards the implicated products after the *Listeria* outbreak.

[4] In the situation of rational choice or decision, information, beliefs and personal analysis are optimal, i.e., the estimates of probabilities are easily realisable, humans have all the information about all possible alternatives, complete and consistent system of preferences that allows one to do a perfect analysis or that guarantees the optimum chosen alternative (Hernandez and Ortega, 2019).

- **Third objective:** Identify the most critical internal factors[5] influencing consumers' behaviour when making economic decisions on implicated products after the foodborne outbreak. Truth is expected to be the essential internal factor that significantly influences the consumer behaviour after the outbreak.

1.4. Data and methodology

This study targeted both student and non-student participants who reside, study, or work in Stellenbosch, located in the Cape Winelands District. The total respondents consisted of 111 participants with 32% of the total population sample being students and 68% of the total sample belonging to the working-class population. About 41% of the total sample population consisted of consumers earning between R0 and R4 999, 31% of the total sample population consisted of consumers earning between R5000 and R14 999. About 28% of the total sample population consisted of consumers earning more than R15 000 per month. The difference in income earnings after tax is one of the important variables that was closely evaluated to see if income has a direct impact on the change in behaviour for RTE meat products after the *Listeria* outbreak in SA. Also, of interest was to determine whether participants with children had a significant change in purchasing behaviour compared to those without children. Fortunately, more than 50% of the total population sample had children under 18 years.

The 111 participants were part of the study that used both behavioural economics and game theory to analyse the objectives as mentioned above. Behavioural economics is a specific economic technique used to analyse human behaviour with psychological insights to explain economic decision-making (Cartwright, 2011). Most of the sub-fields in behavioural economics focus on strategic interactions between people and use the traditional game theory (TGT) tools as the starting point of analysis (Braddeley, 2019). There are several methods used in behavioural game theory, but it was decided to use experimental economics as it is the most appropriate to generate close to real WTP results for this study. According to Kalish and Nelson (1991), WTP refers to the maximum amount of money a consumer would pay for a specific set of product attributes.

Experimental economics is a method of creating empirical data in a controlled environment. The participants are addressed as subjects in an economic experiment, and each subject is given a monetary incentive to make actual decisions. The data is collected either in experimental sessions or a field through games, questionnaires or traditional field studies. According to Frey and Stutzer (2007), the distinct advantages of lab experiments lie mainly in the possibility of controlled intervention for causal inference, which enables the detection of anomalies and the understanding of the content of human preferences. To report on causation, a proper counterfactual is needed, and it can be constructed by propensity score matching (PSM), instrumental variables (IV) estimation, natural experiments and controlled experiments (Harrison and List, 2009). Controlled experiments, including laboratory and field experiments, represent the most effective method of creating the counterfactual since they directly

[5] Internal factors may disrupt the relationship between intentions and behaviour when purchasing RTE meat products. The analysed internal factors include knowledge, trust, salience, fear of negative social evaluation and shopping habits that consumers might have before deciding to purchase or consume the implicated products during and after the foodborne disease outbreaks.

construct a control group through randomisation (Harrison and List, 2009). However, the field experiment occupies an important middle ground between lab experiments and natural occurring field data (List, 2008).

This study used a field experiment to collect the necessary data. Field experiments are randomised experiments conducted in a natural setting and not in a lab. They are categorised into three main types, which include artefactual, framed and natural field experiments. Amongst the three types of field experiments, it was decided to use a framed field experiment to collect the data successfully. The framed field experiment uses either students[6] or a non-standard subject pool (e.g., working population) in a study created with a field context from a specific commodity, stakes, task or information set that subjects or participants can use to make a decision (Harrison and List, 2009). The field context in this study experiment was attached to 500g viennas with the provision of negative and positive information about the *Listeria* outbreak in SA. This type of field experiment was used because it allows designs or manipulations of real-world markets with interesting economic phenomena that can influence participants' behaviour.

The experimental game theory chosen for the study is the Vickrey fourth-price auction used to collect WTP data. According to Li *et al.* (2017), the Vickrey fourth-price auction is a variant of the second-price auction, where the highest bidder wins and pays the second highest price of the product to receive the product auctioned. On the other hand, the Vickrey fourth-price auction enables the three highest bidders to win the auction and pay the fourth-highest price for the product to receive the product auctioned. After the bidding experiment, a survey and evaluation were conducted to collect information based on demographic characteristics, shopping habits with regards to the purchasing of RTE meat products, knowledge or attitude about food safety, salience (main consumer views or opinion on RTE meat products), South African *Listeria* outbreak in 2017/2018, fear of negative social evaluation, the level of trust for the implicated and closely related products. The survey, evaluation and experimental game were facilitated through an oTree open-source platform for social science experiments (Chen *et al.*, 2016).

In order to analyse the three objectives as mentioned above, two models were used, namely, the Tobit regression model and the integrated model of behavioural prediction (IMBP). The first possible influences of negative and positive or balanced information about the SA *Listeria* outbreak on consumer's willingness to pay (WTP) for RTE meat products and the second objective determined consumer behaviour towards the implicated products after the food safety scare in SA examined. Both first and second objective used the WTP and questionnaire to observe any changes after the *Listeria* outbreak. Firstly, the WTP data was compared between the rounds to observe any variations and if there is a difference. The Tobit regression model was used to further determine significant variables that may explain the variation between rounds. It also showed how much of the impact each variable had on the WTP differences. The Tobit regression models were conducted using R software.

[6] Students are considered the standard subject pool in experimental economics (Exadaktylos *et al.*, 2013; Harrison and List, 2009).

The third objective identified the most critical internal factors influencing consumers' behaviour when making economic decisions on implicated products after the foodborne outbreak. In order to identify the critical internal factors, the IMBP conceptual framework and partial least squares structural equation modelling (PLS-SEM) was used. IMBP addressed by Lagerkvist and Okello (2015) suggests that intentions, environmental constraints such as situational factors, interpersonal dependence and personal skills are necessary and sufficient to moderate the intention-behaviour relationship. The conceptual framework for the IMBP further discussed and illustrated in Chapter 2. The WTP data along with the questionnaire and evaluation sheet data was used to formulate appropriate variables or indicators that represent knowledge, salience, intentions of purchasing, environmental constraints, trust and shopping habit as indicated in the IMBP conceptual framework. These variables or indicators were further analysed through the SmartPLS software using the PLS-SEM. The PLS-SEM consists of a structural model representing the structural path between the constructs and the measurement model describing the relationships between the construct and its associated indicators. This model assisted in determining the relationship between trust, knowledge, salience (main consumer views or opinion on RTE meat products), fear of negative social evaluation, intention to purchase, shopping habits and the WTP data in all rounds of the auction. This showed how behavioural factors other than real intentions play a role in determining the WTP for implicated products after the outbreak.

1.5. Delimitation of the study

The Western Cape Province was one of the provinces with the highest reported cases of *Listeria* during the outbreak, with about 136 reported cases and 32 deaths. About 90% of *Listeria* cases during the outbreak were reported in the Cape Metropole District in Western Cape Province (Western Cape Department of Health (WCDH), 2017). Although the Cape Metropole District was an area in the Western Cape with the greatest number of *Listeria* cases reported, other areas also reported the *Listeri*a outbreak associated with RTE meat products. According to Davids (2018), Shoprite Group in the Cape Winelands District recalled Farmer's Deli 500g and 1 kg red viennas with *Listeria* during the outbreak. Since the Cape Winelands District was also affected to some extent, this study limited its focus to people residing or working in the Cape Winelands District within the Western Cape Province. The study was not extended to the Cape Metropole District due to limited resources. The methodology of this study was challenged by the coronavirus disease (Covid) pandemic in 2020. As a result, some methods to collect data were adapted to limit physical human interaction and mitigate the risk of Covid transmission. The initial intention was to collect data in a lab setting, where all the participants or subjects were expected to be physically present in a computer lab to participate effectively, but this was not possible because of Covid. Instead, this study opted for a frame field online experiment setting. The Zoom communication platform was used to engage with participants and allowed them to further participate independently in the auction experiment, survey and evaluation, at their place of work, institution or home through online platforms.

1.6. Outline of the research

Chapter 1 provides the introduction of this study, where it briefly explains the study background, problem statement, research objectives, data and methodology, and the delimitation of the study. Chapter 2 provides an overview of the modern food safety industry, the history of behavioural economics and how it has shaped today's mainstream economy, explains the use of applied behavioural game theory intensively, and the experimental auctions to determine the willingness to pay. Lastly, this chapter also provides a brief explanation of models that can evaluate the intention-behaviour relationship in humans when making economic decisions. Chapter 3 explains the target population for this study, the experimental structure design of the Vickrey fourth-price auction, and provides the procedures used to conduct the whole experiment. Chapter 4 explores the socio-economic profile of the study participants. Chapter 5 discusses the detailed results from the Vickrey fourth-price auction, survey and evaluation sheet. Chapter 6 is the last chapter, where the study's significant findings, possible shortcomings, and recommendations for future research are discussed.

CHAPTER 2

2. Literature review

2.1. Introduction

This chapter focuses on the scientific literature on food safety and foodborne disease outbreaks. It also expands on the history of behavioural economics, methodologies regarding ready-to-eat (RTE) meat products, and measures willingness to pay (WTP) for food, specifically processed meat products. Food safety is a global issue, and both the public and private sector plays a significant role in responding to any problems associated with food safety. Public and private institutions usually establish laws, regulations and standards to set the baseline level of food safety (Wongprawmas and Canavari, 2017). However, food can never be entirely safe since it is afflicted by numerous pathogens that cause various foodborne diseases, algal toxins and fungal toxins (Borchers *et al.*, 2010). Thus, government and private food agencies must monitor the food supply chain for these pathogens and determine the human health risks associated with the exposure of these pathogens. Food safety is one of the most relevant determinants of consumer food demand. When food products are perceived unsafe, consumers' change their behaviour, which is most likely reflected in their WTP premiums (Sckokai *et al.*, 2014).

2.2. Food safety and foodborne disease outbreaks on ready-to-eat (RTE) meat products

2.2.1. Food safety challenges in the 21st century

As defined by the FAO (1996), food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life[7]. Therefore, food security does not merely mean that there is enough food accessible to all people, but it must also be safe for consumption. Food security, by definition, has four pillars: food availability, accessibility, utilisation, and stability (Charlton, 2016). **Figure 2.1** below broadly explains each pillar of food security. If one of the pillars are compromised, nations will potentially experience more poverty, have lower agricultural productivity, increased unemployment, inadequate infrastructures, unsafe food, and so on.

[7] The most commonly used food security definition adopted at the 1996 World Food Summit. However, by the turn of the millennium the concept of social access was added to the definition (Vink, 2012). This definition includes the elements of access, affordability, safety and choice for all people (McGill, 2009).

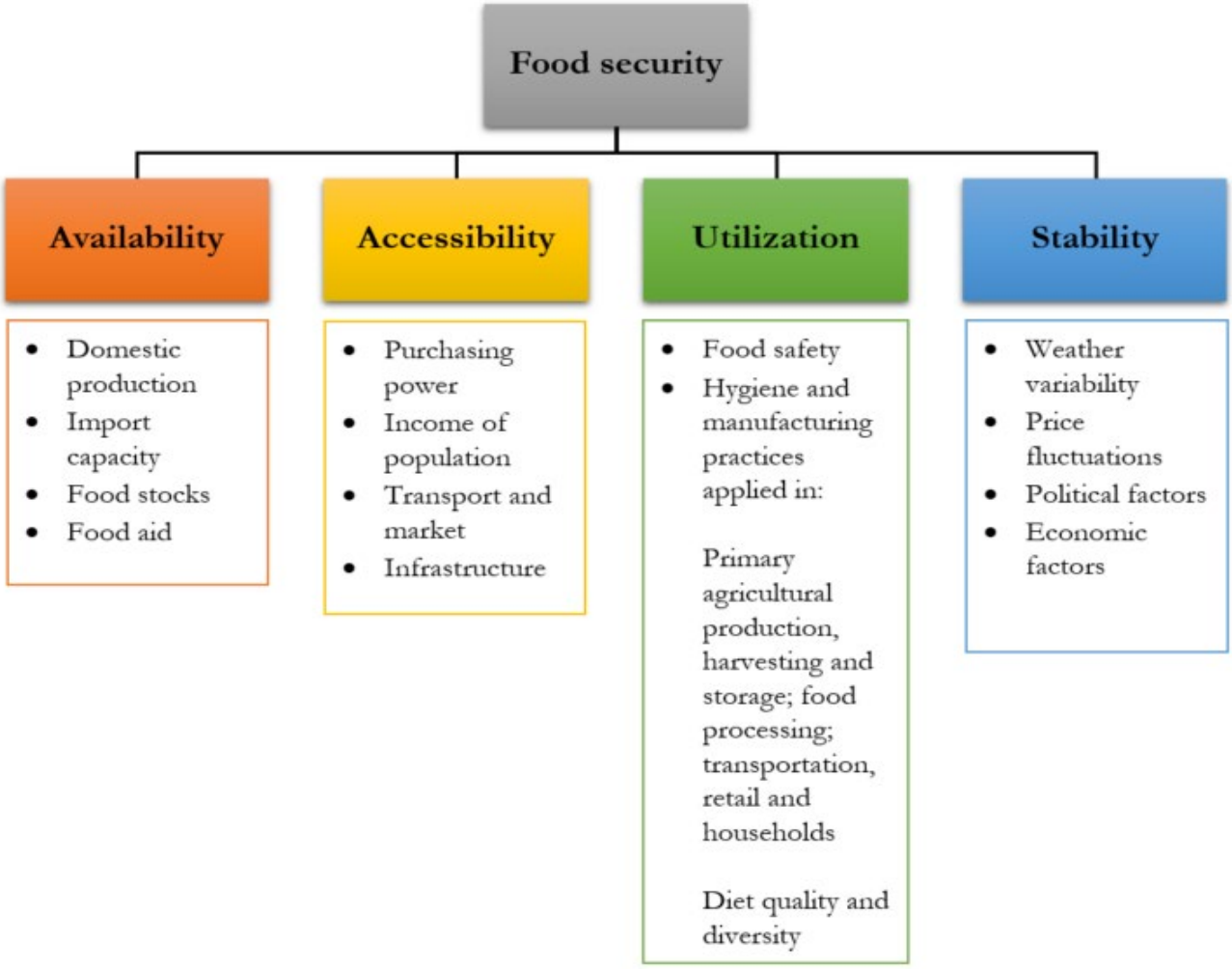


Figure 2.1 - Four pillars of food security

Source: *Charlton (2016)*

Outbreaks due to microbiological contamination directly impact food security since one of the pillars in **Figure 2.1** emphasises utilising safe food for consumption. Thus there is no food security without food safety. Early humans adopted safe food requirements through hunter-gatherer activities, where they preserved their food through cooking and drying. Barley production flourished for more than 18 000 years in the Egyptian Nile Valley because ancient farmers preserved the grain by keeping it dry to avoid fungal spoilage (Forsythe, 2010). Other than drying, early prevention and preparation techniques include adding honey and olive oil. Salt became a significant commodity given its preservative capability. The scientific approach of food preparation began in 1795 by Nicholas Appert, where he used a wide mouth glass bottle that was sealed with a cork and boiled for 6 hours. Durand suggested using tin cans instead of glass bottles in 1810. After thermal processing was introduced, Louis Pasteur and Robert Kock explained the rationale behind food microbiology. Between 1854 and 1864, Louis Pasteur demonstrated that the bacteria were the causative agents of food spoilage and disease (Forsythe, 2010). Since discovering thermal heating, many food processes have adopted pasteurisation with appropriate standards to reduce or eliminate pathogens and other spoilage organisms.

Various food preparation techniques mentioned above have shown that they do not wholly guarantee food safety but reduce the available bacterial counts to an acceptable level of risk to a mixed population or a specific subgroup. According to Wallace *et al.* (2011), food safety management practices have been evolving continually in the food industry since the end of World War II in 1945. Several food safety innovations, such as mechanical refrigeration was developed and widely used. The mechanical refrigeration provided relatively uniform and steady cold temperatures to reduce food spoilage and potential food safety incidents. The use of mechanical refrigeration was quickly extended to most homes, retailers and refrigerated transportation. Refrigerated transportation was greatly assisted by constructing modern rail, highway systems, ocean liners and aeroplanes to transport perishable foodstuffs, frozen foods and ingredients across the ocean or any geographical barriers (Wallace *et al.*, 2011). Such developments replaced the local food production systems with an extensive and complex global food supply chain. As a result, various foods and food ingredients are easily accessible in most countries using international food transportation (Wallace *et al.,* 2011; Whitworth *et al.,* 2017).

Long and complex globalised food supply chains limits traceability and often involve multiple stakeholders who do not have or keep detailed information of each process and procedure along the supply chain (Sivadasan *et al.,* 2006). As a result, quick identification of the food scare sources becomes problematic and causes a dramatic increase in foodborne disease outbreaks (Wallace *et al.,* 2011; Whitworth *et al.,* 2017). The factors involved in spreading pathogens and extending their traditional ranges include the changes in land use or agricultural practices, changes in human demographics and society, poor population health and failure of public health programs, pathogen evolution, contamination of food sources and water supplies, modern and globalised transportation system, changing climate and weather patterns, poverty and lack of political will (Woolhouse and Gowtage-sequeria, 2005). Demographic changes, environmental hazards, social and behavioural factors, scientific and technological progress are the major evolving factors shaping 21st century food safety (Kaferstein and Abdussalam, 1999).

Within two decades, the human population will reach 8.5 billion, about 80% of which is expected in developing countries (WHO Advisory Committee on Health Research, 1997). People over 60 years are predicted to increase from 17% in 1999 to 25% by 2025 in developed and developing countries (Kaferstein and Abdussalam, 1999). This tremendous increase in population will cause serious food security and safety problems, environmental degradation, large-scale urbanisation, and significant changes in the ecosystems (Kaferstein and Abdussalam 1999). Such demographic characteristics will most likely lead to acute socio-economic problems and the emergence of many people with decreased life expectancy rates due to reduced resistance to foodborne diseases.

As for environmental hazards, climate change significantly increases foodborne infections and intoxications since extreme temperatures or favourable conditions substantially increase infectious pathogens. According to Kaferstein and Abdussalam (1999), a substantial increase in foodborne diseases have been reported in temperature regions experiencing long hot summers. Shonhiwa *et al.* (2017) indicated that in South Africa, most of the foodborne disease outbreaks were reported in warmer months and *Salmonella* species are the most commonly

isolated bacterial pathogens. Agricultural chemicals and industrial waste are most likely to be used extensively in the next few decades, given the pressure of population increase. Still, the consequences could be severe, especially in people with reduced resistance to diseases due to malnutrition in developing countries (Kaferstein and Abdussalam, 1999).

Behaviour and lifestyle have a strong bearing on foodborne diseases. Foodborne diseases are quite prevalent in both rich and poor societies. Poverty can be expected to be the principal challenge to equal health care, including controlling foodborne diseases (Kaferstein and Abdussalam, 1999). Affluent consumers generally demand minimally processed foods with long shelf lives, no artificial preservatives, low salt and sugar contents. They also have increased their consumption of shellfish and raw foods (Hollingworth, 1996). Such a risky practice leads to a vast range of pathogens that are likely to multiply to dangerous levels in extreme conditions such as high salinity, acidity, even at refrigerator temperature, and the probability of infection and intoxication increases. According to Palumbo (1986), some emerging foodborne pathogens can show competitive growth at extreme temperatures above 50 ^{0}C and below 0 ^{0}C in foods. These include *Clostridium botulinum* type E, *Yersinia enterocolitica*, enterotoxigenic *Escherichia coli*, *Listeria monocytogenes*[8] and *Aeromonas hydrophilia*. Thus, refrigeration is insufficient to keep food safe from emerging foodborne pathogens with increased survivability. Marginalised, low-income and middle-income consumers typically consume processed products that are relatively cost-effective and convenient.

As listed in **Table 2.1** below, most food products are susceptible to these pathogens, and increased consumption of these products increases the risks associated with foodborne disease outbreaks; this is alarming because products such as fish or seafood, eggs, vegetables, fruits, meat, milk, and dairy are extensively consumed worldwide. The consumption of seafood and freshwater fish has increased significantly worldwide since the 1960s, and the seafood market is expected to continue rising faster than any other fish category towards 2050 (Kearney, 2010). According to Ritchie and Roser (2019), the global production of fish and seafood has quadrupled over the past 50 years, and the average person now eats almost twice as much seafood compared to half a century ago. Kearney (2010) stated that the levels of egg consumption had doubled worldwide, with more increase in developing countries compared to industrialised countries. Meat products such as sausages, burgers, pork pies and so on, account for almost half of all the meat consumed in developed countries. The per capita consumption of milk and dairy products is higher in developed countries. The demand for milk and dairy products in developing countries grows with income, population growth, urbanisation and diet changes. Over six million people worldwide consume milk and dairy products, most of whom are in developing countries (FAO, 2020). As much as the consumption increases rapidly for these products, an increased foodborne disease outbreak due to re-emerging or emerging pathogens in the food industry should be expected.

The list of pathogens in **Table 2.1** below are not the only pathogens that are a threat to food safety. Food safety professionals have identified approximately 1 407 species of human pathogens, of which about 816 are zoonotic,

[8] *Listeria monocytogenes* grows at temperatures as low as 3 ^{0}C where it can multiply in refrigerated foods and greatly resists the deleterious effects of freezing, drying and heat (Forsythe, 2010).

and more than 130 are classified as emerging or re-emerging bacteria or viruses (Wallace *et al.*, 2011; Woolhouse and Gowtage-Sequeria, 2005). The number of human pathogens is still increasing, and they are mainly driven by the changes in climate, ecosystems and globalisation. These are signals that we require new and advanced specific control measures to mitigate and reduce pathogens that can be detrimental to human health. Currently, the technological advancements that are in use in the food industries to reduce food safety hazards include pulsed electric fields and ultra-high pressure treatments, electronic, real-time and continuous critical control point monitoring systems, laboratory detection equipment for chemical analysis, rapid methods for microbiological testing and effective communication systems (Wallace *et al.,* 2011). Furthermore, the large-scale use of solar power as a non-polluting, low-cost renewable energy source should help to increase food safety in some parts of the world by making cheap energy for refrigeration more widely and readily available (Kaferstein and Abdussalam, 1999). Unfortunately, with all the technological advances, globalisation, and economic and environmental conditions, the number of foodborne diseases from developed and developing countries increases.

Table 2.1 - Common pathogens with susceptible food products and recent outbreaks.

Name of pathogens	Products susceptible	Recent outbreaks	References
Campylobacters	Chicken, beef, raw milk, hamburger, cheese and cake icings, untreated water, pork, clams, shellfish and eggs.	From 2010 to 2017, USA reported 236 foodborne *Campylobacters* outbreaks with about 2 381 illnesses. The major food sources associated with the outbreaks were poultry and dairy.	CDC (2019a)
Salmonella	Poultry, meat, chocolate, milk and dairy products, eggs, vegetables, fruits, peanuts, fish and shellfish.	On the 18th January 2019 in France, a cluster of four *Salmonella enterica* serotype Poona (*S*. Poona) were identified in infants' formulas.	Jones *et al.* (2019)
Escherichia coli O157:H7	Beef (particularly ground beef), poultry, raw milk, vegetables and cantaloupe, apple cider, hot dogs, mayonnaise and salad bar items.	About 210 cases were reported due to the contaminated romaine lettuce grown in California region in 2018. About 27 states in USA were affected with about 96 hospitalised and five deaths.	Luna-Guevara *et al.* (2019)
Shigella	Salads, bakery products, sandwich filling, milk and dairy products, vegetables and poultry.	Contaminated asparagus caused *Shigella flexneri* type 3a infections to wedding attendees in Oregon on the 11th of August 2018. About 112 attendees were infected but no deaths.	Marler (2019)
Listeria monocytogenes	Ground meat, poultry, seafood, vegetables, soft-ripened cheese, pâté, poultry, beef , dairy products, hot dogs, potato salad	On the 9th of March 2020 enoki mushrooms from Sun Hong Foods, Inc. was contaminated. About 36 people were infected and 4 deaths were reported.	CDC (2020)

Yersinia enterocolitica	Pork products, cured meat, milk and dairy products.	In Sweden and Denmark, a cross-border outbreak of *Yersinia enterocolitica* occurred in April 2019. The outbreak was associate with imported fresh spinach. A total of 57 cases were confirmed, about 37 from Sweden and 20 from Denmark.	Espenhain *et al.* (2019)
Clostridium species	Meat, seafood, beans, meat stew, meat pies, turkey and chicken gravies, seafood, canned and fermented goods.	On the 27th of June 2019, athletes in an athletic event hosted in Northern Greece contracted *Clostridium perfringens* through the consumption of minced beef meat.	Mellou e*t al.* (2019)
Streptococcus species	Milk, ice cream, eggs, steamed lobster, ground ham, potato salad, egg salad, custard, rice pudding and shrimp salad.	In September 2016, 140 patients from a school dormitory in Japan were infected by *Streptococcus dysgalactiae* subspecies. A broccoli salad was the source of this foodborne disease.	Yamaguchi *et al.* (2018)

2.2.2. Foodborne disease outbreaks associated with ready-to-eat (RTE) meat products

The safety of meat and meat products has faced many challenges associated with microbial pathogens, which has raised several concerns in the 21st century. There are various non-biological food concerns, such as food additives, chemical residues and genetically modified organisms associated with meat and meat products. However, the bacterial pathogen is the most severe meat safety issue resulting in foodborne diseases, which affect the country's economic, social, and environmental aspects (Sofos, 2008). Foodborne diseases have changed drastically because of the discovery of new emerging pathogens, and the previously recognised pathogens increase in occurrence. As indicated in **Table 2.1**, various food items can serve as sources of foodborne diseases, but meat and meat products remain the most common source of foodborne pathogens (Nørrung *et al.,* 2009; Todd, 1997). Changes in animal production can potentially explain this; examples include product processing and distribution changes and increased international trade. These changes, in conjunction with increased global meat consumption, together with changes in consumer preferences, contributes to increased meat-related food risk (Kačániová *et al*., 2015; Heredia and García, 2018). According to Nørrung *et al.* (2009), the most frequent chain of events leading to foodborne diseases involves food animals which are healthy carriers of pathogens that are subsequently transferred to humans through production, handling and consumption of meat or meat products.

Common pathogens associated with fresh meat products are non-Typhi serotypes of *Salmonella, Campylobacter* species*,* Shiga toxin-producing strains of *Escherichia coli O157:H7* as well as other enteric pathogens, whose primary reservoirs are food-producing animals (Rhoades *et al.,* 2009; Heredia and García, 2018; Sofos, 2008; Zhao *et al.,* 2001). These pathogens cause mild and moderate self-limiting gastroenteritis, invasive diseases and may lead to more severe cases of illnesses (Zha*o et al*., 2001). *Salmonella, Campylobacter,* and *Escherichia coli* colonise the gastrointestinal tracts in various wild and domestic animals, especially in animals raised for human consumption (Aldsworth *et al*., 2009; Meng and Doyle, 1998). Salmonellosis is ranked as one of the most frequently reported foodborne diseases worldwide, accounting for about 93.8 million foodborne diseases with 155 000 deaths per year worldwide, and it causes invasive infections as well as reactive arthritis (Forsythe, 2010; Meng and Doyle, 1998; Heredia and García, 2018). According to Brandwagt *et al.* (2018), a *Salmonella Bovismorbificans* outbreak associated with the consumption of uncooked ham products occurred in October 2016 in the Netherlands. From October 2016 to March 2017, about 54 cases were identified, and the source was traced back to a Belgian meat processor (Brandwagt *et al*., 2018). Most infected people reported mild cases of diarrhoea, stomach pain, fever and others were admitted to the hospital due to the severity of their illnesses (Brandwagt *et al.,* 2018).

Pathogenic strains of *E. coli* are categorised according to clinical symptoms and mechanisms of pathogenesis into several groups that vary in their incubation periods and duration of illness (Aldsworth *et al*., 2009; Forsythe, 2010). *E. coli* strains consists of entero-invasive *E. coli* (EIEC), entero-toxigenic *E. coli* (ETEC), entero-aggregative *E. coli* (EAEC), diffusional adherent *E. coli* (DAEC), entero-pathogenic *E. coli* (EPEC) and entero-haemorrhagic *E. coli* (EHEC) (Aldsworth *et al*., 2009; Forsythe, 2010). EHEC is recognised as a major foodborne pathogen, whilst others are associated primarily with transmission through water and human contact (Aldsworth *et al*., 2009; Forsythe, 2010). The EHEC consists of several serotypes, including the most common *E. coli* Ol57:H7 serotype

in reported foodborne disease outbreaks globally. *Escherichia coli* O157:H7 can cause bloody diarrhoea and haemolytic uremic syndrome (Aldsworth *et al.*, 2009; Forsythe, 2010; Meng and Doyle, 1998; Heredia and García, 2018; Zhao *et al.*, 2001). *Escherichia coli* O157:H7 outbreak occurred in October 2016 due to uncooked minced meat cutlets (mixture of minced beef, pork, onions and eggs) sold frozen in Japan's supermarkets (Furukawa *et al.,* 2018). About 61 patients and 17 asymptomatic cases of EHEC O157:H7 infections were confirmed (Furukawa *et al.,* 2018).

Campylobacter species are the primary cause of human bacterial gastroenteritis, resulting in 400-500 million cases worldwide each year (Forsythe, 2010; Igwaran and Ifeanyi, 2019). Foodborne diseases caused by *Campylobacter* species have been linked to severe neurological disorders such as Guillain-Barre syndrome and Miller-Fischer syndrome (Forsythe, 2010). Other severe conditions caused by *Campylobacter* species include bloody intestinal diarrhoea, oesophageal diseases, periodontitis, celiac disease, cholecystitis and colon cancer (Heredia and García, 2018). Whitworth (2020) reported a recent *Campylobacter* outbreak occurred in 2019 due to the consumption of poultry meat in Denmark. About 88 patients had a *Campylobacter jejuni* infection with the exact clone belonging to sequence type ST122.

Listeria monocytogenes (also refered to *L. monocytogenes* or *Listeria*) has been regarded as the pathogen of concern in ready-to-eat (RTE) meat products exposed to post-processing contamination and environment that supports the organism's growth during storage (Kurpas *et al.*, 2018; Lambertz *et al.*, 2012; Sofos, 2008). RTE meats can be eaten without any further preparation. Their processing includes one or more pathogen control steps to make the products safe for consumption without further processing or cooking by the consumer (Gilbert *et al.,* 2009). The processed RTE meats can be sourced from beef, pork, lamb, poultry and mixed species. **Table 2.2** below categorise different types of RTE meats and specify their microbial control to keep them safe for consumption.

Table 2.2 - Types of processed ready-to-eat meats

Processed RTE meat type	Examples	Microbial control
Raw cured shelf stable meats	Raw ham, sausages and salami.	Low water activity (curing and/or drying) or low pH.
Dried meats	Biltong and beef jerky.	Low water activity.
Cooked perishable uncured meats	Roast beef and other cooked meats not reheated before consumption.	Cooking
Cooked perishable cured meats	Cooked ham, pastrami, silverside, corned beef, frankfurters and pâté.	Cooking, preservatives (sodium nitrite) and refrigeration.

Source: Gilbert et al. (2009)

Several studies have shown that different kinds of RTE meat products are the primary vehicle for transmitting *Listeria monocytogenes* pathogen to consumers (Forsythe, 2010; Hoelzer *et al.,* 2012; Kačániová *et al.*, 2015). According to Chen and Nightingale (2013), the common presence of *L. monocytogenes* in nature and production systems

presents a significant challenge to the ready-to-eat (RTE) food industry since *Listeria* can easily be transmitted from these environments into the food supply chain. **Table 2.3** below shows several recent outbreaks associated with *L. monocytogenes* isolated from different RTE meat products.

Table 2.3 - Recent *Listeria monocytogenes* outbreaks associated with RTE meat products

Year	Country	Ready-to-eat Contaminate food	Reported cases and deaths	Reference
2016	Italy	Sliced beef ham	Students and staff members from two different schools were affected. More than 100 cases were reported and about five hospitalised.	Maurella *et al.* (2018)
2017-2018	South Africa	Polony	About 1 060 reported cases and about 216 reported deaths.	NICD (2018)
2017-2019	Netherlands	Multiple RTE meat products including boiled and raw sausages.	About 16 reported illnesses and three reported deaths.	ECDC-EFSA (2019); Whitworth (2019)
2019	United States	Pork patty rolls	About four reported cases.	CDC (2019b)
2019	Spain	Chilled roasted pork meat	About 222 reported cases, three deaths and six miscarriages.	WHO (2019c)
2019	United States	Deli-sliced meats and cheese	About ten reported illnesses and one reported dearth.	CDC (2019c)

Currently, there are more than six identified species within the *Listeria* genus (Weller *et al.*, 2015). Amongst the *Listeria* species, only *L. monocytogenes* impose a significant threat to public health since they affect humans and ruminants (Guillet *et al.,* 2010; Lianou *et al.*, 2017). According to Forsythe (2010), *L. monocytogenes* has been found in at least 37 mammalian species, both domestic and feral, with at least 17 species of birds, some fish and shellfish species. It is regarded as the most dangerous foodborne pathogen with a high mortality rate between 20% and 30% (Forsythe, 2010; Montero *et al.,* 2015; Muhterem-Uyar *et al.,* 2015; Swaminathan and Gerner-Smidt, 2007). It

can be isolated in various environments, including silage, decaying vegetation, soil, sewage, drains in food production units, fresh and seawater (Aldsworth *et al.*, 2009; Forsythe, 2010; Tchatchouang *et al.,* 2020).

Listeria species are gram-positive, rod-shaped bacteria that do not produce endospores, facultative anaerobic bacteria, and survive in extreme environmental conditions (Aldsworth *et al.*, 2009; Forsythe, 2010; Kurpas *et al.,* 2018; Tchatchouang *et al.,* 2020). It can survive in environments with a high concentration of salts of up to 10%, a wide temperature range, pH between 4 and 9.4 and water activity ≥ 0.92 (Forsythe, 2010; Lianou *et al.*, 2017; Tchatchouang *et al.,* 2020). They use flagella[9] to move at specific temperatures, grow between 0 ^{0}C and 42 ^{0}C, but their optimum growth temperature is between 30 ^{0}C and 35 ^{0}C (Aldsworth *et al.*, 2009; Forsythe, 2010). *L. monocytogenes* is further divided into 13 serotypes, and most of the foodborne outbreaks are caused by 1/2a, 1/2b and 4b serotypes (Aldsworth *et al.*, 2009; Forsythe, 2010; Montero *et al.,* 2015; Swaminathan and Gerner-Smidt, 2007). Most outbreaks are associated with 4b serotypes (Chen and Nightingale, 2013; Swaminathan and Gerner-Smidt, 2007). Pregnant females, elders and people with weak immune systems are at the most significant risk when consuming foods contaminated with *L. monocytogenes* (Forsythe, 2010; Montero *et al.,* 2015; Muhterem-Uyar *et al.,* 2015). It can cause acute symptoms and chronic complications such as influenza, fever, severe headache, vomiting, nausea, sometimes delirium or coma, septicaemia in pregnant women, foetuses or neonates, internal or external abscesses, meningitis and sepsis (Aldsworth *et al.*, 2009; Forsythe, 2010; Muhterem-Uyar *et al.,* 2015; Swaminathan and Gerner-Smidt, 2007; Tchatchouang *et al.,* 2020).

L. monocytogenes can survive in freezers, warehouses, vacuum-packed food and surfaces in processing plants that contact food or uncooked products (Gómez *et al.*, 2014; Lambertz *et al.*, 2012). The major steps for RTE meat production include farms, slaughterhouses, manufactures, shops, restaurants and transportation of these products and their ingredients between these places (Kurpas *et al.*, 2018). Each step has possible sources of *L. monocytogenes* contamination. The contamination of final products usually occurs in processing plants or at the retail level and less often from food-producing animals (Hellström *et al.*, 2010). Swaminathan and Gerner-Smidt (2007) stated that *L. monocytogenes* readily produces biofilms that helps it to survive for prolonged periods in food production plants and can survive up to ten years in the production environment. If the food processing step does not include a heat treatment or another curing action, *L. monocytogenes* can remain in the finished products (Gilbert *et al.,* 2009). Given its ability to adhere to a wide range of materials commonly used in the food processing facilities, *L. monocytogenes* can establish persistent contamination on food-processing equipment and other areas due to the increased resistance to routine cleaning and disinfection procedures (Lunden *et al.,* 2002). *Listeria* species and other gram-positive bacteria usually show frequent resistance to antibiotics with the ability to transfer genetic information from one species to another through various mechanisms (Balsalobre and Hernández-Godoy, 2004). According to Gómez *et al.* (2014), the application of antimicrobial agents is jeopardised by the emergence and spread of microbes resistant to affordable and first choice antibiotics. According to Swaminathan and Gerner-Smidt (2007), isolates

[9] When *L. monocytogenes* grows at 20 ^{0}C or less it has peritrichous flagella and swims with a characteristic tumbling motion and when growing at 37 ^{0}C it does not produce flagella (Aldsworth *et al.,* 2009).

of *L. monocytogenes* are naturally susceptible to penicillin, aminoglycosides, trimethoprim, tetracycline, macrolides and vancomycin.

2.2.3. South African Listeria outbreak

In South Africa (SA), about 216 deaths were reported due to the lethal outbreak of *Listeria monocytogenes* (*L. monocytogenes*) that occurred in 2018. About 1 060 medical laboratory-confirmed *Listeria* cases were reported from January 2017 until July 2018, and the implicated products were recalled on the 4th of March 2018 (NICD, 2018). The outbreak occurred across the whole country with the most cases and deaths reported in the Gauteng Province (~614 reported cases and 108 deaths), followed by Western Cape Province (~136 reported cases and 32 deaths) and KwaZulu-Natal Province (~83 reported cases and 21 deaths) (NICD, 2018). A total of 636 samples were clinically investigated, and about 91% (576/636) consisted of a sequence type 6 (ST6) strain, and 9% (60/636) consisted of 16 different sequence types (NICD, 2018; WHO, 2019b). According to WHO (2019b), the ST6 sequence type isolated in the samples was the same type identified in the widely consumed ready-to-eat processed meat product called "polony". According to Olanya *et al.* (2019), as from January 2017 to the 4th of March 2018, individuals interviewed indicated that they consumed polony before experiencing symptoms of food poisoning associated with *L. monocytogenes*. The outbreak was traced back to a meat processing company that exported to about 15 countries in the African region (WHO, 2019b).

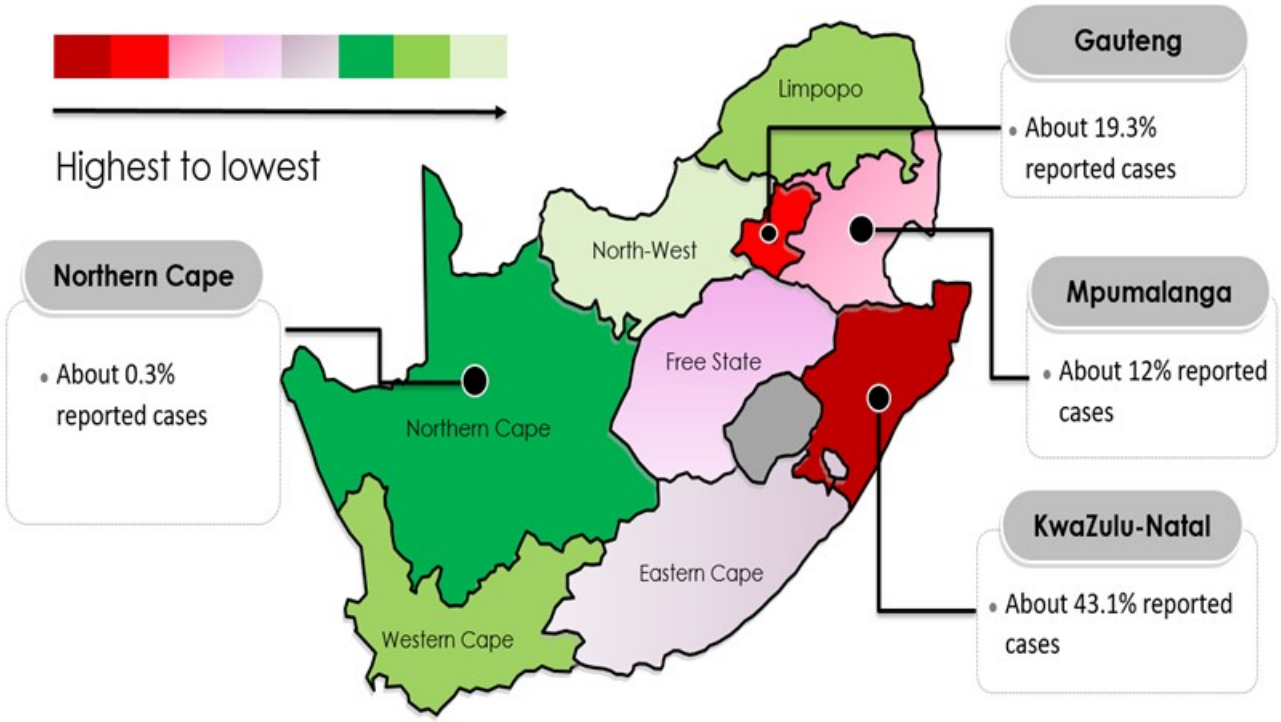


Figure 2.2 - Foodborne disease outbreaks reported per province in SA, over a five year period, 2013–2017
Source: Shonhiwa et al. (2017)

Figure 2.2, from 2013 until 2017, Western Cape, Limpopo, North West and Northern Cape Province had the lowest reported cases of foodborne diseases. However, this changed when SA witnessed a *Listeria* outbreak from 2017 to 2018. Western Cape Province was one of the SA provinces with the highest numbers of reported illnesses and death cases due to the *Listeria* outbreak. One would have expected that Western Cape Province is the safest province in South Africa when it comes to foodborne diseases, but this proves that irrespective of how a country or a region may be regarded as safe, foodborne disease outbreaks may occur, mainly if no proper safety measures are applied in the food production facilities. Olanya *et al.* (2019) conducted a study to estimate costs associated with the illnesses, hospitalisations, deaths and productivity in SA due to the *Listeria* outbreak in 2017/2018. The costs were calculated using the extracted data from the public records of the South African Department of Health, United States Department of Agriculture and Economic Research Services.

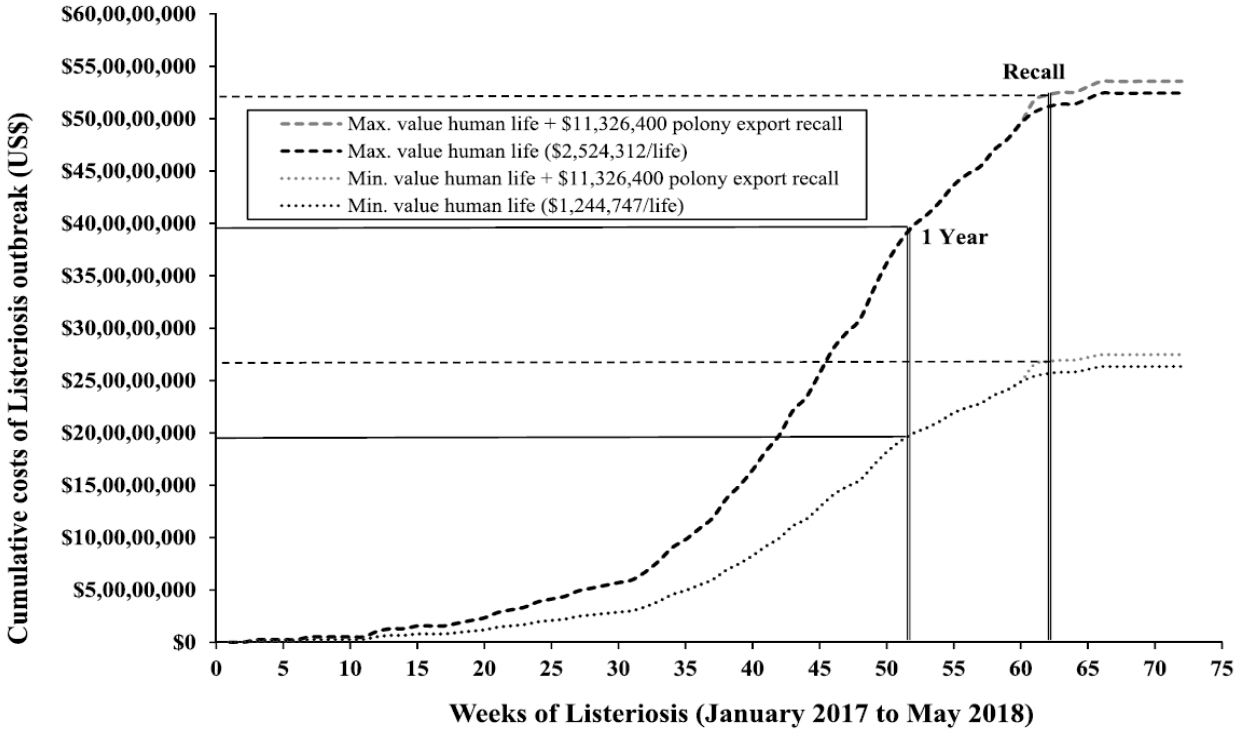


Figure 2.3 - Estimated cumulative costs associated with *Listeria* outbreak in SA (2017-2018)
Source: Olanya et al. (2019)

As indicated in **Figure 2.3**, the 2017/2018 *Listeria* outbreak negatively impacted the South African economy and welfare. Based on the costs calculations by Olanya *et al.* (2019), the estimated death cost of 204 *Listeria* death cases for low-value human life was approximately US$ 254 million, and the estimated death cost of 204 *Listeria* death cases for high-value human life was about US$ 515 million. The estimated hospitalisation cost of 1034 *Listeria* hospitalisation cases was approximately US$ 11 million. The estimated productivity loss for 430 people who were out of work due to the *Listeria* outbreak was approximately US$ 600 thousand. *Listeria* contamination in South Africa's food processing industry resulted in about 4000 metric tons of polony recalls. The polony revenue losses were approximately over US$ 11 million in SA. The estimated social and economic total cost of the *Listeria* outbreak in SA was approximately US$ 276 million at low-value human life and about US$ 537 million at high-

value human life (**Figure 2.3**). This study estimated some of the cumulative costs associated with the *Listeria* outbreak, but it could not include other direct and indirect costs. According to Olanya *et al.* (2019), some direct and indirect costs were not quantified due to medical confidentiality issues. Others were difficult to trace, such as value chain costs and changes in consumer demand or product substitution.

Thus far, it is clear that there are several foodborne disease outbreaks that occur around the world due to different factors that are faced in the food supply chain almost each and every day. These outbreaks since they are a great human health issue, consumers tend to be more concerned about foodborne diseases especially as a result of microbial contaminations. During and after foodborne disease outbreaks, consumers tend to avoid all food that was contaminated. Such is expected from humans as a natural response to a threat, but after the outbreak is over and implicated products are announced safe to consume, what causes some consumers to still prefer to buy other products that were not implicated as compared to the products that were implicated during the outbreak? This can be better explained by the behavioural economics concept, since it explains how consumers make economic decisions using both psychological insight and economics theories that might affect human behaviour. The following section reveals some unrecognised economist icons who started behavioural economics before it was recognised as a concept different from the mainstream economics. It shows how some of the mainstream economist incorporated some of the behavioural economics concepts in their work early before it was recognised in the academic field.

2.3. History of behavioural economics

2.3.1. Old behavioural economics

Economists have a good model of which they use to understand economic behaviour and its consequence. This model derives the supply and demand curves, shows equilibrium prices and quantities and design policies to increase efficiency and social welfare. According to Cartwright (2011), the potential problem with the standard economic model is that it is based on some strong assumptions. It assumes that people are most likely homo economicus, rational, selfish, benefit maximisation and cost-minimising with relatively stable preferences, have unlimited computational capacity, and never make systematic mistakes (Cartwright, 2011; Hernandez and Ortega, 2019, Rehman, 2016). Behavioural economics tests this standard economics model on humans by applying insights from laboratory experiments, psychology and other social sciences in economics (Baddeley, 2013; Cartwright, 2011).

Moreover, behavioural economics shows us when the standard economic model does a good job and when not, changing the traditional economic model to fit better with reality (Cartwright 2011). As a result, behavioural economics assumes that circumstances influence human behaviour, location, time, society, and emotional judgments, thoughts based on prejudice, and how they make their choices. However, it is essential to emphasise that behavioural economics does not replace the existing standard economic models but extends the rational choice and equilibrium models (Cartwright 2011).

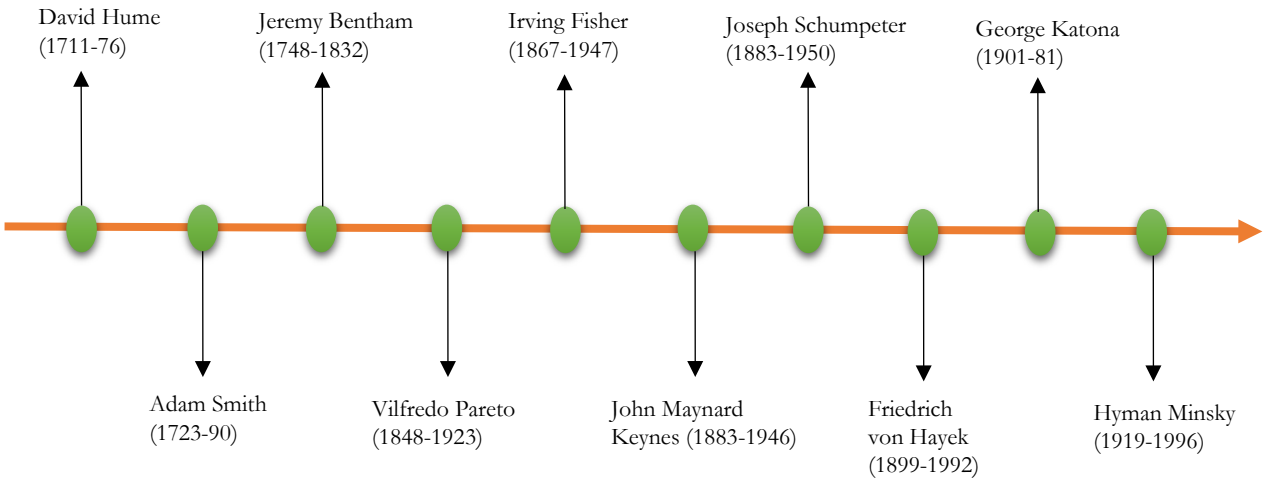


Figure 2.4 - Historical economists who contributed to behavioural economics development

Adapted from Baddeley (2013)

Figure 2.4 shows some of the economists who contributed to the historical development of behavioural economics and some behavioural approaches that preceded economics as we see it today. Richard Thaler is believed to invented behavioural economics, but such claims sharply contrast with Baddeley's (2013) perspective. Baddeley (2013) is of the opinion that the history of behavioural economics goes back to the eighteenth century, beginning with the contributions made by David Hume and Adam Smith. David Hume contributed to the early analysis of economic psychology focused on the moral dimensions of decision-making (Baddeley, 2013).

Adam Smith was popular with his rhetorical justification of free market and the invisible hand of price mechanism coordinating individual behaviour in socially beneficial directions as explained in his book '*An Inquiry into the Causes of the Wealth of Nations'* which was first published in 1776 (Baddeley, 2013; Cartwright, 2011). He also elaborated on socio-psychological motivations, mainly the role of emotion and sentiment, in his other book '*The Theory of Moral Sentiments* ' published in 1759 (Baddeley, 2013; Cartwright, 2011; Glimcher *et al.*, 2009). Smith explained in this book that people are motivated solely by self-interest but also feel a natural sympathy with others and have an innate sense of virtue (Baddeley, 2013; Cartwright, 2011). Jeremy Bentham analysed several behavioural motivations of human action, especially the impacts of pleasures and pains. He was the founder of utilitarianism, where his concept of utility was focused on the balance of pain and pleasure. Bentham believed that pain and pleasure are the 'sovereign masters' motivating what people do. He also emphasised the quantification of happiness and developed a hedonic calculus with a detailed taxonomy ranking key features of pleasures and pains (Baddeley, 2013).

Vilfredo Pareto is best known for his mathematical rigour, his concept of Pareto efficiency and his influence on general equilibrium theory. However, he later developed an interest in social psychology, where he explored a range of behavioural influences and divergences between logical and non-logical conduct, focusing on feelings (Baddeley, 2013). Irving Fisher is recognised for his early analysis of investment and interest rates, balancing

impatience to spend and investment opportunities. The impatience principle that he implemented suggested a rule for subjective and psychological motivations. He focused on personal factors as determinants of time preference, affected by individual differences. John Maynard Keynes argued that economic and financial decision-making is driven by a series of fundamental psychological laws, including the propensity to consume, attitudes to liquidity and expectations of returns from investment. According to Keynes, economic behaviour is the outcome of a complex mixture of rational and psychological behaviour. As a result, economic behaviour fits with the modern neuroeconomic models in which behaviour is the outcome of a complex interaction of emotion and cognition. Joseph Schumpeter focused on the idea that social forces drive entrepreneurship. According to Schumpeter, an innovative entrepreneur will bring a new concept to the marketplace, attracting many imitators (Baddeley, 2013). The more imitators join the industry for new profit opportunities, the more the marketplace or the business cycle is driven by socio-psychological influences.

Hayek also had a keen interest in psychological and behavioural motivations underlying decision-making. In '*The Sensory Order',* Hayek (1952) analysed the nature of mind and distinguished two orders he classified into phenomenal and physical orders. He also studied the processing of stimuli, biological aspects and characteristics of the nervous system, which contributed to constructing a theory of mind in which the mental order mirrors the physical order of events seen in the world around us (Baddeley, 2013). His analysis contributed significantly to modern behavioural economics and neuroeconomics. In 1951, George Katona published *Psychological Economics,* where he encouraged other economists to use insights from psychology when analysing economic issues (Hattwick, 1989). Katona used ideas from cognitive psychology to explore how individuals learn from other groups. He distinguished different learning forms such as mechanical learning, problem-solving, and understanding. Hyman Minsky was one of the pioneers who extended Keynes's insights about socio-psychological forces in the macro-economy, specifically into the impact on the financial system. Minsky financial fragility hypothesis is about how emotional influences destabilise financial structure (Baddeley, 2013).

2.3.2. New behavioural economics

The old behavioural economics still used the mainstream economics assumptions since they did not have enough supporting theories or principles for this new concept in economics. Whilst, the new behavioural economics show a great understanding of the differences between the mainstream economics and new economics concept called behavioural economics. Behavioural economics is widely used in disciplines such as computer science, economics and social science, where several sub-fields of behavioural economics are applied. Behavioural economics is not a stand-alone study field, but it has different interlinked sub-fields such as bounded rationality, economic psychology, cognitive biases, behavioural finance and neuroeconomics (**Figure 2.5**).

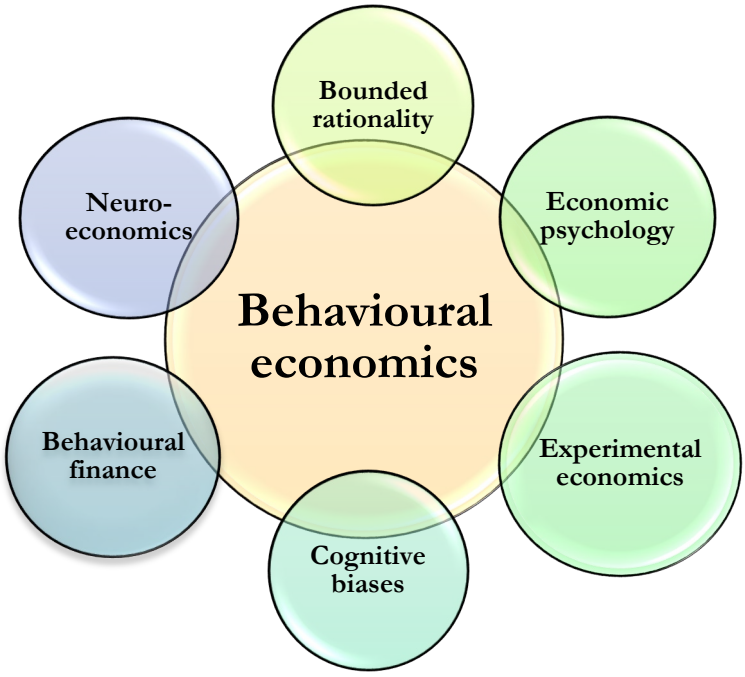


Figure 2.5 - Different sub-fields of behavioural economics

Source: Cartwright (2011)

Economists and some psychologists have produced various decision making theories and experiments that focus mainly on rational behaviour. Bounded rationality is a concept used in different fields such as economics, psychology and computer sciences. In economics, most models or human behaviour studies assume that humans can be reasonably described as "rational" entities that can never fail to behave rationally according to their preferences (Ballester and Hernández, 2012). Rational humans are assumed to have complete information, assuming they know all the courses of action and the results (Hernandez and Ortega, 2019). Bounded rationality revises this assumption considering that perfectly rational decisions are often not feasible in practice due to the finite computational resources available for making decisions (Ballester and Hernández, 2012; Di and Liu, 2016). In 1955, Herbert Simon published a paper that questioned the sense of approximating people by homo economicus (Cartwright, 2011; Hattwick, 1989). He looked at humans' information and computational capacities and used this as a starting point for his economic models (Cartwright, 2011; Ballester and Hernández, 2012). According to Ballester and Hernández (2012), Simon was the first to coin bounded rationality, and in 1978 he won the Nobel Prize in Economics for his pioneering research on decision-making processes (Cartwright, 2011). However, replacing homo economicus with something more human-like was not broadly accepted since his finding lacked proof that homo economicus is not a good approximation of how people behave.

The concept of economic psychology[10] dated back to 1881 and was established by the French social psychologist Gabriel Tarde (Ajdukovic *et al.,* 2018). In the 1800s, Tarde developed the theory of economic psychology based

[10] Some of the pioneers of economic psychology include Colin Camerer, Ernst Fehr, Daniel Kahneman, David Laibson, George Loewenstein, Matthew Rabin and Richard Thaler (Tomer, 2007).

on the interpersonal transmission of subjective values and beliefs (Ajdukovic *et al.*, 2018; Wärneryd, 2008). Tarde was much interested in the social sciences, including sociology, social psychology and political economy. He proposed a societal and human development theory based on three factors: repetition, opposition, and adaptation. In social sciences, these factors were imitation and invention, which operated on the desires and beliefs of individuals and societies (Wärneryd, 2008). An essential catalyst for the development of behavioural economics was the decline of schools in behavioural psychology and the emergence of cognitive psychology[11]. Cognitive biases are mental errors caused by simplified information strategies and fast thinking, known as System 1 thinking (Behimehr and Jamali, 2020). According to Dhami (2016), cognitive psychology emphasises mental processes in tasks involving decision-making, perception, attention, memory, and problem-solving. Daniel Kahneman and Amos Tversky are the two most recognised cognitive psychologists whose work in the 1970s helped shape modern behavioural economics (Behimehr and Jamali, 2020). Research by Tversky and Kahneman (1974) on human judgement, heuristics and biases were among the early works in the cognitive psychology field.

Behavioural finance is an area in finance studies that consider both finance and psychology to explore the effect of cognitive biases on the behaviour of market participants, capital market and other assets (Kapoor and Prosad, 2017). This type of finance area started in the mid-1980s, and it is one of the most important parts of investment finance and corporate finance. Behavioural finance has many applications that assist individuals, corporations, analysts, investors, and legislators in making better financial decisions and improving the functioning of capital markets. Before the 1980s, finance researchers could not explain how markets can become inefficient and how people can systematically behave irrationally using traditional economic theories. As a result, behavioural finance was established to describe all types of market anomalies, specifically in the stock market (severe rises or falls in stock price) (Kapoor and Prosad, 2017). Kahneman and Tversky successfully applied cognitive psychology in behavioural finance, where they published their paper on prospect theory in 1979, which later was approved by many financial economists in the early 1980s.

Experimental economics[12] is a sub-field of behavioural economics that applies insight from economics and psychology to understand economic behaviour better when making economic decisions. As from the 1980s, experimental methods in economics were widely used and are now accepted as part of the economic discipline. From 1955, Vernon Smith performed a series of experiments to see whether basic predictions of the market's standard economic model would prove correct (Bardsley *et al.*, 2010; Cartwright, 2011). Daniel Kahneman used well established experimental methods in psychology to challenge economists conventional assumptions about human rationality (Bardsley *et al.,* 2010). In 2002, Daniel Kahneman and Vernon Smith were awarded the Nobel Memorial Prize in Economic Sciences to recognise their work as pioneers of experimental economics (Bardsley *et al.,* 2010). These initial experiments led to a continuous line of research in market institutions. In the 20th century, laboratory experiments were extensively used in empirical economic analysis, especially in studying alternative market mechanisms (Cartwright, 2011). Other than Daniel Kahneman and Vernon Smith, the most recent Nobel

[11] Cognitive psychology is used interchangeably with cognitive bias.
[12] Behavioural economics incorporates psychological principles to improve economic analysis whilst experimental economics incorporates psychological methods to improve the testing of economic theory (Glimcher *et al.,* 2009).

Memorial Prize in Economic Sciences for its contribution to behavioural economics was awarded to Richard H. Thaler in 2017. According to Earl (2018), Thaler exposed the empirical shortcomings of rational choice theory and developed a theory of mental accounting that can be used to understand how consumers respond to different pricing strategies.

According to Glimcher *et al.* (2009), neuroeconomics has its origin in events following the neoclassical economic revolution of the 1930s, and cognitive neuroscience started in the 1990s. Neuroeconomics combines psychology, economics, and neuroscience theories to build formal quantitative models of the mental representations and neural processes that underlie human motivation and choice behaviour (Carter, 2012). The interdisciplinary convergence of these different fields convinced economists and social psychologists that formal mathematical models of decision making and empirical neurobiological experiments on decision making could result in a richer understanding of how humans make economic decisions. Neuroeconomics analyses brain activity using advanced imagery and biochemical tests before, during and after economic choices. The prevalent methods used in neuroeconomics to investigate economic decision-making include electroencephalography, magnetoencephalography, positron emission tomography and functional magnetic resonance imaging (Kenning and Plassmann, 2005). Although neuroeconomics is relatively new, it has an impressive start in the economics spectrum. It will still have a more significant impact on fundamental research in economics, either by providing new methodologies or by challenging scientists, economists, and psychologists' intuitions.

2.4. Methodological tools of behavioural economics

Behavioural economics combines different methods from economics, such as traditional econometric and modelling tools and experimental approaches from psychology. According to Baddeley (2019), most of the sub-fields in behavioural economics focus on strategic interactions between people and use the traditional game theory (TGT) tools as the starting point of analysis. Game theory is a mathematical model where two or more players must make choices that potentially affect the interest of other players. When the standard game theory[13] is used together with behavioural insights, it produces a large and diverse field called behavioural game theory (BGT). BGT is a research area concerned with how people play games or behave (Baddeley, 2019; Camerer, 2003; Tomer, 2007).

Behavioural game theory is greatly used in behavioural economics especially when seeking to obtain quantitative data such as WTP from participants. Much economic literature addresses various methods to measure consumers' WTP for specific products, but not all provide an accurate measure of WTP. Experimental auction is one of those methods which gives an accurate estimation of WTP since it is incentive compatible. Thus, it gives the incentive to the participants to reveal their true willingness to pay for a specific product. The experimental auction used in

[13] Traditional game theory assumes that players are rational, strategic, selfish and they choose options that will maximize their pay-offs in the game without considering others (Bonau, 2017; Camerer, 2009). These assumptions which forms the basis of standard economics are known to be unrealistic in real life since humans beings are not a true reflection of homo economicus (Camerer, 2003).

this study is the Vickrey fourth-price auction where study participants bid for a particular product. The following part of this section will explain the different models in behavioural game theory which include the experimental economics. The underlying assumptions of behavioural economics will be explained and compared with the traditional game theory.

2.4.1. Behavioural game theory

Traditional game theory (TGT) assumes that individuals and firms behave rationally when interacting in decision making. Camerer *et al.* (2004) stated that traditional game theory is based on three principal assumptions:

a. Players form their beliefs by analysing what the other players are likely to do (strategic thinking).
b. Players make the decision that best fits given those beliefs (optimisation/preferences).
c. All players adjust their decisions and belief until they are mutually consistent (equilibrium).

There is a conflicting contrast between TGT and behavioural game theory (BGT[14]) since BGT does not accept the assumptions of homo economicus based on the neoclassical economics stream. BGT seeks empirical information about how human beings behave in strategic situations instead of highly rational beings or programmed strategies (Camerer, 2003; Baddeley, 2019; Gachter, 2004; Tomer, 2007). It combines theory and experimental evidence to explain better strategic behaviour in economics, political and social interactions, building on aspects and concepts from behavioural decision theory. BGT was established to test the standard game theory assumptions. If there are deviations from what the standard theory predicts, the BGT can assist in detangling the reasons for the discrepancies.

Furthermore, BGT can assist in revealing players' preferences and explain their strategic reasoning processes (Gachter, 2004). Lastly, it can also explain how people learn in games. According to Camerer (2003), in BGT, the decisions of other players can be predicted either by thinking or learning. Still, the analysis relies on strategic thinking when there is a lack of prior experience with analogous games to learn the other players' likely behaviour. BGT analysis is based on the following three stylistic principles presented by Camerer and Ho (2015):

a. **Precision** – Includes deviations to form an alternative theory that is widely applicable.
b. **Generality** – Behavioural game models are general enough to be applied to many different games without extensive customisation.
c. **Empirical discipline** – BGT models are data-driven, and they rely significantly on experiments and lab control to identify which theories work best.

Traditional game theory involves standard equilibrium models, where players' beliefs are always correct, and no players are ever surprised by their opponents' actions (Chong *et al.*, 2016). On the other hand, behavioural game

[14] Behavioural game theory (just like behavioural economics to mainstream economics) does not aim to eliminate traditional or standard game theory, but seeks to make TGT a more powerful tool for analysis in strategic and complex situations such as in real life scenarios (Gachter, 2004).

theory explains non-equilibrium behaviours, which deviate from the standard equilibrium assumption in game theory. In non-equilibrium models, players' subjective beliefs are not always correct, and players can be surprised by opponents' actions in games, as is observe in many real-world scenarios (Chong *et al.,* 2016). As indicated in **Table 2.4** below, behavioural game theory has many models to address internal and external factors such as weather, emotions, skills, cognitive capabilities and so on. These internal and external factors significantly influence participants' behaviour, especially regarding preferences and when making choices. The traditional game theory ignores the internal and external factors when analysing decision-making. As a result, behavioural game theory provides more accurate predictions of human behaviour in decision making (Bonau, 2017).

Table 2.4 - Behavioural game theory models

Behavioural game theory models	Functionality	Limitations	Application
Cognitive Hierarchy Model (CHM)[15]	CHM capture players beliefs about steps of thinking and are designed to predict the early stages in repeated games or one-short games (Camerer and Ho, 2015; Gracia-Lázaro *et al.*, 2017). According to Chong *et al.* (2005), the CH model allows players to form different beliefs of what others will do. The differences in belief arise from different iterations of strategic thinking that players perform.	- They are usually applied to static games (Carvalho and Santos-Pinto, 2014). - Asymmetry: It assumes that each participant in a game believes that they have a better understanding of the game than other players (Carvalho and Santos-Pinto, 2014). - Weakens equilibrium (Camerer and Ho, 2015).	CH model provides valuable insights into P-beauty contest games (Camerer and Ho, 2015), market entry games (Bonau, 2017), 'hide and seek' games (Crawford and Iriberri, 2007), Swedish lottery (Östling *et al.,* 2011), etc.
Quantal Response Equilibrium (QRE)	According to McKelvey and Palfrey (1995), the QRE model is a noisy optimisation model under which players can make minor errors. However, the player's beliefs about other players are always accurate. This model considers that players tend to exhibit a behaviour that brings a higher expected payoff (Camerer and Ho, 2015).	- Noisy or stochastic response (Camerer *et al.*, 2004).	QRE successfully explains deviations from the Nash equilibrium in many games such as asymmetric 'hide and seek' (Camerer and Ho, 2015), two-stage bargaining games and maximum value auction games.
Experience Weighted	Camerer and Ho (2015) proposed the EWA model that used both reinforcement and belief learning. Reinforcement learning assumes that their previous	- It always assumes that players always learn the equilibrium, and learning models	EWA model can be successfully be applied in a three-stage emission game (Uwasu, 2012) and

[15] This model assumes that a level zero player randomizes independently at each information set and players of higher levels choose best responses at information sets using backward induction and Bayes' rule to update beliefs about their rivals level of strategic sophistication (Carvalho and Santos-Pinto, 2014). CHM not only assist in explaining non-equilibrium behaviour but they also explain the lack of non-equilibrium behaviour, when there has been no learning, experience or communication (Camerer and Ho, 2015).

Behavioural game theory models	Functionality	Limitations	Application
Attraction Learning (EWA)	payoffs reinforce strategies, and the propensity to choose a strategy depends in some way on its stock of reinforcement. Players who learn by reinforcement do not generally believe what other players will do (Uwasu, 2012). The belief learning assumes that players keep track of the history of previous play by other players and form some belief about what others will do in the future based on past observation (Uwasu, 2012). Then they tend to choose a best-response, a strategy that maximises their expected payoffs given the beliefs they formed.	always converge to the equilibrium (Pangallo *et al.,* 2017). - Unfortunately, learners do not learn at equilibrium in some games, and the EWA model does not always converge to equilibrium. - Backwards-looking model (Bonau, 2017).	mixed strategy games (Camerer and Ho, 2015).
Models including sophistication	Sophisticated players utilise strategic thinking in addition to learning (Bonau, 2017). Such players believe that others are learning and anticipate how others will change in deciding what to do. Models that include sophistication account for effects of matching and information (Camerer and Ho, 2015).	- Assumes the behaviour of sophisticated players. - Assumes some players go through learning processes with repetition of the game (Bonau, 2017).	The sophistication model provides useful insights in repeated beauty contest games and repeated trust games (Camerer and Ho, 2015).
Models including social preferences	Models that include social preferences play a significant role in strategic interactions such as reciprocity, altruism and fairness. According to Bonau (2017), mathematical theories underlying social preferences includes the inequality-aversion theory, me-min-un theory and reciprocity theory.	- Some measures of social preferences do not have straightforward applications.	The social preferences model provide useful insights into public goods games and dictator games (Camerer and Ho, 2015).

2.4.2. Experimental auction game

The use of auctions[16] dates back to the early 500 B.C in Babylon. Art objects and antiques have always been sold through auctions. Still, today numerous kinds of commodities ranging from agricultural products, manufactured goods to financial assets, precious stones etc., are sold through auctions. Experimental auction is a quantitative research method used by applied economists and psychologists to elicit individuals' preferences for goods and services (Troost, 2019). Participants in the experimental auction are expected to submit their sealed bids, determining their payoffs for a certain product. The most common rule in experimental auctions is that the highest bidder(s) win the auction and pay the purchase price determined by the individuals' bids. Auctions are conducted in many different forms, and the most common forms are the Dutch auction, sealed-bid first-price auction, sealed-bid second-price auction and the open ascending or English auction (Krishna, 2010; Lorentziadis, 2016).

An essential characteristic of experimental auctions is the type of mechanism used to determine the market price for the specific products(s) being valued and the auction winner(s) (Lusk and Shogren, 2007). The experimental auction mechanisms can be used by behavioural economists to create hypothetical market situations where some factors can be controlled but still offer the respondents an incentive to state their true willingness to pay (WTP) when bidding (Troost, 2019). Thus the experimental auction is an incentive-compatible mechanism. There are numerous incentive-compatible auction mechanisms used to elicit consumers' WTP. The three most commonly used are Vickrey's second-price auction, Becker-DeGroot-Marschak (BDM) mechanism, and the random *n*th price auction (Zhong *et al*., 2018).

Vickrey second-price sealed-bid auction and variants

Vickrey (1961) introduced a second price auction that gives bidders an incentive to state their true value for auctioning the goods or services. In a Vickrey auction (VA), the bidders submit their bids without knowing other players' bids. As a result, it is a sealed bid auction. In this auction, each bidder submits the sealed bid expressing the amount they are willing to pay for the product auctioned. The bidder with the highest bid wins the auction and pays the price equivalent to the second-highest bid. Thus, no participant in the auction knows what amount they will pay for the product. The weakly dominant strategy in the second-price auction is to bid truthfully, i.e., to bid the true value that the auctioned good or service is truthfully worth (Lusk and Shogren, 2007). Suppose there is participant **1** and **2** with private values V_1 and V_2 and their submitted bids b_1 and b_2. If participant **1** bids more than or equal to their premium costs ($b_1 \geq V_1$), there are three possible conditional scenarios:

a. If b_1 is equal to V_1 and b_2 is less than V_1. Participant **1** wins the auction and receives positive utility or surplus.
b. $b_2 < V_1 < b_1$: Participant **1** wins the auction and receives the same utility or surplus as they would have received if participant **1** bids the true value $\mathbf{V_1}$.
c. $V_1 < b_2 < b_1$. Participant **1** wins the auction and receives a negative utility.
d. $V_1 < b_1 < b_2$. Participant **1** loses the auction and receives zero utility.

[16] The word 'auction' was derived from a Latin word *augere*, which means to increase (Krishna, 2010).

If participant **1** bids less than or equal to their premium costs ($b_1 \leq V_1$), there are three possible conditional scenarios:

a. If b_1 is equal to V_1 and V_1 is less than b_2: Participant **1** loses the auction and receives zero utility.
b. $b_1 < V_1 < b_2$: Participant **1** loses the auction and receives zero utility.
c. $b_2 < b_1 < V_1$: Participant **1** wins the auction and receives the same utility or surplus if participant **1** bids the true value $\mathbf{V_1}$.
d. $b_1 < b_2 < V_1$: Participant **1** loses the auction and receives zero utility.

The weak dominant strategy explained above shows that bidding on the true value in Vickrey auctions (VA) is optimal. Thus, bidding $b_1 = V_1$ or $b_2 = V_2$ weakly dominates all other strategies, and the Nash equilibrium strategy is where $b_1 = V_1$ or $b_2 = V_2$. The Vickrey second-price sealed-bid auction has been widely used and is traditionally one of the most popular auction mechanisms globally (Van Zyl, 2011).

Due to its acceptability, some researchers, such as Li *et al.* (2017), have used a different variant of the Vickrey second-price auction to determine stated or/and revealed consumers' preferences. These variants use the exact mechanism as the second price auctions but differ in the bidder's payments rule. Another common VA variant is the fourth price auction, where the three highest bidders win the auction and pay the fourth-highest price to receive the goods or services auctioned. VA that allows more than one participant to win is usually used in studies with large groups of participants to increase the chances of participants to receive incentives and motivate them to participate in the study. Since VA has benefits when used in field or laboratory experiments, it also has limitations in **Table 2.5** below.

Table 2.5 - The Vickrey auction advantages and disadvantages

VA advantages	**VA disadvantages**
Truthful bidding is a dominant strategy.	The bidders can coordinate their bid prices to remain artificially low (Sandholm, 2000). As a result, the bidders get the goods at a lower price than they would without colluding.
No incentive for counter-speculation (Sandholm, 2000).	Auctioneers can be insincere and may overstate the second-highest bid to the highest bid. According to Rothkopf *et al.* (1990), cheating by the auctioneers has been one of the major drawbacks in VA.
Very useful in computational auction systems (Sandholm, 2000).	Very difficult to use VA in field experiments such as supermarkets and farmers markets (Troost, 2019).
Participants submit sealed bids, thus a private value auction.	Winners curse phenomena can occur. Participants tend to overbid, thus bid more than what the object is worth and what they are willing to pay to increase their chances of winning the product auctioned.

Becker-DeGroot-Marshak mechanism (BDM)

BDM is one of the most used incentive-compatible valuation methods adopted in food consumer studies (Canavari *et al.*, 2019). In the BDM mechanism, each participant submits their sealed bid for the good (Horowitz, 2006; Lusk and Shogren, 2007). Then, the sale price is randomly drawn from a distribution of prices ranging from 0 to a higher price than the anticipated maximum bid. If the submitted bid is above the randomly drawn price, the participant receives the good and pays the drawn price, but if the bid is below the drawn price, the participant loses the auction and pays nothing (Horowitz, 2006). The dominant strategy for this mechanism is the same as the one used in the Vickrey auction. According to Noussair *et al.* (2004), BDM enables bidders to use a dominant strategy where each bidder is expected to bid an amount equal to their true valuation for the good. The main advantage of BDM is that it can be conducted for one participant at a time; thus, BDM is practically useful where it is difficult to run a classical auction that requires many participants simultaneously (Lusk and Shogren, 2007). As a result, BDM is usually used in field experiments taking place in supermarkets or farmers markets.

Random nth price auction

The random *nth* price auction is an incentive-compatible auction and combines the elements of two mechanisms: the Vickrey auction and the Becker-DeGroot-Marschak (BDM) mechanism (Shogren *et al.*, 2001; Zhong *et al.*, 2018). According to Lusk and Shogren (2007), this auction combines Vickrey's second-price auction features, encouraging competition amongst bidders and the BDM mechanism, which gives all bidders a chance to win the auction. The critical element of this auction is a random and endogenous market-clearing price (Van Zyl, 2011). The randomness of the price ensures that all bidders are engaged, while the endogenous price guarantees that the payment (market-clearing) price is in line with the value that the consumer attaches to the product (private value) of the bidders (Shogren *et al.*, 2001).

In the random *nth* price auction, each participant submits a sealed bid for the auctioned product, and the auctioneer or auction monitor collects all the bids to sort them from highest to lowest (Van Zyl, 2011). Then the auctioneer randomly draws a number (***n***) from the distribution two to ***k*** (***k*** = number of participants) and sells one unit of the good to each of the highest bidders (***n-1***) at the randomly drawn *nth* price (Noussair *et al.*, 2004; Shogren *et al.*, 2001). These participants are referred to as winners of the auction because they get to trade in the auction. Note that the distribution starts from two to (***k***) and not one to (***k***). If the distribution was from one to (***k***) and the random number drawn is n=1, there would be no winners as the winners of the auction would be equal to ***n-1***, which will be zero (Troost, 2019; Van Zyl, 2011). The main advantage of this auction mechanism is that it keeps all bidders engaged in multiple bidding rounds. However, it can be challenging to explain the random nth price auction to participants and determining its market price can be time-intensive if there are too many participants.

2.4.3. Application of experimental auction games in food safety

The application of different experimental auction on food safety-related issues is discussed in recent studies, as summarised in **Table 2.6** below.

Table 2.6 - Application of experimental auction methods in recent food safety research

References	Study main aim	Methods applied	Main results
Li *et al.* (2017)	The primary objective was to determine whether consumers' WTP for eggs was affected by the eggs recall due to *salmonella*. The second objective was to investigate the possible influences of negative and positive information about the recall on the WTP.	Vickrey fourth-price auction	Less than one-third of the participants stopped buying and eating eggs due to recall. About 17% threw away the eggs from their houses to respond to the recall. Furthermore, positive information showed a significantly positive effect on WTP.
Hou *et al.* (2019)	This study aimed to establish a relatively complete system of pork attributes traceability with basic functions of ex-ante quality assurance and ex-post traceability based on the major safety risks in China's pork supply chain system. Secondly, to investigate consumers' WTP for information attributes of pork information traceability.	Becker-DeGroot-Marschak mechanism (BDM)	The results demonstrate that consumers have higher WTP for ex-ante quality assurance than for ex-post traceability. The highest WTP is for the ex-ante quality assurance attribute of pork quality inspection. Consumers' WTP for traceability information is influenced by their characteristics, including age, education and income, concern and satisfaction about food safety and confidence in food safety labelling.
Zhong *et al.* (2018)	Determine whether information about food additives affected consumers' risk perception and willingness to accept (WTA) food with additives.	Random *nth* price auction	Consumers are generally more sensitive to negative than positive information on food additives. Consumers with higher food safety satisfaction have lower WTA than those who are not satisfied with food safety. Interestingly, consumers with relatively good knowledge of additives had higher WTA than those with no such knowledge.

2.5. Theories of behavioural prediction models

This section focus on the theories of behavioural prediction models, which explains the relationship between intention and behaviour. There are many different types of behavioural prediction models, the theory of reasoned action (TRA), theory of planned behaviour (TPB) and the integrative model of behavioural prediction (IMBP) are the best known and most widely applied models to explain the intention-behaviour relationship. All these models also forms part of the behavioural economics methodology since they are used to understand how consumers make decisions when influenced by other internal factors that can be most likely be explained by psychology.

2.5.1. Theory of reasoned action

The theory of reasoned action (TRA) is based on the assumption that people can reason about behaviour; that is, they can argue why they will or will not perform a specific behaviour (Kreijns *et al.*, 2013). The second assumption is that behaviour is entirely voluntary, meaning that behaviour reflects self-control and intentions. This theory explains that people will perform a particular behaviour only if it is within their intentions to perform that behaviour. Thus, the intention is seen as a proxy for behaviour. In TRA, the intention is a function of two variables, i.e., attitude and subjective norms (Kreijns *et al.,* 2013).

2.5.2. Theory of planned behaviour

TRA has been further developed by Ajzen (1991) into a theory of planned behaviour (TPB). TPB is an extension of the TRA model and includes an additional construct: the perceived control over the performance of the behaviour (Kreijns *et al.,* 2013). Ajzen (2002) stated that perceived behavioural control is the perceived ease or difficulty of carrying out a particular behaviour and is the aggregated form of control beliefs about the presence or absence of factors that hinder performance.

2.5.3. An integrative model of behavioural prediction

The integrative model of behavioural prediction (Fishbein and Ajzen, 2009) evolved from the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975) and the theory of planned behaviour (TPB) (Ajzen, 1985). The integrative model of behavioural prediction (IMBP) model extends TRA by including the construct of self-efficacy rather than perceived behaviour control in the TPB model (Kreijns *et al.,* 2013). IMBP theory suggests that intention is a significant predictor of behaviour and that intention, as well as environmental constraints such as situational factors, interpersonal dependence and personal skills, are necessary and sufficient to moderate the intention–behaviour relationship (Collado-rivera *et al.*, 2018; Fishbein, 2008; Kreijns *et al.*, 2013). Behavioural intention is determined by attitude, perceived norms and personal agency (**Figure 2.6**).

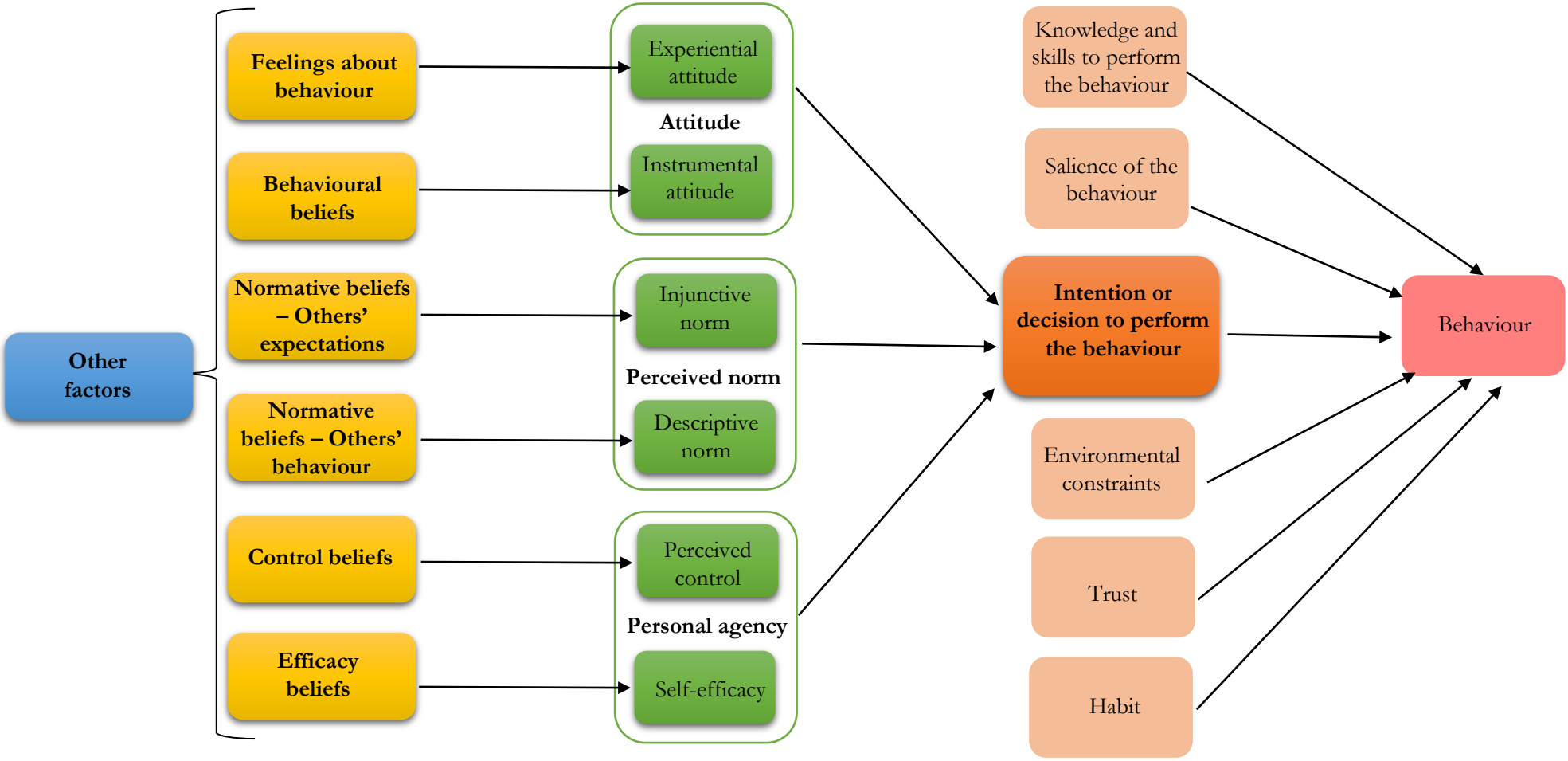


Figure 2.6 – Integrative model of behavioural prediction conceptual framework

Adapted from Fishbein and Cappella (2006)

An individual needs the knowledge and skills to carry out the behaviour. The behaviour must be important to the individual, and there should be few or no environmental constraints that can make behavioural performance difficult. The more an individual performs the behaviour, the behaviour becomes a habit to the individual and the more the individual trusts choices as a result of behaviour. Currently, few studies have used the IMBP to analyse the consumers' WTP for a specific product. The most recent study was conducted by Lagerkvist and Okello (2016). They evaluated consumers' revealed preferences for safety and hygiene in fresh vegetable produce at a traditional peri-urban market in Nairobi. According to their results, fear of negative social evaluation, trust and shopping habits had a significant relationship with the real payments for kale sold in the Nairobian markets.

2.6. Conclusion

This chapter's first part was dedicated to discussing the food safety associated with foodborne disease outbreaks on ready-to-eat (RET) meat products. The pathogen is one of the environmental factors that compromise the safety of food in the world. The pathogens in the food sector are mainly caused by the changes in land use, human demographics and society, poor health, pathogen resistance, cross-contaminations, global transportation, changes in climate and weather patterns, poverty and lack of political will. The safety of meat and meat products has faced many challenges, primarily because of microbial pathogens. Among the most common microbial pathogens that threaten RTE meat products, *Listeria monocytogenes* is the primary concern. These pathogens can spread in ready-to-eat (RTE) meat products exposed to post-processing contamination and environment that supports the organism's growth during storage (Kurpas *et al.*, 2018; Lambertz *et al.*, 2012; Sofos, 2008).

After discussing the food safety and microbial pathogens that cause foodborne diseases associated with RTE meat products, the history of behavioural economics was discussed. Some unrecognised economist icons were revealed who started behavioural economics before it was recognised as a concept different from mainstream economics. The methods used to collect and analyse the WTP data obtained from the auction experiment were further explained. Behavioural game theory (BGT) was differentiated from traditional game theory since this study followed the assumptions based on the BGT. The BGT assumptions deviate from what the standard theory predicts. It uses empirical information about human behaviour in strategic situations instead of highly rational beings or programmed strategies. It combines theory and experimental evidence to explain the strategic behaviour of individuals better. The fundamental aspects of experimental auctions were also covered. The three most common incentive-compatible auctions were discussed, with a focus on Vickrey's auction since it is the mechanism used in this study. Finally, the theories of behavioural prediction models that explain and predict the relationship between real intention and human behaviour were also briefly discussed.

CHAPTER 3

3. Experimental design and procedures

3.1. Introduction

An auction is an economic mechanism whose purpose is to allocate goods and form prices for those goods through a process known as bidding. According to Lusk and Shogren (2007), experimental auctions are powerful tools that can be used to obtain people's values about goods in a real-world situation. In the previous chapter, the three most common incentive-compatible auction mechanisms were discussed. It was concluded that the Vickrey fourth price auction was suitable for this study since the mechanism can reveal the demand, is relatively simple to explain and has endogenous market-clearing (payment) price (Shogren *et al.*, 2001). However, the main shortcoming of the Vickrey auction at an individual level is that it does not include off margin bidders since the bidding range is fixed. In this study, participants were advised about the consequences of over and underbidding to avoid off the margin bidding. This chapter will explain the Vickrey fourth price auction procedures along with the experimental organisation and data analysis for this study with more details.

3.2. Experimental organisation

In this section, the discussion focuses mainly on the target population and respondents. The target population (also known as the theoretical population) refers to a particular group of individuals with varying characteristics of interest. The characteristics of the interest group are explained below, along with the desired respondents for the study.

3.2.1. Target population

This study targeted students and non-student subjects who reside, study or work in Stellenbosch, located in the Cape Winelands District. As indicated in **Table 3.1** below, different consumers are situated in Stellenbosch, although most are middle-class and affluent consumers. **Figure 3.1** below shows that the majority of the population in Western Cape Province consists of middle-income, affluent consumers and very few marginalised consumers compared to other provinces in South Africa. The south and east of Stellenbosch have middle-class and wealthy consumers. The north and northwest of Stellenbosch consist of middle-class and low-income neighbourhoods (Venema, 2016).

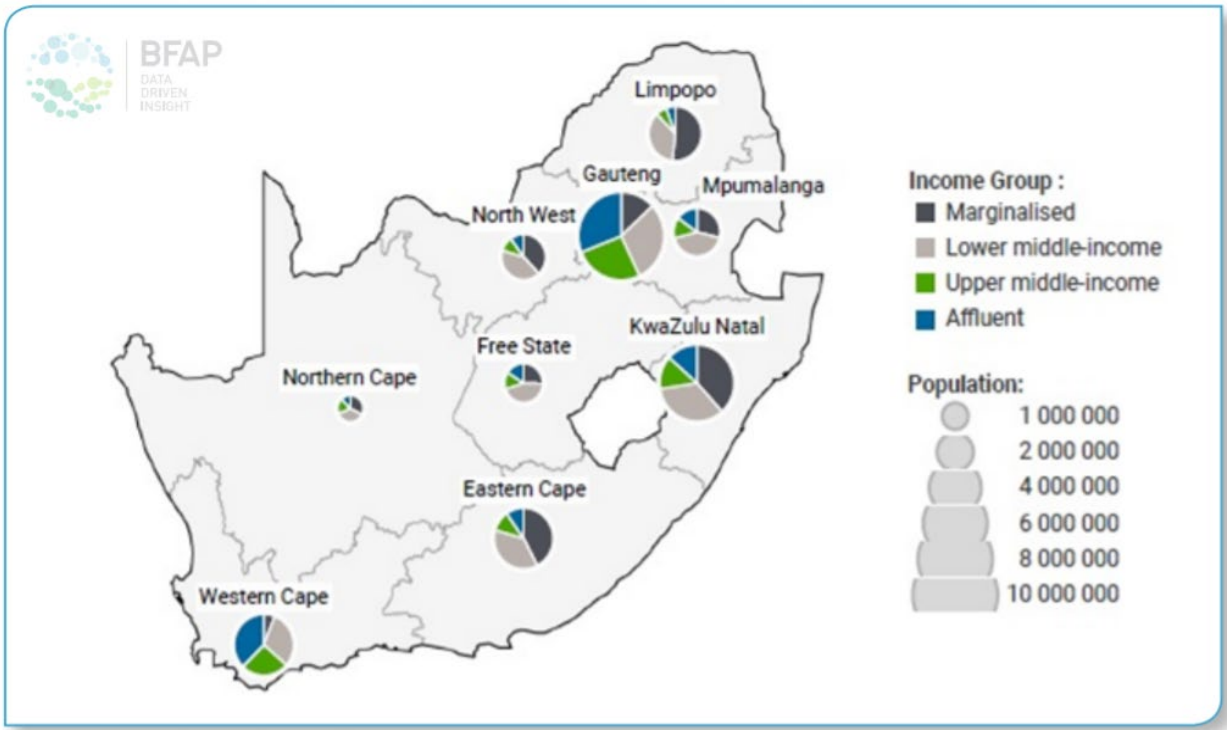


Figure 3.1 - Provincial distribution of the main socio-economic sub-groups in South Africa

Source: BFAP (2018)

The non-student subjects can work in any field, and as for students, they can attend any educational facility such as Stellenbosch University, high schools and college. Since the study randomly selected subjects, it was expected to have a variety of participants that either had children or did not have any children. This distinction assisted in analysing how the outbreak influenced the consumers with children under 18 when buying RTE meat products compared to consumers without children under the age of 18.

Table 3.1 - Profile of socio-economic sub-segments amongst South African consumers

Consumer sub-groups	Corresponding SEM segments	Monthly income estimations
Marginalised consumers	SEM 1-SEM 3	R0-R 4 999
Middle-class consumers	SEM 4-SEM 7	R5000-R14 999
Affluent consumers	SEM 8-SEM 10	≥ R 15 000

Source: Adapted from BFAP (2019)

The following are the major variables that were used for this study especially when analysing the data. Consumption patterns, income and age groups seemed to play a significant role in food preferences. Thus, this study examined how these variables impacted the WTP after a food safety scare.

Consumption preferences and biases

Participants' occupation is very crucial as it may significantly influence the results of the experimental game. Firstly, subjects must have sufficient English comprehension to understand the rules and play the game. The subject pool

consisted of both students and non-student participants. A study conducted by Exadaktylos *et al.* (2013) examined the effects of a dataset consisting of student and non-student subjects and volunteers and non-volunteers. This study was driven by the concern that behavioural experiments where the subject pool is almost exclusively comprised of university students are not representative since such a subject pool has a narrow socio-demographic array of characteristics (Exadaktylos *et al.*, 2013; Harrison and List, 2009). According to Exadaktylos *et al.* (2013), self-selection bias affects non-student volunteers and slightly affects students. Self-selection bias occurs when volunteers share some attributes that make their behaviour diverge systematically from non-volunteers (Exadaktylos *et al.*, 2013).

Student bias mainly comes from artefactual field experiments where both student and non-student participants are used (Haigh and List, 2020; Palacios-Huerta and Volij, 2009) and also comes from databases containing behavioural data drawn from more general populations (Exadaktylos *et al.*, 2013). Students are more strategic compared to non-student subjects. Several studies have shown that students are slightly less "pro-social" than non-students in various experimental designs and settings, i.e., students behave less generously, less cooperatively, less trustfully (Exadaktylos *et al.*, 2013). Thus, using only the self-selected students in social and natural experiments produces qualitatively and quantitatively more accurate results compared to non-student subjects. Therefore, using both student and non-student subjects in this study will enable us to broaden the socio-demographic characteristics but will not necessarily reduce student and self-selection bias.

Food intake choices are influenced by several factors such as geographical aspects, education, disposable income, government and other support services, urbanisation, globalisation, demography, marketing, religion, culture, social networks, ethnicity and time (Ronquest *et al.,* 2015). Thus, it is important to consider a range of different professions, education level, income, demographic characteristics etc., to observe how each factor contributes to the real willingness to pay (WTP) for ready-to-eat (RTE) processed meat products. It is also believed that non-student subjects have a better experience with the products used in the experiment or the scenario imposed in the experiment. Non-student subjects may have children at home under the age of 18 years who consume RTE products daily since, in most cases, these products are convenient and affordable. As a result, they were most likely more affected by the *Listeria* outbreak as compared to students. Thus, both self–selected non-student and student subjects were used to get more accurate and realistic results.

Income

The participants in this study consisted of regular consumers of ready-to-eat processed meat products such as 'polony', 'viennas'[17] and ham. Participants were classified into marginalised, middle-class and affluent consumers, as specified in the Socio-Economic Measurement[18] (SEM) segmentation tool. The SEM segment replaced the Living Standard Measure (LSM), which was terminated in 2015 (BFAP, 2019). As indicated in **Table 3.1**, the SEM

[17] Vienna is a thin parboiled sausage traditionally made of pork or beef in a casing of sheep's intestine, then given a low temperature smoking.

[18] The SEM segmentation tool is a socio-economic measure that differentiates how people live, along a spectrum from low to high socio-economic living standards, based on what they have access to in and near their homes (The Broadcast Research Council of South Africa (BRC), 2018).

scale starts from one up to ten. A segment categorised in SEM 1 to 3 represents the marginalised consumers, a segment with SEM 4 to 7 represents middle-class consumers, and a component with an SEM scale above seven represents affluent consumers. According to the BFAP (2019), the marginalised consumer group has minimal access to amenities such as a built-in kitchen sink, hot running water and a flush toilet while having a strong rural component. Furthermore, this type of consumer resides in KwaZulu-Natal, Eastern Cape, Limpopo and Gauteng provinces in South Africa (BFAP, 2019).

Middle-class consumers have improved access to amenities such as a built-in kitchen sink, hot running water and a flush toilet while having a strong urban component (BFAP, 2019). Such consumers reside in Gauteng, KwaZulu-Natal, Eastern Cape, Limpopo and Western Cape provinces in South Africa. The majority of the affluent consumers have access to basic amenities and live in Gauteng, KwaZulu-Natal and Western Cape (BFAP, 2019). Thus, this study welcomes the vast range of monthly income to observe how different consumers behave towards changes in food safety, especially in RTE meat products in South Africa. All the classes of consumers were included in order to cater for both students and employees. To have the subjects with the required characteristics a stratified random sample was used.

Age

Age is correlated with income; thus, goods bought by different age groups are influenced by the household income, the number and demographic characteristics of household dependents. Stellenbosch municipal area consists mainly of working-age people between the ages 15 and 65 years. From 2011 to 2016, Stellenbosch experienced a higher growth rate in households relative to the Cape Winelands District (Stellenbosch Municipality, 2017). Furthermore, household income is relatively higher in the working-age population than in South Africa. A variation in household income and daily activities within the working-age population influences consumers' purchasing behaviour. Some working-age people are either employed or students, and they usually don't have time to cook or prepare food, which makes them reliant on convenient food or RTE food. Therefore, this study examined how different age groups and income influence their purchasing behaviour or WTP for RTE meat products.

Also, some of the population have dependents such as children under 18 years, which influences their food preferences and purchasing behaviour. According to Labadarios *et al.* (2005), the largest and only national food consumption survey conducted in South Africa showed that the most consumed food items of children aged 1-9 years old were maize, sugar, tea, whole milk and brown bread. A study conducted by Steyn *et al.* (2001), determined that the most consumed food items by the South African adult population are maize, sugar, tea, bread (brown and white), non-dairy creamer, brick margarine, chicken meat, full-cream milk and vegetables. Furthermore, in 2009, a cross-sectional 24-hour food recall survey revealed that the most consumed food groups for South Africans aged 16 and older were cereals and roots, meat and fish, dairy, vegetables, legumes, and vitamin A-rich fruit (Labadarios *et al.*, 2011). As a result, age played a major role in this study to observe how age relative to food preference influences WTP when food safety is compromised in South Africa. It was also important that the subjects who participated in this study had children under 18 years old to capture the variation in WTP for RTE meat products as influenced by the age factor.

3.2.2. Respondents

Respondents determination is an initial step taken when designing an experiment and the choice depend on a variety of factors, including the study objectives and budget constraints (Lusk and Shogren, 2007). According to Canavari *et al.* (2019), a priori respondents or power calculations are almost non-existent in agricultural economics journals. However, researchers from other disciplines are paying much attention to including the power calculations for their respondents. In auction games, estimates of the respondents are facilitated by the continuous nature of the observed variable. Still, they can get slightly more complicated if the repeated nature of the auction setting needs to be considered. The respondents' calculations must be incorporated in any experimental auction study so that researchers may not end up with statistically insignificant results. Statistically insignificant results can be influenced by small number of respondents that are not large enough to detect a difference of practical significance.

To formulate optimal respondents and experimental design, specific rules of thumb, including optimal respondents calculations, must be considered (Canavari *et al.*, 2019; List *et al.,* 2010). One such rule is that 30 subjects per treatment group must be used (List *et al.*, 2010). To be on the safe side, this study opted to use 32 subjects per treatment group, resulting in about 128 subjects for the overall experiment. However, due to the slow response and lack of interested participants, the total subjects for this study resulted in 111 participants.

3.3. Experimental design

The experiment was designed based on the frame field experiment scope. The study consisted of both student and non-student subjects. The subjects were exposed to contextual treatments with imposed rules in an auction experiment. The auction mechanism used was the Vickrey fourth price auction facilitated through an online oTree open-source platform for social science experiments (**Table 3.2**). All the subjects were told that they were participating in an auction experiment with different treatments and finite rounds. The contextual treatments consisted of information about the *Listeria* outbreak in 2017-2018 and randomised within sessions. The overall design of the experiment is extensively explained in **Table 3.2** below.

Table 3.2 - Summary of experimental design

Experiment components	Description
Framed field experiment	Students and non-student subjects with contextual framing and imposed rules.
Chosen effort	Subjects choose a number symbolising costly effort within an interval: observable effort and control over cost function.
Auction game	Vickrey fourth price auction where the three subjects with the highest bids pay the fourth-highest price to obtain the goods/services.
Within-subject design	Each subject participates in all or several treatments. Different behaviour between treatments is based on different actions of one subject.
Repeated game	Each subject makes the same decision repeatedly, and the game may extend over several rounds. Subjects can change their behaviour, and one session produces many observations.
Finite game	Subjects know the number of rounds.
Stated preferences	Subjects are asked to state the monetary value they attach to a particular good or service (directly or indirectly).
Computer	Experimental game, survey and evaluation was facilitated through an oTree open-source platform for social science experiments.
Treatments	Two different treatments were used. Treatments were randomised within sessions.
Rounds	Three rounds per session.
Compensation	Payment depends on the subjects' decisions, and subjects are paid based on their decision in one randomly chosen round.

3.4. Experimental procedures

This study used an experimental economics approach to capture the long-term effects of product recalls on implicated and related products. Socio-demographic characteristics, shopping habits, knowledge or attitude about food safety, and the WTP data were collected using an auction as developed by Vickrey (1961), a survey and an evaluation sheet. This auction experiment took place over three days from the 7th to the 9th of December 2020.

There are several variants of Vickrey auctions, and the second price Vickrey auction is the most common (Lusk and Shogren, 2007). In this variant, the winner pays the second-highest bid and receives the product. Per the second price variant logic, the auctions can be expanded to an n-th price auction. This study used the Vickrey fourth price auction, where the three highest bids win the auction and winners pay the amount equivalent to the fourth-highest bid. However, the bidders did not use actual money. Still, they selected their WTP on the computer screens, and the winning bidders received food vouchers equivalent to the 500g viennas retail price after the experiment. The auction experiment, questionnaire and evaluation sheet were programmed in the oTree open-source platform (Chen *et al.*, 2016) and conducted through computers.

As indicated in **Appendix A**, the experiment consisted of a survey, evaluation sheet and an auction game to collect the necessary information and WTP data. The survey and the evaluation were conducted after the experimental auction. All the subjects were treated as a single group per session, with all the subjects receiving the experimental auction link through their emails simultaneously. Each participant started with three experimental rounds in the auction. The first bidding round in the Vickrey fourth-price auction was without any treatment, and the rest had different treatments that influenced the behaviour of the consumers in each round. The winners of the bid and the payment prices were revealed after a few weeks. The consecutive steps in **Appendix A** were based on the Vickrey fourth price auction conducted by Li *et al.* (2017). Each step is explained below in more detail and supported by relevant literature from previous experimental studies.

Step 1: Invitation to participate and consent form

The invitation was sent to the Stellenbosch University students using official university emails. The Western Cape Department of Agriculture employees were invited through their work emails, and other non-government persons were approached randomly to participate in the study. The invitation consisted of the consent form (**Appendix B**), a section that required contact details, different flexible timeslots to participate, and the type of internet connection the subjects used to participate (**Appendix C**). The consent form was important to address the significance of the study, the procedures and rules to be followed, compensation, and so forth. By signing the consent form, the subjects consented to participate in the auction and to complete the questionnaire and evaluation sheet as part of the study. The contact details were also a crucial part of the invitation because we could identify and contact our subjects for further information regarding the experiment. Since the study was conducted online, different flexible timeslots were provided to choose when best suited them to participate. The timeslot was divided into four timeslots over three days since the study had four sessions with a maximum of 32 subjects who could participate in each session. The type of internet connection was asked to distinguish which participants were using their own data, workplace Wi-Fi or private institution Wi-Fi. This information was necessary in order to set up a suitable compensation strategy. The subjects who used the workplace or private institution Wi-Fi were exempted from receiving compensation for their internet connection; only those who used personal data and Wi-Fi were compensated for their data.

Step 2: Zoom meeting

During this study, the Covid pandemic restricted most of our livelihood and daily activities. As a result, people were forced to work from home and study in their homes. Thus, limited human physical contact was required to mitigate the risks of spreading coronavirus to other people. The pandemic shaped this experiment design and procedures to adhere to the South African Covid regulations. An online meeting was facilitated to briefly explain the significance of the study, auction mechanisms and related experiment procedures expected to be followed before commencing with the auction experiment. The participants were also given a chance to ask questions about the experiment.

Step 3: Explanation of the Vickrey fourth-price auction

Instructions of the Vickrey fourth price auction was given to the subjects before the experiment commenced. The auction moderator verbally explained the auction mechanism. Practical examples were used to explain the auction mechanism to help participants to understand the experiment better. We also emphasised that bidding their actual WTP is the best strategy in an auction (Li *et al.*, 2017; Lusk and Shogren, 2007). Also, examples of potential problems of over-bidding and under-bidding were explained.

Step 4: Unique participants' identification (ID) numbers and auction internet URL links

Each subject was randomly assigned a unique identification (ID) number corresponding to the number of their auction internet URL links. Hence, subjects were anonymous. The ID assisted in matching the qualitative data in the questionnaire with the WTP data and identifying the auction winners. Troost (2019) and Van Zyl (2011) have used the ID numbers in their auction studies for similar reasons, and this made their experiment very easy to conduct and follow throughout. The auction internet URL links were sent via emails to each participant shortly after the zoom meeting. Each participant received a unique URL link where they started their auction experiment, and their participation was monitored online using an oTree online platform.

Step 5: Bidding sessions

The bidding sessions were separated into four sessions with a maximum of 32 per session. Sessions were hosted in different timeslots over three days. Each session had different internet URL links for 32 participants. Also, the links differed across all sessions. The links from the oTree online platform directed each participant to the auction experiment, questionnaire and evaluation sheet. There were three rounds in the auction experiment, seven sections in the questionnaire and an evaluation sheet with two sections. All the participants in different sessions played the experimental auction as the Vickrey fourth price auction. The participants were expected to bid their WTP for 500g viennas. The bidding values were not restricted; each participant could bid freely without any maximum price ceiling on the viennas. The subjects were allowed to bid their willingness to pay a premium above or below the current retail price for the products. An image (**Figure 3.2**) was displayed to all subjects in the first round of the auction, and they were asked their willingness to pay for the 500g viennas. The product was not branded, but only the image of the actual product was displayed**.** In the first round, no information accompanied this image, thus no treatment. The first round of the experimental auction was the same for all participants in all sessions.

Figure 3.2 - 500g viennas from an unknown brand

The second and the third rounds of the experimental auction were different to all participants. Participants in the second round either received negative information treatment or control treatment. The control treatment did not have any negative or positive information accompanying the 500g viennas and requested participants to bid based on the image in **Figure 3.2**. The negative information consisted of facts about the *Listeria* outbreak in South Africa. The negative information included details on the recall as reported in the media headlines. In each session, the subjects were provided with negative facts about the *Listeria* outbreak, as illustrated in **Figure 3.3**. Once the subjects read the information, they were required to bid their WTP on the identical product of 500g viennas.

Negative information treatment

- On the 4th of March 2018, the government issued an urgent nationwide recall on the implicated product.
- It was termed the world's largest *Listeria* outbreak.
- The *L. monocytogenes* pathogen was identified in a widely consumed ready-to-eat processed meat product called "polony".
- The same strain was also found in the processing environment of the manufacturer of the implicated product.
- Listeriosis has been made a notifiable medical condition in South Africa Since December 2017.
- About 1 060 laboratory-confirmed cases have been reported from 01 January 2017 to 17 July 2018.

Figure 3.3 - Negative information treatment

Participants in the third round either received positive information treatment or control treatment. The positive information treatment consisted of positive facts about the *Listeria* outbreak that occurred in SA between 2017 and 2018. The positive information consisted of the details about the recall from media headlines and relevant articles. In each session, the subjects were provided with positive facts about the *Listeria* outbreak, as illustrated in **Figure 3.4**. Once the participants read the information, they were required to bid on the identical product of 500g viennas.

Positive/balanced information treatment

- The number of cases reported since the official end of the 2017/2018 *Listeria* outbreak in South Africa is well within (and in fact, below) the expected range for sporadic disease.
- The number of reported cases per week had decreased from 24.9 to an average of 6.4 since March 5, after the products were recalled.
- As of 15 June, 4 162 tons of recalled products have been destroyed by thermal treatment or landfill. This includes products destroyed at exported destinations.
- Food should be heated above 70 ^{0}C as heat kills the *Listeria* bacteria.
- Listeriosis is very rare, affecting an estimated 1-5 in 1,000,000 people per year in most developed countries.
- Consuming food with 0–100 CFU/g of *L. monocytogenes* does not cause any illnesses.
- There are no longer any traces of *Listeria* in South Africa.

Figure 3.4 - Positive information treatment

The control treatment was either received in the second or third round. All the participants who received this treatment were called control subjects. The control round was the same as the first round. It displayed the same 500g viennas image in **Figure 3.2** and asked the control subjects their willingness to pay for the viennas. Thus, each participant had four possible treatment combinations of rounds in their unique links that they were required to play. The first possible treatment combination received by participants in the auction round consisted of the negative information treatment in the second round and the positive information treatment in the third round. The second possible treatment combination in the auction rounds consisted of the negative information treatment in the second round and the control treatment in the third round. The third possible treatment combination in the auction rounds consisted of the control treatment in the second round and the positive information treatment in the third round. Lastly, the fourth possible treatment combination in the auction rounds consisted of the control treatments in the second and the third round.

Step 6-7: Questionnaire and evaluation sheet

The survey was conducted shortly after the auction experiment. The questionnaire collected demographic characteristics, shopping habits, objective knowledge or attitude about food safety and salience for all the subjects participating. It was necessary to collect information based on each subject's knowledge or attitude about food safety since it directly influences consumer behaviour. The questionnaire also consisted of questions regarding the *Listeria* outbreak in South Africa from 2017 to 2018, South African consumers' level of trust towards RTE meat products, and the fear of negative social evaluation (FNSE). The FNSE was measured using the 12-item scale developed by Leary (1983). The assessment of FNSE was on a five-point Likert scale (1 = not at all a characteristic of me, 2 = not a characteristic of me, 3 = neutral, 4 = characteristic of me, and 5 = extremely characteristic of me). After the questionnaire, the participants were directed to the last part of the experiment, which is the evaluation sheet. In the first part of the evaluation, participants were required to rate the relative importance of each element in the information treatment. The second part of the evaluation assessed other potential influences that can affect the bidding behaviour of participants. The assessment of other potential influences was on a seven-point Likert scale (1 = strongly disagree, 2 = slightly disagree, 3 = disagree, 4 = Neutral, 5= slightly agree, 6 = agree and 7 = strongly agree).

Step 8: Announce winners and collection of prices

After a few weeks, the results were announced through emails, and all participants were shown all the winners in each session and their bids. Each session had three winners, thus a total of 12 winners of the overall auction experiment. The three winners with the highest bids from each session received 500g viennas vouchers for the fourth-highest bid revealed in the chosen auction round. All the viennas vouchers were sent to all the winners through emails. Compensation for other participants who were not winners was provided. This compensation consisted of participation and data compensation, sent to participants through emails as a food voucher. All participants, excluding subjects from the Western Cape Department of Agriculture (WCDoA), received the participation compensation as a food voucher. The WCDoA participants were excluded by law from receiving any compensation, including the 500g viennas vouchers. No government official is allowed to receive any gifts or donations for any volunteered participation. Another type of compensation is the reimbursement of data used in

participating in this study – participants who indicated that they used their own data to participate received data compensation as a food voucher.

3.5. Data analysis

This study collected raw data through an auction game experiment, survey, and evaluation sheet. The whole experiment, including the survey and evaluation sheet, was programmed in an oTree open-source platform to conduct an online experiment. Thus the data was collected through electronic devices such as a computer or laptop from each subject who participated. After the experiment, all the raw data was extracted from the oTree platform and analysed with the following models.

3.5.1. Exploratory factor analysis

Exploratory factor analysis (EFA) is a multivariate statistical method that is used to identify the smallest number of hypothetical constructs (also known as factors or latent variables) that can parsimoniously explain the covariation observed in a set of measured variables or reflective indicators (Hair *et al.*, 2013; Watkins, 2018). The correlation whole factor analysis was conducted in R Studio software (R Core Team, 2018). The EFA was used in this study to summarise the data to a small number of latent variables that adequately represent the original set of variables. Firstly, the unit of analysis must be specified. According to **Figure 3.5** below, there are two analysis units: R factor analysis and Q factor analysis. The R factor analysis is the most common type of factor analysis used to analyse variables that identify the dimensions that are not easily observed. The Q factor analysis is not used as frequently as the R factor analysis. The Q factor analysis condenses large numbers of people into distinctly different groups within a large population. Since EFA was used to summarise data, the R factor analysis was selected as the unit of analysis.

The test for intercorrelations between measured variables is used to determine whether a particular data set is appropriate for EFA. The two tests were used, namely, the Bartlett test of sphericity and the measure of sampling adequacy. Bartlett (1954) stated that the Bartlett test of sphericity is used to test for correlations between variables statistically. It also determines whether the correlation matrix is sufficiently different from the identity matrix. A statistically significant Bartlett's test (< 0.05 significant level) indicates that sufficient correlations exist between the variables in order to proceed with the EFA (Hair *et al.*, 2013). The Kaiser-Meyer-Olkin measure of sampling adequacy is the ratio of correlations and partial correlations that reflects the extent to which correlations are a function of the variance shared across all variables rather than the variance shared by particular pairs of variables (Hair *et al.*, 2013). The overall KMO-MSA value must be above 0.50 before proceeding with the factor analysis. Once the variables have met the correlation requirements, factor analysis can be conducted. The correlation tests and factor analysis was performed in R Studio software (R Core Team, 2018). Within factor analysis, the factor extraction method must be selected between the principal component analysis (PCA) and common factor analysis (CFA) to extract the factors that will represent the structure of variables on the analysis.

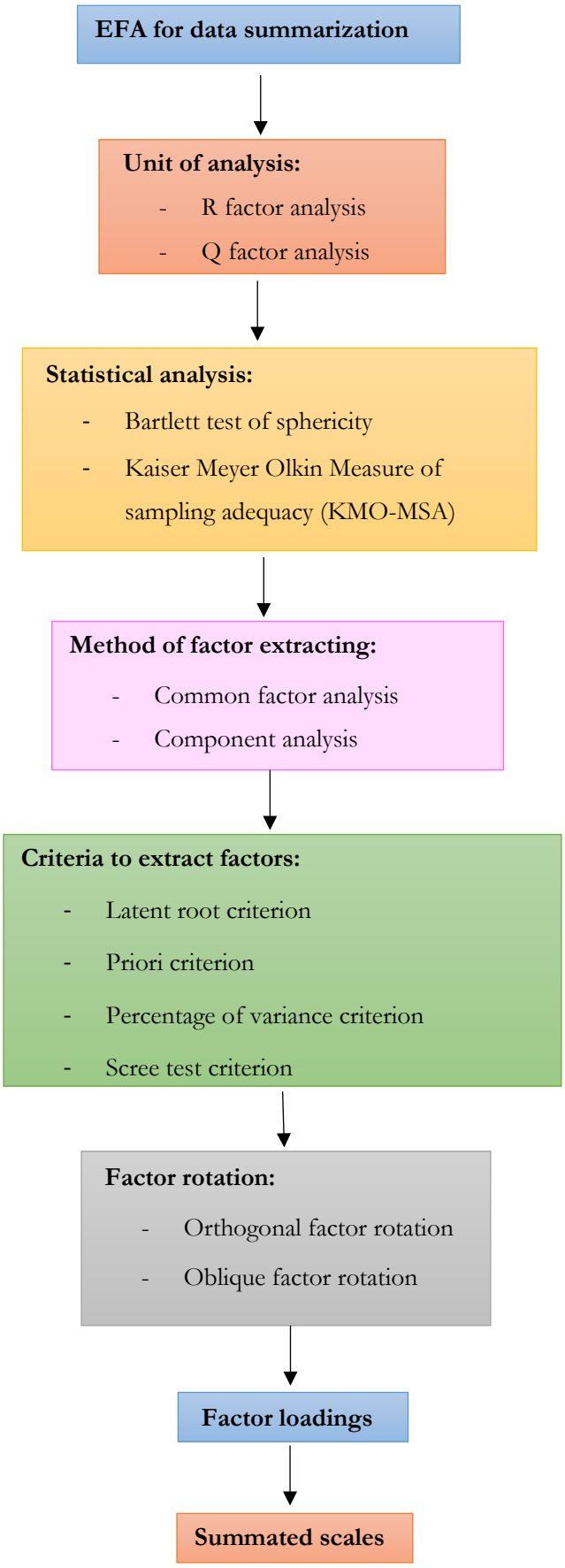


Figure 3.5 - Steps to conduct factor analysis

Adapted from Hair et al. (2013)

CFA analyses only the reliable, common variance of data whilst PCA analyses all the data variance (Kim, 2008). According to Hair *et al.* (2013), the principal component analysis is appropriate for data reduction. The common factor analysis is most appropriate when identifying the latent dimensions or constructs represented in the original variables. This study used the CFA analysis in this study since our goal was to determine the latent variables for further research. It further used the latent root criterion to determine the number of factors to extract. The latent root criterion is the most commonly used technique and can be applied in both PCA and CFA. Factors with latent roots or eigenvalues greater than one are considered significant and those with latent roots or eigenvalues less than one are not significant. The factors with significant eigenvalues determine the number of factors to be extracted in the data.

To interpret the factor loadings, factor rotation must be applied to unrotated factor loadings. The factor rotation changes the pattern of the unrotated factors and increases the understanding of each factor. There are two types of factor rotation, namely, orthogonal and oblique rotation. In this study, the orthogonal rotation method was used to simplify the rows and columns of the factor matrix to facilitate interpretation. There are three orthogonal approaches, namely, Quartimax, Varimax and Equimax. The Varimax rotation method was used to simplify the columns of the factor matrix. Significant factor loading were selected after the Varimax rotation, based on the rules of thumb provided by Hair *et al.* (2013). Factor loadings with values between 0.30 and 0.40 are minimally acceptable. Factor loadings with values equal to or greater than 0.50 are considered significant and retained in the analysis. Once all the significant factor loadings are identified, a commonality for each variable must be examined. The communalities represent the amount of variance accounted for in each variable by the rest of the variables. Variables must have commonalities of greater than 0.50 to be retained in the analysis (Hair *et al.*, 2013). Variables loading highly on a factor are summarised, and the average score is calculated to be used as a replacement variable (summated scale). Once the summated scales are formulated, reliability and validity tests must be conducted.

3.5.2. Tobit regression model

The Tobit regression model is used to quantify the magnitude and direction of the effects of factors influencing the independent variable. The Tobit regression model (McDonald and Moffitt, 1980), was conducted in R Studio software (R Core Team, 2018). The standard Tobit model was used to estimate the factors contributing to WTP change before and after the information treatment. Participants' bids were confined to a range of R0 to R∞ in the auctions. We assumed that a latent variable WTP_i^* represented participant i's actual willingness to pay. The value of the latent variable can only be observed when the relevant bids are greater than zero. Specifically, the relationship is:

$$bdiff_{i,jk}^* = \begin{cases} bdiff_{i,jk} = X\beta + \varepsilon_i \quad if \;\; b_{i,j} > 0 \;\; and \; b_{i,k} > 0 \\ [b_{i,k}, \infty) \quad if \; b_{i,j} = 0 \\ [-b_{i,j}, -\infty) \quad if \; b_{i,k} = 0 \\ (\infty, -\infty) \quad if \; b_{i,j} = 0 \; and \; b_{i,k} = 0 \end{cases}$$

$$WTP_i^* = x_i'\beta + \varepsilon_i$$

$$WTP_i = \begin{cases} 0 & if\ WTP_i^* \leq 0 \\ WTP_i^* & if\ 0 < WTP_i^* < \infty \\ \infty & if\ WTP_i^* \geq \infty \end{cases}$$

Equation 3.1 - Standard Tobit model

Where i represents the subjects.

Xi represents a vector of relevant independent variables.

β is a vector of coefficients.

ε_i is an error term.

3.5.3. Partial least squares structural equation modelling (PLS-SEM)

A partial least squares path modelling was used to test how internal factors may disrupt the relationship between intentions and behaviour. The PLS-SEM was conducted in SmartPLS software (Ringle *et al.,* 2015). It allows researchers to model, simultaneously estimate and test complex theories with empirical data (Sarstedt *et al.,* 2014). This model works efficiently when used to estimate path models with many constructs, several structural path relationships and/or many indicators per construct. According to Sarstedt and Cheah (2019), the PLS-SEM consists of a structural model representing the structural path between the constructs and the measurement model describing the relationships between the construct and its associated indicators. **Figure 3.6** below presents an example of a structural equation model for an integrated model of behavioural prediction.

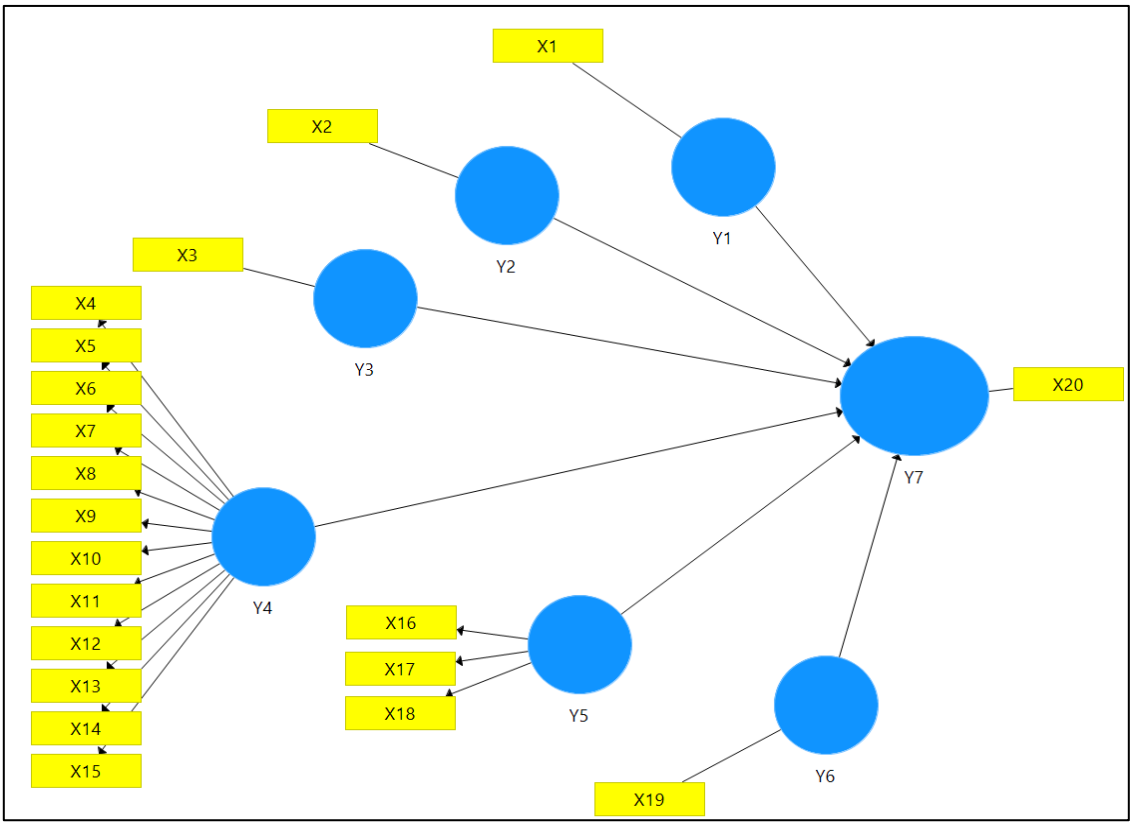


Figure 3.6 - Structural equations model based on the integrated model of behavioural prediction (IMBP)

Source: Compiled by author (2020)

The constructs are not measured directly and are represented in the structural model as blue circles or ovals (Y_1 – Y_7). When constructs have single-headed arrows going only out of them, they are called exogenous latent variables (Y_1 – Y_6), whilst constructs that have single-headed arrows going into them, they are endogenous latent variables (Y_7). In the IMBP, the exogenous latent variables include salience, knowledge, shopping habits, trust and fear of negative social evaluation. Whilst the endogenous latent variable is the behaviour in the IMBP. The PLS-SEM was conducted to estimate the relative strength of the cause-effect relationships between the latent variables mentioned above. The endogenous latent variables always have an R^2 value of which reveals how well exogenous latent variables explain the endogenous latent variables. Observed variables or indicators measure the latent variables. The yellow rectangles (X_1 – X_{20}) in **Figure 3.6** are the observed variables or indicators and represent the raw data obtained from an auction, survey and evaluation sheet. Sarstedt *et al.* (2014) stated that the measurement model determines the relationships between the latent variables and indicators. There are two ways to measure the latent variables, namely, reflective measurement and formative measurement. The reflective measurement approach measures the relationship from the constructs to the indicators, and the formative measurement approach measures the relationship from indicators to the construct. The evaluation of PLS-SEM occurs in two stages (**Figure 3.7**), where stage 1 examines the measurement theory and stage 2 covers the structural theory. The structural approach determines whether the inherent relationships are significant, meaningful and test the hypotheses (Sarstedt *et al.*, 2014).

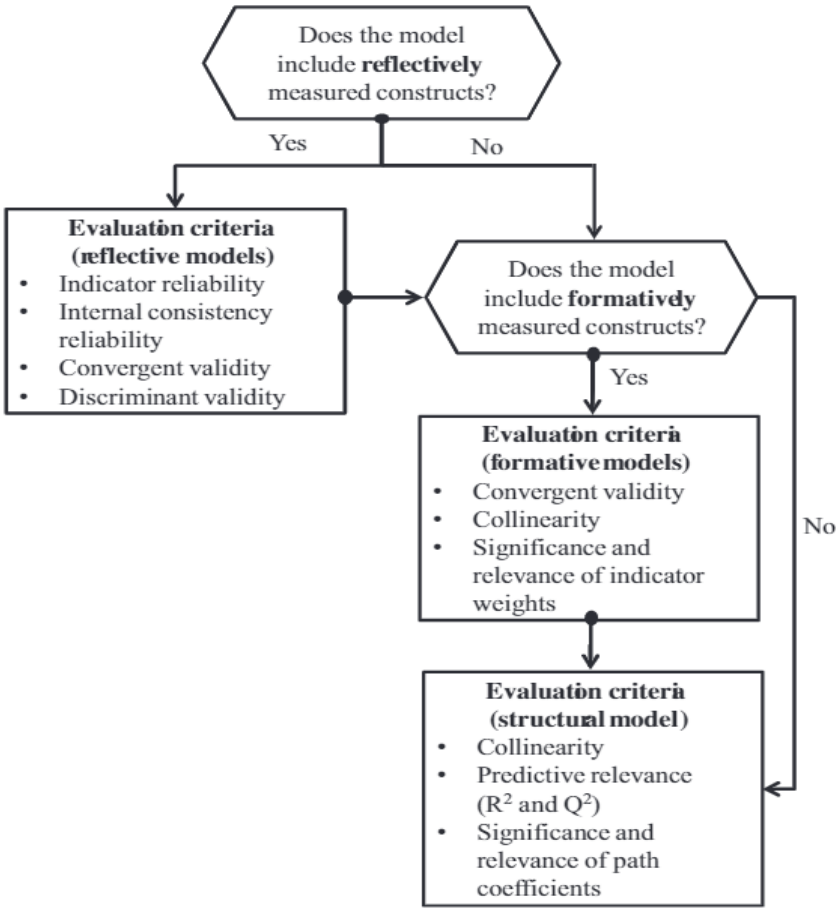


Figure 3.7 - PLS-SEM evaluation stages

Source: Sarstedt et al. (2014)

In stage 1.1, this study assessed the reflective measurement model by measuring the indicator reliability, internal consistency reliability, convergent validity and discriminant validity. Firstly, indicator loadings were examined, and the loadings above 0.70 indicate that the construct explains over 50% of the indicator's variance. The internal consistency reliability is evaluated using the composite reliability. According to Hair *et al.* (2017), composite reliability values between 0.60 and 0.70 are considered acceptable, and values between 0.70 and 0.95 are considered satisfactory to good. The convergent validity is measured by the average variance extracted (AVE) for all items associated with each construct (Sarstedt *et al.*, 2014). AVE value of 0.50 or higher is acceptable and indicates that the construct explains 50% of the variance of its items on average. The most recommended criterion for evaluating discriminant validity is the Fornell and Larcker (1981) criterion. In this criterion, the construct should not exhibit shared variance with any other construct greater than its AVE value (Sarstedt *et al.*, 2014).

In stage 1.2, the evaluation of formatively measured constructs involves examining convergent validity, collinearity, statistical significance, and the indicator weights' relevance (Hair *et al.,* 2017). Convergent validity shows the extent to which the measured constructs correlate with a reflectively measured construct (Sarstedt *et al.*, 2014). Hair *et al.* (2017) suggests that the formatively measured construct should explain at least 65% of the reflectively measured item(s) variance, indicated by a path coefficient of approximately 0.80. The level of collinearity is assessed by a variance inflation factor (VIF), and a higher VIF value above 5 indicates a greater level of collinearity among the indicators; thus, there is a problem of multicollinearity in the model (Sarstedt *et al.*, 2014). In order to determine the significance and the relevance of indicator weight, a complete bootstrap was run. Bootstrapping is a non-parametric procedure that allows testing the statistical significance of various PLS-SEM results such as path coefficients, Cronbach's alpha and R^2 values (Ringle *et al.,* 2015). A bootstrap maximum likelihood estimation approach was used with a 5000 bootstrap subsample, 300 maximum iterations, and a stop criterion of seven. The subsamples assist in computing bootstrap standard errors, which allow for the computation of *t*-values and *p*-values for each indicator weight. Indicator weights are standardised to values between -1 and +1 (Sarstedt *et al.*, 2014). Weights closer to +1 represent a strong positive relationship, and weight comparable to -1 indicates a strong negative relationship. If the weight is statistically significant, the indicator is retained and if it is non-significant but the indicator is 0.50 or higher, the indicator is still retained. If the weight is non-significant and the loading is below 0.50, the indicator should be deleted from the measurement model.

Once the measurement model assessment indicated adequate measures, one can move to stage 2 of the PLS-SEM evaluation process. In this stage, the researcher must first test the structural model for potential collinearity between predictor constructs. After testing for collinearity, the researcher can assess the coefficient of determination (R^2), cross-validated redundancy (Q^2), the estimated model's overall fit, and the path coefficients. A bootstrap must be run to get the R^2, Q^2, overall fit and path coefficients results. A bootstrap maximum likelihood estimation approach was used with a 5000 bootstrap subsample, 300 maximum iterations, and a stop criterion of seven.

The strength and significance of the path coefficients are assessed to determine the relationships or structural paths hypothesised between constructs. Path coefficients values are standardised between -1 to +1. Coefficients values closer to +1 represent a strong positive relationship, and coefficients values closer to -1 indicate a strong negative

relationship. R^2 measures the variance explained in each of the endogenous constructs, and it ranges between 0 and 1, with a higher value closer to 1 indicating a greater degree of predictive accuracy. According to Hair *et al.* (2011), the R^2 values of 0.75, 0.50 and 0.25 for endogenous latent variables in the structural model can be described as substantial, moderate and weak, respectively. The Q^2 builds on the blindfolding procedure, which omits a part of the data matrix, estimates the model parameters and predicts the omitted part using the previously computed estimates (Sarstedt *et al.*, 2014). The Q^2 values larger than zero indicate that the exogenous constructs have predictive relevance for the endogenous constructs under consideration (Hair *et al.*, 2011). The standardised root means square residual (SRMR) criteria evaluate the estimated model's overall fit, and when the value of SRMR $\leq$ 0.08, the research model has a good fit (Henseler *et al.,* 2016).

3.6. Conclusion

This chapter discussed the experimental design and procedures to collect the necessary data for this study. The first part of this chapter discussed the primary target population and respondents. This study targets students and non-student subjects who reside, study or work in Stellenbosch, located in the Cape Winelands District. This study required different consumers who are classified as marginalised, middle-class or affluent consumers. The experimental design was based on the frame field experiment scope, where subjects are exposed to contextual treatments with imposed rules in an auction experiment. The auction mechanism used was the Vickrey fourth price auction and facilitated through an online open-source oTree platform for social science experiments. We followed an eight-step procedure to conduct the experiment and to engage with the subjects who participated. After the data was collected, different types of models to analyse the data were used. The EFA was used to summarise some of the questionnaire and evaluation data to a small number of latent variables. The summarised data was further used in the Tobit regression model. The Tobit regression model was used to quantify the magnitude and direction of the factors that affected WTP change before and after the information treatment. Lastly, a partial least squares path modelling was conducted to determine how internal factors may disrupt the relationship between intentions and behaviour when purchasing RTE meat products after the recall.

CHAPTER 4

4. Socio-economic and consumer behaviour profile

4.1. Introduction

In this chapter, the sample demographics, processed meat consumption behaviour, consumer awareness of the *Listeria* outbreak, and consumer evaluation of food safety are analysed. Firstly, the sample demographic characteristics were discussed, focusing on gender, age, ethnicity, level of education, occupation, monthly household income and average household size. Secondly, the consumption behaviour for RTE meat products was analysed to determine the processed meat consumption preferences in South Africa (SA). Thirdly, consumer awareness for the *Listeria* outbreak in SA was analysed to determine how efficient information was received about the outbreak and which information was retained by RTE meat products consumers that might have affected their consumption patterns and habits. Lastly, this chapter analysed the consumers' perceptions about South African food safety.

4.2. Sample demographics

The sample demographics were obtained from an auction survey and are summarised below in **Table 4.1**. The statistics validity of the sample demographics is explained in Chapter 5, where the auction and survey results are discussed. The total respondents consist of 111 subjects with about 50 control and 61 treatment participants. The statistics validity between the control sample and treatment sample was analysed and discussed in Chapter 5. Since it was assumed that all participants had perfect information regarding the *Listeria* outbreak, the participants in the experiment were randomised to reduce biases and judgement.

Table 4.1 - Sample demographics

	Percentages (%) of total respondents		
Variables	**Sample (n=111)**	**Control (n=50)**	**Treatment (n=61)**
Gender			
Male	45%	18%	27%
Female	55%	27%	28%
Age			
Below 25 years	23%	10%	13%
25-34 years	44%	21%	23%
35-49 years	26%	10%	16%
50-64 years	7%	4%	3%
65 years and over	0%	0%	0%

	Percentages (%) of total respondents		
Variables	**Sample (n=111)**	**Control (n=50)**	**Treatment (n=61)**
Ethnicity			
White	16%	6%	10%
Black African	39%	23%	16%
Coloured	43%	18%	25%
Indian	0%	0%	0%
Other	0%	0%	0%
Prefer not to say	2%	0%	2%
Highest level of education completed			
Less than matric	6%	3%	3%
Matric	32%	13%	19%
Certificate or diploma	17%	6%	11%
Bachelor's degree	31%	18%	13%
Master's degree or doctorate	14%	7%	7%
Occupation			
Student	32%	17%	15%
Manager	2%	0	2%
Professional (Science, health, education, business, technology, legal, social and cultural)	10%	4%	6%
Technicians (Science, health, education, business, technology, legal, social and cultural)	1%	0	1%
Clerical support workers	14%	6%	8%
Service, sales and armed forces (Personal care, sales, protective services and armed force workers)	1%	0%	1%
Craft and related trades workers	0%	0%	0%
Plant and machine operators and assemblers	0%	0%	0%
Agricultural, forestry and fishery labourers (farmers and farm workers)	5%	4%	1%
Cleaners and helpers	3%	1%	2%
Labourers in mining, construction, manufacturing and transport	1%	0%	1%
Other occupation	31%	13%	18%

	Percentages (%) of total respondents		
Variables	**Sample (n=111)**	**Control (n=50)**	**Treatment (n=61)**
Monthly household income after tax			
R0 – R 4 999	41%	20%	21%
R5000 – R 14 999	31%	11%	20%
≥ R15 000	28%	15%	13%
Have children under the age of 8 years	31%	15%	16%
Have children between 8 and 18 years	22%	9%	13%
Average household size	3,50 per household		

According to **Table 4.1**, the sample of this study consisted of 45% males and 55% females. The sample's ages were classified into five categories with a minimum age of less than 25 years and a maximum age of 64 years. Most (44%) participants were in the 25-34 years age category, 26% in the 35-49 category, and 23% was younger than 25. The respondents of students are about 32%, and 68% of the total population is a working-class population. About 32% of the total sample population hold a matric qualification, and 31% have a bachelor's degree as the highest qualification obtained. The sample's monthly household income after tax represents all the consumer sub-groups in **Table 3.1**. About 41% of the total sample population consisted of consumers earning between R0 and R4 999, 31% of the total sample population consisted of consumers earning between R5000 and R14 999. About 28% of the total sample population consisted of earning more than R15 000 per month. More than 50% of the total sample population have children under 18 years and have an average household size of 3.5 people per household.

4.3. Consumption of ready-to-eat meat products

The consumption behaviour for RTE meat products was analysed to determine the processed meat consumption preferences of consumers who regularly purchase and eat RTE meat products in South Africa. According to **Table 4.2** below, most participants indicated that they are primary food shoppers in their households, and they frequently buy processed products. About 60% of the total sample population indicated that they are the primary shoppers of food in the household. They usually purchase processed meat products, dairy products, fruit and vegetable products and baked products. The participants further indicated that they regularly purchase RTE meat products, with 56% of the total sample purchasing RTE meat products 1-2 times per week.

Furthermore, about 37% of the total population purchase RTE meat products 1-2 times per month. As indicated in **Table 4.2**, almost all the processed meat products are bought often in South African households. This study indicated that viennas are the most frequently bought RTE meat product, with about 57% of participants who often buy it. Polony is the second most frequently bought RTE meat product, with about 41% of participants who

consume them. Ham is the least consumed RTE meat product with about 31% participants who regularly consume ham. Most of the participants purchase RTE meat products.

Table 4.2 - RTE meat products purchasing and consumption behaviour

Sample characteristics (n=111)	**Characteristics of the sample (n=111)**
Main buyer	
Yes	60%
No	40%
Type of ready-to-eat product purchased	
Meat products (e.g. viennas)	80%
Dairy products (e.g. cheese)	84%
Fruit and vegetable products (e.g. salads)	71%
Baked products (Sandwiches)	36%
None of the above	0%
How often are ready-to-eat meat products purchased	
Never	1%
1-2 times per week	56%
1-2 times per month	37%
1-2 times per year	6%
RTE meat products bought often	
Polony	41%
Viennas	57%
Ham	31%
Purchased for personal consumption or the whole household	
Personal consumption	59%
Consumption for the whole household	41%

For consumers to purchase a product, there are specific quality attributes they observe. These quality attributes may include taste, convenience, nutritional content, cost and safety of the products. Participants were required to rate each of these quality attributes based on RTE meat products in this study. Each quality attribute was measured with a five-point Likert scale. One is very important, two is important, three is moderately important, four is slightly important, and five is unimportant. According to **Figure 4.1** below, almost all the RTE meat products quality attributes are rated as very important factors for purchasing processed meat products. About 42% of the participants stated that taste is very important and about 21% indicated that taste is moderately important. About 37% of the total sample indicated that convenience is very important, and about 28 % of respondents stated that convenience is important.

Most participants indicated that the nutritional content of RTE meat products is important. About 25% of the total sample size stated that nutritional content of processed meat product is important and about 23% of the total sample size indicated that is very important. About 35% of the total sample size indicated that the cost for RTE

meat products is very important and about 23% of the total sample population indicated that the cost for RTE meat products is moderately important. Lastly, consumption safety for RTE meat products was indicated by most participants as very important. About 41% of the total sample population stated that consumer safety is paramount and about 19% of the total sample size indicated that consumer safety is essential.

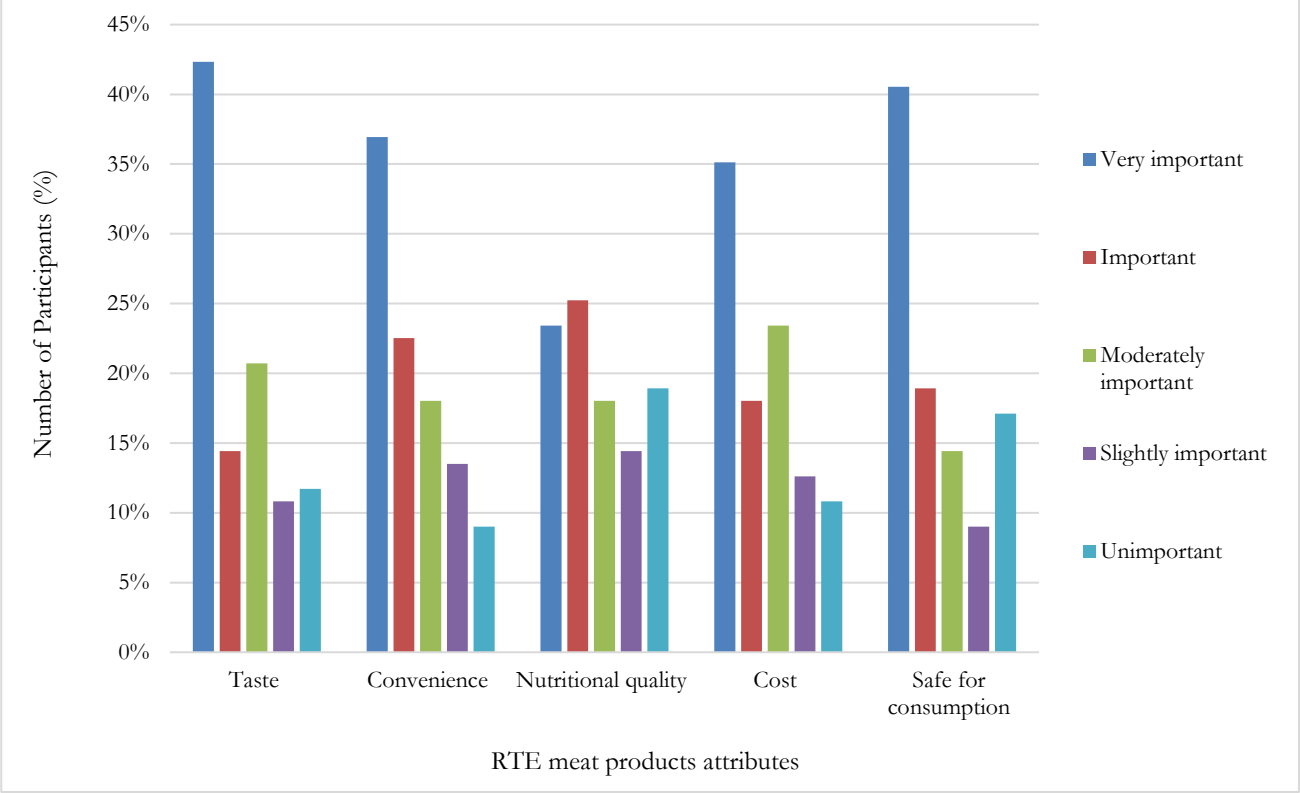


Figure 4.1 - Factors influencing consumer purchasing behaviour for RTE meat products

4.4. Consumer awareness of *Listeria* outbreak in South Africa

Figure 4.2 below shows the results of questions that identified the participants' knowledge about the *Listeria* outbreak in SA from 2017 to 2018. The vast majority of participants (95%) indicated that they were aware of this event. However, participants could have falsely answered that they were aware so as not to appear ill-informed. Approximately 87% of respondents knew that polony was the implicated product during the outbreak. Nearly 62% of respondents recalled the year of the outbreak correctly. Even though most participants answered some of the questions correctly, most lacked the more specific details such as the number of cases reported, deaths and the province with the lowest number of confirmed cases during the outbreak. Approximately 28% of respondents answered correctly about the number of reported cases and death cases associated with the outbreak.

More than 40% of respondents did not know the answer about the reported cases and death cases. In the last question, more than 40% of the total participants answered incorrectly about the province with the lowest number of confirmed cases during the outbreak. Furthermore, nearly 53% of participants did not know the answer associated with the province with the lowest number of confirmed cases during the outbreak.

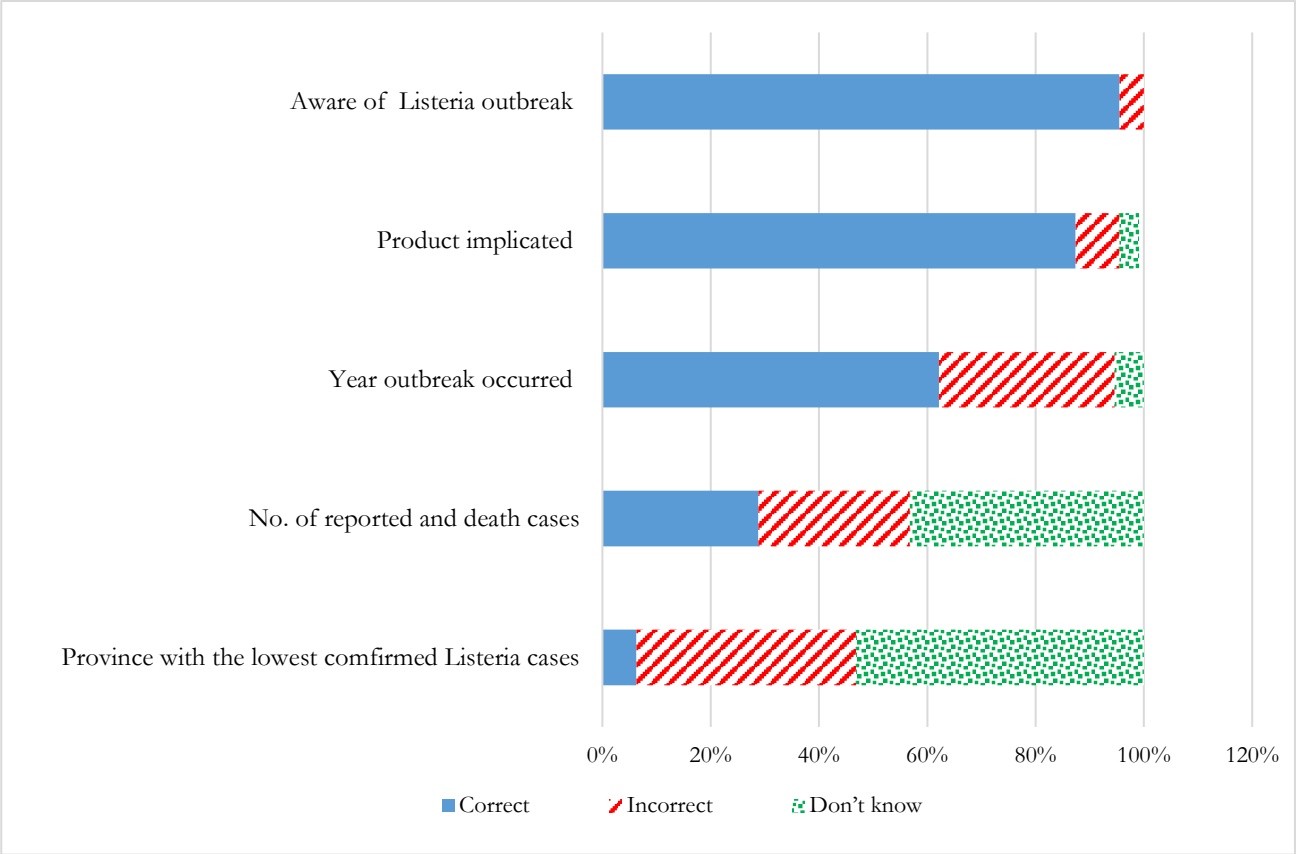


Figure 4.2 - Summary of participants' knowledge about the *Listeria* outbreak in South Africa

4.5. Consumer evaluation of food safety issues

Table 4.3 below shows the relative importance of various elements from the information treatments presented to participants in the auction experiment. Each element was evaluated on a scale from one (unimportant) to five (very important). Most elements, on average, were viewed as somewhat important as the minimum score was 3.54. In the negative information treatment, participants believed that the number of the implicated products recalled was the most important element (4.32), followed by the number of confirmed illnesses reported (4.31). From the positive information treatment, the number of confirmed illnesses was the most important element (4.27), followed by the nationwide recall scope (4.23). This result indicates that although consumers are influenced by negative information on recalls, they also value scientific reports with positive information. We further identified other potential factors that influenced bidding behaviour using exploratory factor analysis (EFA). According to Hair *et al.* (2013), factor analysis[19] is an interdependence technique whose primary purpose is to define the underlying structure among the variables in the analysis. The main objective of factor analysis is to group highly intercorrelated

[19] Factor analysis can either result in a summarized data or reduced data. According to Hair *et al.* (2013), in summarized data, factor analysis derives underlying assumptions which describe data in much smaller numbers than in the original individual variables whilst data reduction extends the process by deriving an empirical value (factor score) for each factor and then substitute it with the original values.

variables into distinct sets or factors. The highly intercorrelated variables have similar patterns of responses because they are all associated with the latent variable, which is not directly measured.

Table 4.3 - Importance of elements from information treatments on participants' WTP

Negative information treatment elements	
Nationwide scope of recall	4.29
Number of the implicated products recalled	4.32
Number of confirmed illnesses	4.31
Known deaths	4.24
Positive information treatment elements	
Nationwide scope of recall	4.23
Number of the implicated products recalled	4.16
Number of confirmed illnesses	4.27
Known deaths	4.18
Ready-to-eat (RTE) meat products safe if cooked above 70 ^{0}C	3.98
Number of reported case are well within the expected range	3.85
Listeriosis is very rare	3.54
Food safety regulations keeps *L. monocytogenes* at less than 100 CFU/g	3.92
No traces of *Listeria*	3.99

In this study, factor analysis was used to summarise the data and reduce the data obtained from the evaluation sheet. Consumer evaluation of food safety issues was conducted after the experiment survey. The questions were coded using a seven-point Likert scale where each element was rated from one (strongly disagree) to seven (strongly agree). It should be ensured that the variables are sufficiently intercorrelated to produce representative factors to conduct a factor analysis. The sampling adequacy for consumer evaluation data was acceptable since the KMO-MSA value was 0.83, and for each variable, the KMO-MSA is greater than 0.50. The Bartlett test of sphericity for consumer evaluation data demonstrated that the variables are highly correlated ($X^2(153) = 1342.23$, $p < 0.001$). The correlation measure and factor analysis between variables were conducted through R software (R Core Team, 2018). After completing factor analysis with an orthogonal rotation method, the following rotated factor loadings and communalities were obtained, as indicated in **Table 4.4** below. According to Hair *et al.* (2013), the rotation[20] of factors greatly assists in providing factor loadings[21] with the adequate interpretation of the variables analysed.

[20] The orthogonal rotation method was used and approached applied was the VARIMAX rotation in R software.
[21] Factor loading represents the correlation between an original variable and its factor.

Table 4.4 - Factor analysis results summary after Varimax rotation

Factors (latent variables)	Variables	Factor loadings	Commonalities	Average rating
Factor 1 – Distrust of food industry (Institutional risk)	The Department of Health does a great job keeping the food supply safe.	0,778	0,683	4,320
	The Department of Agriculture does a great job keeping the food supply safe.	0,728	0,584	
	The meat industry cares about consumers.	0,765	0,635	
	Farmers do a great job keeping the food supply safe.	0,751	0,605	
	The South African food supply chain is the safest in the world.	0,753	0,648	
	Meat producers treat livestock well.	0,799	0,653	
Factor 2 – Risk associated with consumption of RTE meat products (RTE meat products consumption risk)	Not buying any RTE meat products.	0,887	0,875	3,516
	Trying to avoid eating RTE meat products.	0,841	0,772	
	Not buying any meat whether processed or not.	0,735	0,633	
	Not ordering dishes with RTE meat products in restaurants.	0,735	0,681	
Factor 3 – Risk associated with meat and meat products industry (meat and meat products industry risk)	Very worried about the food safety of livestock.	0,795	0,749	5,477
	Very worried about the food safety of ready-to-eat (RTE) meat products.	0,842	0,565	
Factor 4 – Risk associated with food recall (Recall risk)	I don't try recalled food again for a long time after a recall.	0,668	0,761	4,297
	Other consumers will be slow to buy RTE meat products again.	0,609	0,810	

After the factor analysis, only the variables with factor loadings greater than 0.55[22] and communalities greater than 0.50 are retained in the analysis. Each variable in **Table 4.4** was rearranged and grouped according to significant loadings. Variables that highly load in factor 1 were grouped to a latent variable called the institutional risk. It captures a latent sense of risk associated with consumer distrust of the food industry. Variables that highly load in factor 2 were grouped and called the RTE meat products consumption risk, describing the risks associated with the consumption of RTE meat products. Variables in factor 3 were grouped and called the meat and meat products risks. The grouped variables in factor 4 were called the recall risk, which captures the risk associated with a food recall. All of the factors or latent variables are further used in the econometric models in Chapter 5. According to the average rating for each factor or latent variable, measured with a seven-point Likert scale (1-strongly disagree to 7-strongly agree), almost all the ratings were below five. On average, participants are neutral about the institutional risk, RTE meat products consumption risk and recall risk. However, factor 3 had a rating of five,

[22] In a sample with 100 participants, factor loadings of 0.55 and above are considered significant.

meaning that participants on average slightly agreed that they worry about the livestock and processed meat industry risks.

4.6. Conclusion

This chapter presented participants' socio-economic profiles where various demographic characteristics were discussed. The sample demographic statistics revealed that the total respondents consisted of more females (55%) than males (45%), and the most prevalent age category was the 25-34 years age category (44%). The total respondents had a more working-class population than students. The consumer behaviour profile for the participants was further discussed in detail. About 60% of the total respondents indicated that they are the primary shoppers of food in the household. They usually purchase processed meat products, dairy products, fruit and vegetable products and baked products.

Furthermore, the participants revealed that they regularly consume RTE meat products, with about 56% of the total respondents purchasing RTE meat products 1-2 times per week. Thus, this indicates that the subjects who participated in this study were suitable for assessing the post behaviour of regular consumers of RTE meat products in SA. The results showed that most participants were aware of the previous outbreak since most participants answered most questions correctly. The factor analysis results showed that they were most worried about the livestock and processed meat industry risk compared to other risks in the food sector. In Chapter 5, the auction results are further discussed and linked with the statistical analysis of the socio-economic and consumer behaviour profile.

CHAPTER 5

5. Experimental auction results and discussions

5.1. Introduction

This chapter focuses on discussing the results from the auction experiment, relating the outcome with the real-world market. Behavioural economics techniques was applied to understand better the consumers' behaviour towards making the economic decision in purchasing implicated products after a recall. In behavioural economic models, people look to others when making decisions and seeking happiness (Baddeley, 2013). Their findings show that consumers are usually affected by skills, personalities, moods and emotions. The mainstream economic models do not necessarily consider internal and external factors (such as skills and environmental constraints) that may affect consumers' economic decisions primarily based on food safety, climate change and other social or environmental phenomena. The behavioural analysis in this chapter shows that some other variables influence consumer behaviour and disrupt the relationship between real intention and behaviour after a food safety scare.

5.2. Descriptive statistical analysis

A descriptive statistics analysis was conducted to provide a high-level overview of the data and to check the normality of the bidding data collected. The mean, standard deviation, minimum value, maximum value, first quartile and third quartile was used to summarise the bidding data. Skewness and Kurtosis were used to check the normality for each variable. According to McShane-Vaughn (2016), skewness is the symmetry of distribution, and kurtosis measures the height and sharpness of a distribution's central peak. The skewness value can be positive or negative, but the skewness value is zero for a perfectly symmetrical or normal distribution. Negative skewness indicates that the distribution has a negative or left skew and a positive skewness value indicates a positive or right skew distribution. If the skewness is less than -1 or greater than one, the distribution is highly skewed, and if the skewness is between -1 and -0.5 or between 0.5 and one, the distribution is moderately skewed.

Furthermore, if the skewness is between -0.5 and 0.5, the distribution is approximately symmetric. As for the kurtosis, if the kurtosis value is less than 3, the distribution is flat (plytokurtic). If the kurtosis value is greater than three, the distribution has a high peak (leptokurtic). If the distribution has a kurtosis value equal to three, the distribution is perfectly normal (mesokurtic).

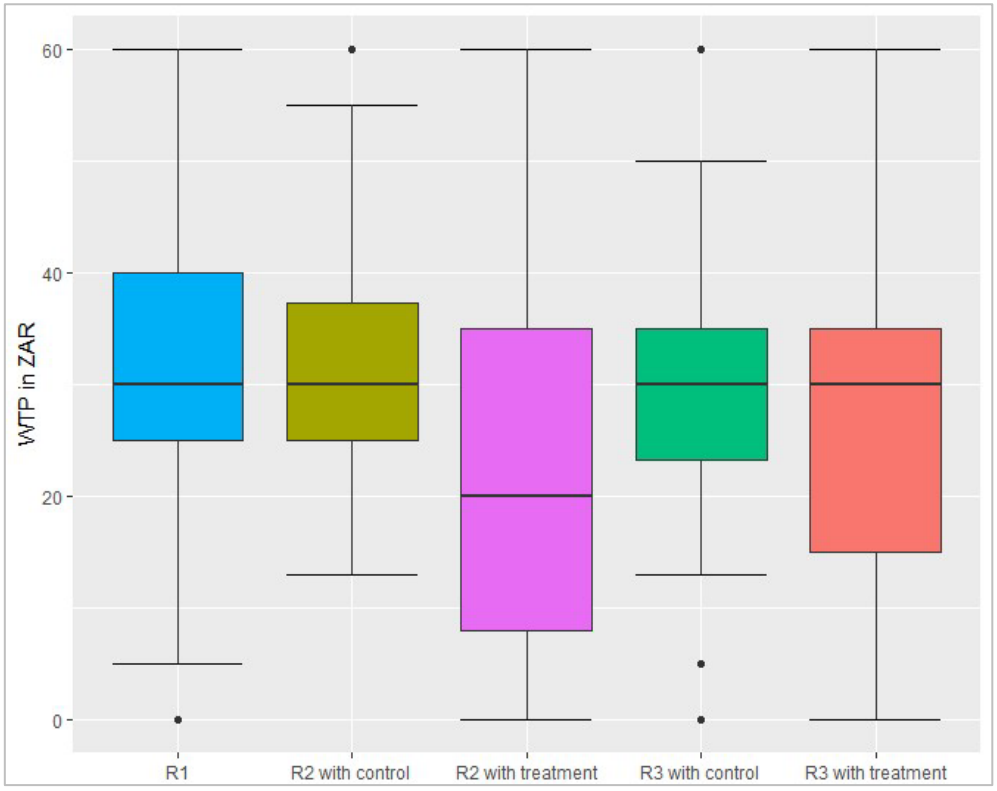


Figure 5.1 - Descriptive statistical analysis between experiment rounds

The auction experiment had four sessions, whereby each session consisted of three rounds. In each three-round, participants were expected to make biddings between R0 and R∞. In the first round, participants did not receive any information treatment, whilst in rounds two and three, participants received negative or positive information treatment. The mean bid between the experiment's rounds is the same, except round two, where participants received an information treatment. The mean bid in round one, round two with control treatment (R2 with control), round three with control treatment (R3 with control) and round three with information treatment (R3 with treatment) is R30. The mean bid in round two with information treatment (R2 with treatment) is R20, the lowest of the mean bids in other rounds. Round two (R2) with treatment and round three (R3) with treatment have the highest standard deviation compared to other rounds.

5.3. Inferential statistical analysis

Since the WTP data distributions in treatments and control rounds are not normally distributed, a non-parametric test called the Mann-Witney-U test was used for the inferential statistical analysis. A Mann-Whitney-U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous but not normally distributed. It tests the null hypothesis that it is equally likely that a randomly selected value from one sample will be less than or greater than a randomly selected value from a second sample. The Mann-Whitney-U test was conducted with a statistical package in R software (R Core Team, 2018). The test statistics, Wilcoxon test statistic and the p-values are reported in **Table 5.1** below.

Table 5.1 - Mann-Whitney-U test for experimental treatments in rounds two and three

Type of non-parametric tests	Variables	Treatment or control	W	Significant level (p value)	Null hypothesis (H_0)
Mann-Whitney-U test	Round 2	Negative treatment	986.5	0.001342	Reject the null
		Control treatment			
Mann-Whitney-U test	Round 3	Positive treatment	1055	0.3665	Accept the null
		Control treatment			

The Mann-Whitney-U test null hypothesis states that the population medians are all equal. The p-values are compared to determine whether the difference between the medians is statistically significant. A significant level of 0.05 is usually used to determine the differences. If the p-value is less than the 5% significant level, it indicates a difference and rejects the null hypothesis (H_0). According to **Table 5.1**, the p-value of round two between the negative and control treatment is less than the significance level of 0.05. Thus, the null hypothesis is rejected and conclude that the difference in round two between the negative and control treatment medians is statistically significant. Therefore, there is a statistically significant difference in WTP after the participants were exposed to negative information. The p-value of round three between the positive and control treatment is greater than the significance level 0.05. Thus, the null hypothesis was accepted and conclude that the difference in round three between negative and control treatment medians is not statistically significant. Therefore, there is no significant difference in WTP after the participants were exposed to positive information.

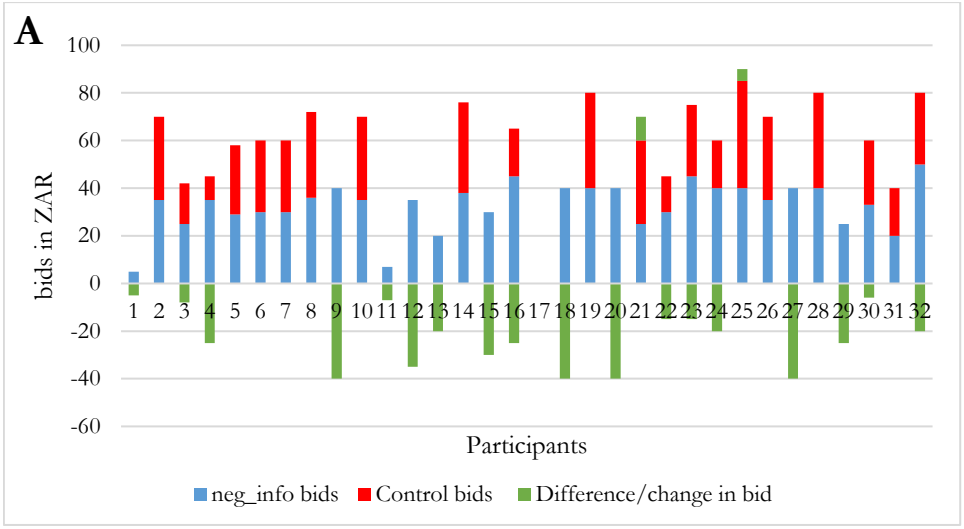
5.4. Discussion of auction results

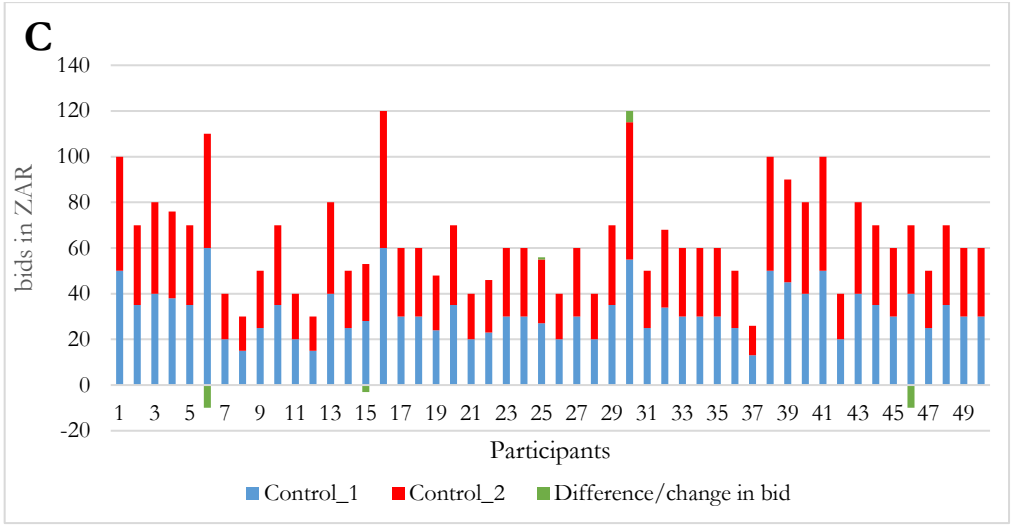
In this section, the results from Vickrey fourth price auction is presented and discussed in detail. The main aim of this auction experiment was to measure the WTP for RTE meat products, particularly viennas, after the *Listeria* outbreak in SA. Secondly, the impact of information treatments on bidding behaviour was analysed. It was expected that the negative information treatment decreased the WTP whilst the positive information increased the WTP. Currently, the products implicated during the outbreak are sold as normal in the market.

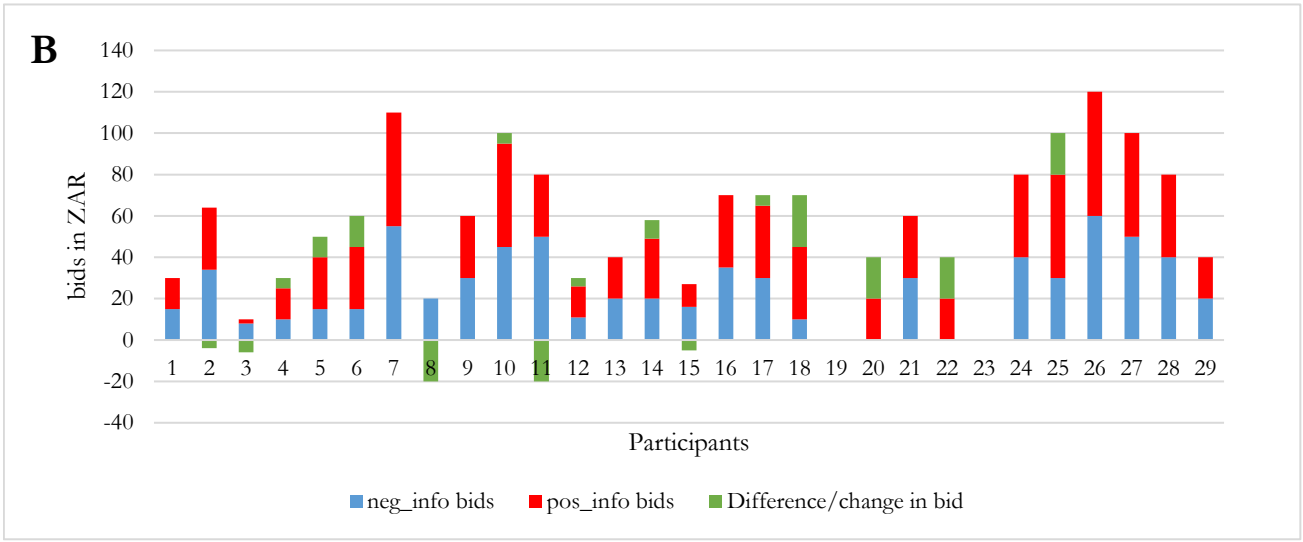
The study looked at which factors have the greatest influence on consumer behaviour when purchasing RTE meat products. Moreover, the internal factors that can influence the WTP for 500g were analysed. An IMBP conceptual framework was used to present the structure of the relationship between internal factors and behaviour. However, the PSL-SEM was used to test how these internal factors disrupted the relationship between intentions and behaviour.

5.4.1. Impact of negative and positive information treatment on consumer WTP

The following results show the possible influences of negative and positive or balanced information about the SA *Listeria* outbreak on consumers' WTP.







WTP from each rounds was compared between treatments and notifiable differences were observed. The differences are shown in each diagram (**A**-**C**).

Diagram **A**: **Figure 5.2** - WTP and bid change after participants received negative information

Diagram **B**: **Figure 5.3** - WTP and bid change after participants received negative and positive information treatment

Diagram **C**: **Figure 5.4** - WTP and bid change in no treatment rounds (control round 1 and control round 2)

Figure 5.2 shows the WTP and bids change for participants who received negative information treatment in the second round of the experiment. From the total number of participants, 32 participants received negative information, and most of them showed a significant change in this bidding round. Most bids decreased, and the highest difference in the bid was R40.00 after negative information. This decrease in WTP after negative information was expected. Surprisingly, the highest difference in the bid after the negative treatment was equal to the average current market price of 500g viennas. Thus, this means that some consumers may not find worth in the implicated product after the recall and decide not to eat it or value it the same way as before the food scare. According to Zhong *et al.* (2018), most studies have shown that negative or positive information about food scares can affect consumers' risk perception and further determine their attitude and buying behaviour.

Moreover, these studies have indicated that negative information can directly reduce food demand and have a dominant effect on consumer decisions involving WTP. Fox *et al.* (2002) examined the effects of negative and positive descriptions of food irradiation on WTP for a pork sandwich irradiated to control *Trichinella*. They showed that the positive description increased WTP, while the negative description decreased it. When the participants were given both descriptions, the negative description dominated and reduced the overall WTP. (Lee *et al.*, 2011) compared the effect of positive, negative and two-sided traceability information on consumers' WTP for imported beef. The results indicated that negative and two-sided information significantly reduced WTP, whilst the effect of positive information was insignificant. Such studies have shown that consumers tend to place a higher weight on negative information than positive or balanced information. As a result, the WTP is significantly influenced by negative information relative to positive information during and after a food recall or food scare.

Figure 5.3 shows the WTP and bids change for participants who received negative and positive information treatment during the experiment. As expected, after receiving positive information, most participants increased their WTP for 500g viennas. The change in the bid after the positive information was not as significant or large as the change after negative information. Thus, this shows that negative information might have reduced the WTP of some participants even though they slightly increased their WTP after positive information. Some participants, after the positive information treatment, decreased their WTP. This result shows how negative information can dominate and significantly impact consumer food safety attitudes and shopping habits. **Figure 5.4** shows very little change in bids between control round one and control round two bids. Most participants bid with the same WTP in control round one and control round two. Thus there were no significant changes between these control rounds.

Table 5.2 - Tobit regression results on WTP after the *Listeria* recall in South Africa

Variables	Coefficient estimate	Significant level
(Intercept)	25.606907 (6.706752)	***
Age	-0.004409 (0.137630)	
Female	2.353970 (2.078096)	
Coloured	5.854848 (2.417555)	*
Edu_level	2.676463 (2.411851)	
Occupation	-2.618194 (3.043169)	
Income	2.351316 (2.788819)	
Children_18	4.827700 (2.362499)	*
Primary_shopper	1.946725 (2.299090)	
Meat_industry_risk	-0.546052 (0.868411)	
RTE_consumption_risk	-0.083074 (0.908910)	
Recall_risk	0.729771 (0.817961)	
Institutional_risk	-0.052235 (0.944779)	

Numbers in the parentheses are standard errors.

Significance levels: ******* 0.1%, ******1%, *****5%, '**.**' 10%

Appendix O describes the explanatory variables used in the regression models. The first-round bids were taken as the truthful value that the consumers place on the 500g viennas, especially after the *Listeria* outbreak between 2017 and 2018. Almost all the demographic variables were not statistically significant, but the ethnic group for coloured people was statistically significant at the 5% significant level. The coloured participants WTP increased by R5.85 more than the other ethnic group for 500g viennas after the recall. The other important variable was the participants with children under 18 years, and it was statistically significant at 5%. Participants with children under 18 years of age were willing to pay R4.83 more for 500g viennas than participants with no children. This result was expected because most working populations with children tend to buy RTE meat products convenient for breakfast or lunch for children.

Table 5.3 - Tobit regression results on WTP after negative information treatment

Variables	Coefficient estimate	Significant level
(Intercept)	6.95578 (10.96098)	
Age	0.05715 (0.20331)	
Female	4.29397 (3.02166)	
Coloured	6.22128 (3.25399)	.
Edu_level	9.83074 (3.54367)	**
Occupation	-3.78151 (4.39729)	
Income	-11.32890 (4.50101)	*
Children_18	6.32137 (3.61596)	.
Primary_shopper	8.18526 (3.01476)	**
Meat_industry_risk	-0.93856 (1.40312)	
RTE_consumption_risk	-4.65939 (1.66848)	**
Recall_risk	3.25847 (1.47975)	*
Institutional_risk	3.35684 (1.53951)	*

Numbers in the parentheses are standard errors.

Significance levels: *** 0.1%, **1%, *5%, '.' 10%

Again, coloured participants were not sensitive towards negative information since they increased their WTP by R6.22 for 500g viennas compared to other ethnic groups. The WTP increase from coloured groups might be because they have forgotten about the devastating implications of the *Listeria* outbreak since it occurred two years back. Thus, the more years pass from the *Listeria* incident, the more people forget about its impact and gradually pay for the implicated product. Participants with an education level equivalent to a bachelor's degree or higher qualifications are willing to pay R9.83 more for the 500g viennas in the negative information treatment. This result shows that highly educated consumers tend to trust more the food safety of the implicated product after the associated food scare. However, participants who earned R15 000 or more decreased their willingness to pay for 500g viennas by R11.32 after receiving the negative information treatment.

Even after receiving the negative information treatment, participants with children under 18 increased their WTP for 500g viennas with R6.32 more than the participants with no children. Primary shoppers also had a positive effect and increased their WTP by R8.19. Participants worried about the food safety risks associated with the consumption of RTE meat products decreased their WTP for 500g viennas by R4.66 after receiving negative information about the previous outbreak. Participants showed that they are not worried about risks associated with food scares, such as the *Listeria* outbreak. As a result, participants who were not concerned with the risk associated

with food recalls increased their willingness to pay for 500g viennas by R3.26 after receiving negative information about the previous outbreak. Participants who had a positive attitude towards the food institution and industries in SA increased their WTP for 500g viennas by R3.36.

Table 5.4 - Tobit regression results on WTP after negative and positive information treatment

Variables	Coefficient estimate	Significant level
(Intercept)	6.13705 (6.04235)	***
Positive_info	1.11116 (0.06111)	***
Age	-0.09661 (0.08589)	
Female	-3.69062 (1.70355)	*
Coloured	4.35406 (1.87033)	*
Edu_level	-0.29642 (2.35607)	
Occupation	-0.10896 (2.74662)	
Income	-1.05357 (1.82602)	
Children_18	-9.27574 (2.03620)	***
Primary_shopper	-3.40959 (1.46085)	*
Meat_industry_risk	0.59929 (0.65025)	
RTE_consumption_risk	1.09136 (0.52917)	*
Recall_risk	-2.44531 (0.66535)	***
Institutional_risk	0.35188 (0.64329)	

Numbers in the parentheses are standard errors.

Significance levels: ******* 0.1%, ******1%, *****5%, '**.**' 10%

Participants who received both information treatments had a slight increase of R1.11 in their WTP for 500g viennas. Female participants decreased their WTP after receiving both information treatments by R3.69 for 500g viennas. Coloured participants also increased their WTP by R4.35 for 500g viennas. Surprisingly, participants with children who received both information treatments had a significant decrease in their WTP for 500g viennas by R9.28. Also, primary shoppers decreased their WTP by R3.41, and those worried about the risk associated with food recalls slightly reduced their WTP by R2.24. Participants who are less concerned about the risk associated with consumption of RTE meat products slightly increased their WTP to pay by R1.09, and those with a positive attitude towards the food institutions or industries slightly increased their WTP by 35 cents for 500g viennas.

5.4.2. Analysis of consumer behaviour after the outbreak

The second objective of the study was to determine if consumer behaviour towards the implicated products is still affected by the 2017/2018 *Listeria* foodborne disease outbreak. In order to see if the consumers were affected, we observed their response from questions which were about their consumption of RTE meat products and other closely related meat products. Moreover, the WTP data that was discussed above, was also used to observe any changes after participants have received information that reminded them about the *Listeria* outbreak that took place more than three years ago. In relation to one of the common assumptions of mainstream economics, consumers are rational and as a result we expect that their behaviour doesn't change towards the products that were implicated during the foodborne disease outbreak. The following diagram reflects how the auction game was conducted and assist in explaining the Nash equilibrium for the auction game.

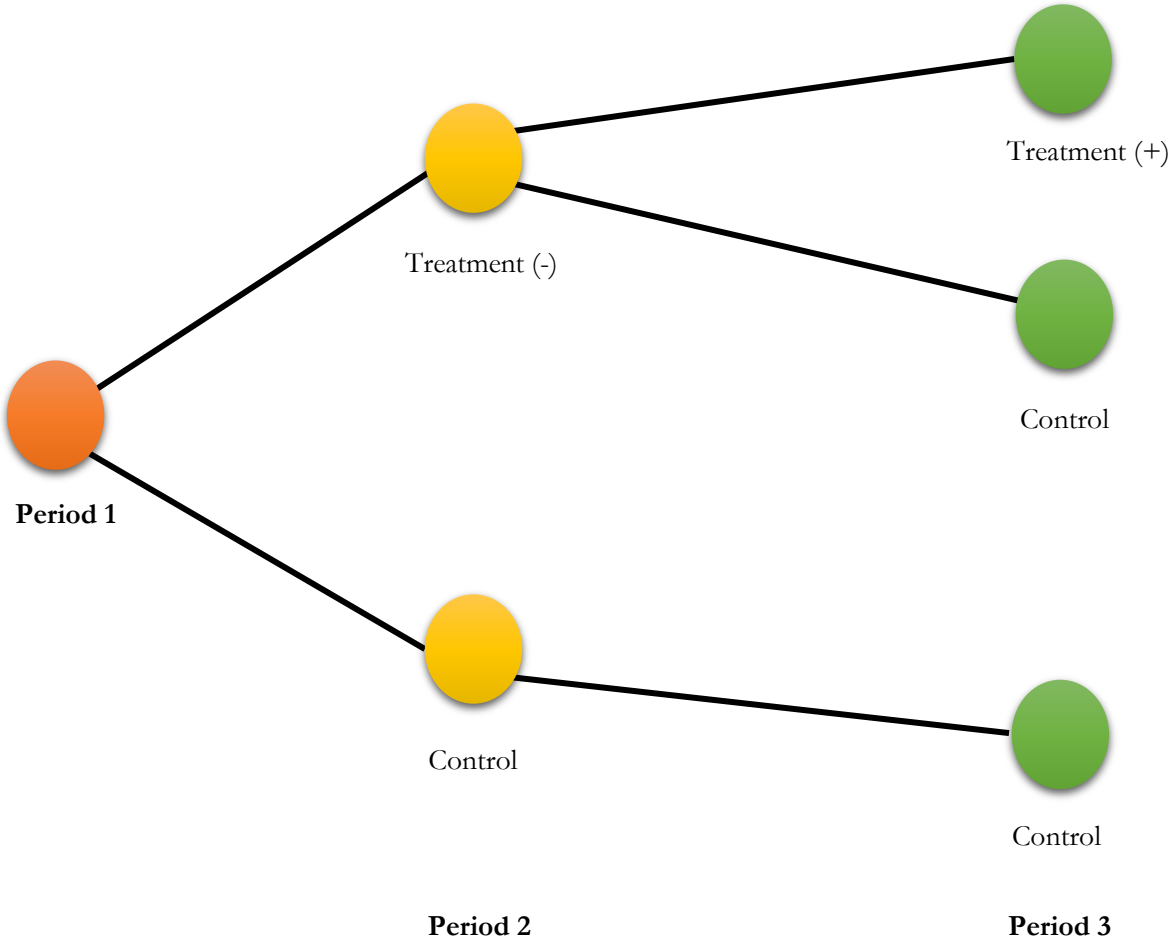


Figure 5.5 -Tree diagram for the experimental auction rounds

Figure 5.5 is a schematic tree diagram that represents the description of the auction experiment rounds in each period. In period one, all participants did not receive any information treatment when asked about their willingness to pay for 500g viennas. In period two, some participants received negative information treatment, whilst others received no information treatment (control) before asking about their willingness to pay for 500g viennas. Furthermore, some participants who received negative information treatment in period two received positive information treatment whilst others received no information treatment (control) before being asked about their

willingness to pay for 500g viennas in period three. Some participants received no information treatment (control) before asking about their willingness to pay for 500g viennas in period two. They also did not receive any information treatment (control) in period three.

The weakly dominant strategy in the Vickrey price auction is to bid truthfully, i.e., to bid the true value that the auctioned good or service is truthfully worth (Lusk and Shogren, 2007). Bidding more than your true value can lead to a win, but you might pay more than what the good is worth. Bidding less than your true value could lead to loss and miss the opportunity to buy the product, which increases the participant's total utility. However, bidding with an accurate value maximise the total utility of the bidder in the Vickrey auction. Suppose that the true value (v_i) is less than the highest bid (B). The participant who bids truthfully will lose and obtain a zero utility. However, if any participant bids more than B, the participant wins, pays B, and enjoys a negative utility ($v_i - B < 0$) lower than when the participant bids truthfully. Suppose that the true value (v_i) is greater than the highest bid (B). The participant who bids truthfully will win and enjoys a positive utility ($v_i - B > 0$). If any participant bids less than B, the participant loses and receives zero utility. Rational consumers always seek to maximise utility, but the auction experiment has shown that most participants enjoy a total positive utility that is less than their maximum total utility. As a result, most participants in the Vickrey auction are irrational consumers.

Nash equilibrium (NE) is one of the most crucial concepts in game theory. It is used to determine the optimal solution in a non-cooperative game in which each player lacks any incentives to change their initial strategy. Each player chooses a strategy that maximises their expected payoff given the strategy employed by other players. Sophisticated rational players are expected to select strategies that are in the NE. In the Vickrey fourth price auction truthful bidding, $b_i = v_i$ for all i is a Nash equilibrium. Thus, if players deviate from this equilibrium, they are regarded as irrational players. Nash Equilibrium is all the participants' valuation values for the implicated products in round 1 of the auction experiment. It was assumed that the valuation values are between R0 and R100 since there were no bids with an amount greater than R100.

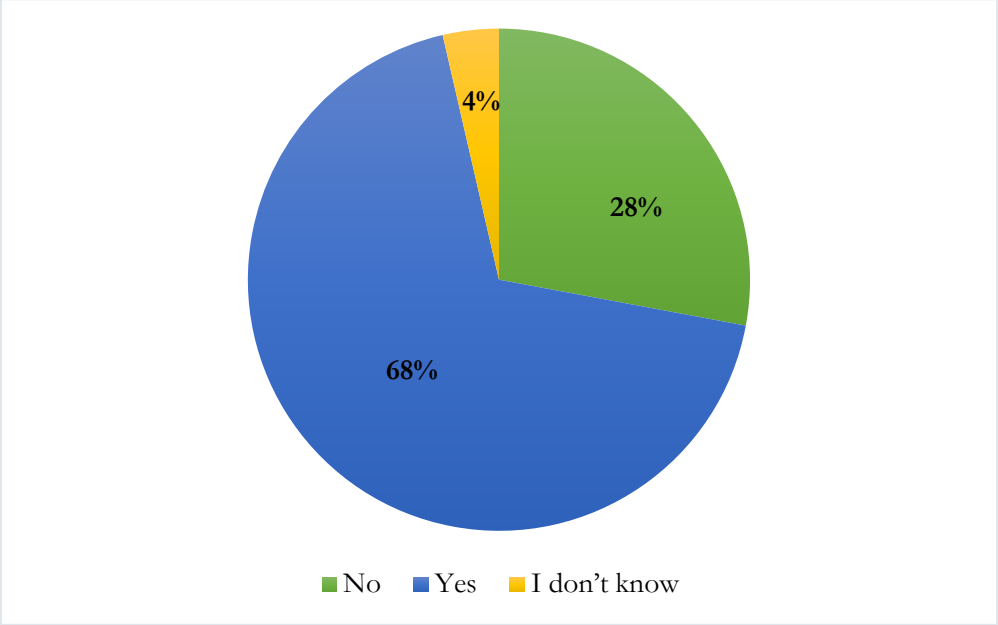


Figure 5.6 - The changes in purchasing behaviour for RTE meat products due to the *Listeria* outbreak

As indicated in **Figure 5.6**, about 68% of participants agreed that the *Listeria* outbreak changed their purchasing behaviour for RTE meat products. About 28% of participants stated that their behaviour changed after the product outbreak. These participants either shifted to other substitutes, bought less of the implicated products, purchased other RTE meat products that were not involved, or they might have stopped purchasing any RTE meat products until safe to consume. According to the questionnaire, most participants preferred other meat products compared to the RTE meat products. About 73% of the participants indicated they often buy sausages and only 41% of participants often buy polony.

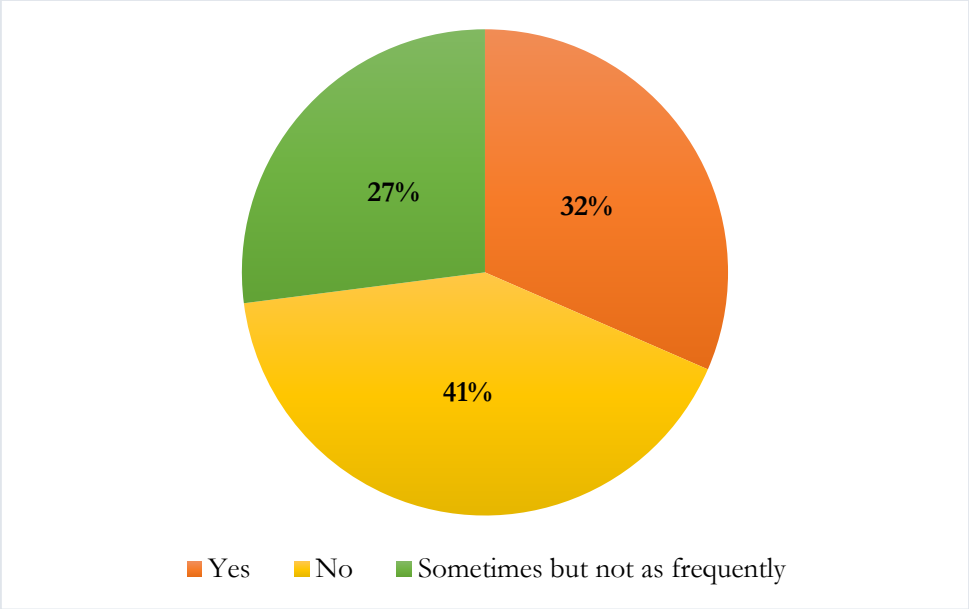


Figure 5.7 - Consumption frequency of the implicated product after the outbreak

According to **Figure 5.7**, about 41% of participants did not consume the product implicated during the outbreak. About 27% of participants do not consume it as frequently as they used to consume it before. Thus, this indicates that most consumers still feel unsafe when consuming RTE meat products even though the outbreak occurred in 2017/2018.

Figure 5.2 and **Figure 5.3** showed the changes in WTP after the participants received negative and positive or balanced information. As previously discussed **Figure 5.2** showed that the WTP decreased significantly in most participants although this study expected that the participants won't decrease their WTP after the outbreak. After receiving positive information, most participants increased their WTP but the increase was not as significant or large as the change after negative information. According to the Nash equilibrium, the participants will bid their true value that the auctioned good or service is truthfully worth to them. However, any deviation from the true value, either an increase or decrease from the true value, indicates that the participants are irrational. Thus, this study showed that the participants were irrational since most participants' WTP after receiving negative information in the second and positive information in the third round of the auction, deviated from the true value in round one when they did not receive any information. This result leads to the rejection of the null hypothesis

that consumers are rational and do not change their behaviour towards the implicated product after the outbreak. Therefore, it can be concluded that consumers are irrational and do change their purchasing behaviour as a result of the food safety scare.

5.4.3. Factors affecting consumers' behaviour toward economic decisions

To determine the causal relationship between consumers' real intention and behaviour, a partial least squares structural equation modelling (PLS-SEM) was conducted using a SmartPLS v. 3.3.3 (Ringle *et al.*, 2015). The auction experiment rounds were separately analysed using the PLS-SEM. The analysis occurred in a two-step approach for reporting PLS-SEM results. The first step consists of the measurement model assessment where the factor loadings, discriminant validity, construct reliability and validity are examined. A second step assesses the structural model and reports the path coefficients (β), the significance of path coefficients, variance explanation of endogenous constructs (R^2), effect size (f^2) and predictive relevance (Q^2). Hypothesis testing in the context of PLS-SEM is usually conducted through the calculation of *p*-values for each path coefficient. The following hypothesis was tested using PLS-SEM:

H_0: Trust has a major relevant effect and statistically significant relation with the consumers' WTP for RTE meat products after the *Listeria* outbreak.

The first step in the measurement model assessment is conducting the exploratory factor analysis. The initial exploratory factor analysis was conducted on 65 reflective and six formative indicators using the SmartPLS software. Since each data distribution for each round in the experiment did not show a normal distribution, a bootstrap maximum likelihood estimation approach was used with a 5000 bootstrap subsample, 300 maximum number of iterations, and a stop criterion of seven. Bootstrapping is a non-parametric procedure that allows testing the statistical significance of various PLS-SEM results such as path coefficients, Cronbach's alpha and R^2 values (Ringle *et al.*, 2015).

After conducting the exploratory factor analysis, 19 reflective indicators in the participants' WTP round one was left (**Appendix F**), 19 reflective indicators in participants' WTP round two (**Appendix I**), and 16 reflective indicators in participants' WTP round three models (**Appendix L**). The reflective indicators removed in each round model improved the quality and predictive relevance of the structural model. They assisted in achieving noticeable improvements in the internal consistency, convergent validity and discriminant validity of the reflective measurement constructs. The reflective measurement model yielded satisfactory results since the values of the indicator reliability, internal consistency reliability, convergent validity and discriminant validity for all three models below were well above their acceptable threshold (see **Appendix F**, **I** and **L**). Fornell and Larcker criterion for all models showed that the square root value of the AVE of each construct is more significant than its correlation values with other constructs (see **Appendix H**, **J** and **M**). Moreover, the SRMR values for all three models were less than 0.08, indicating a good fit for the overall model (see Appendix **G**, **K** and **N**).

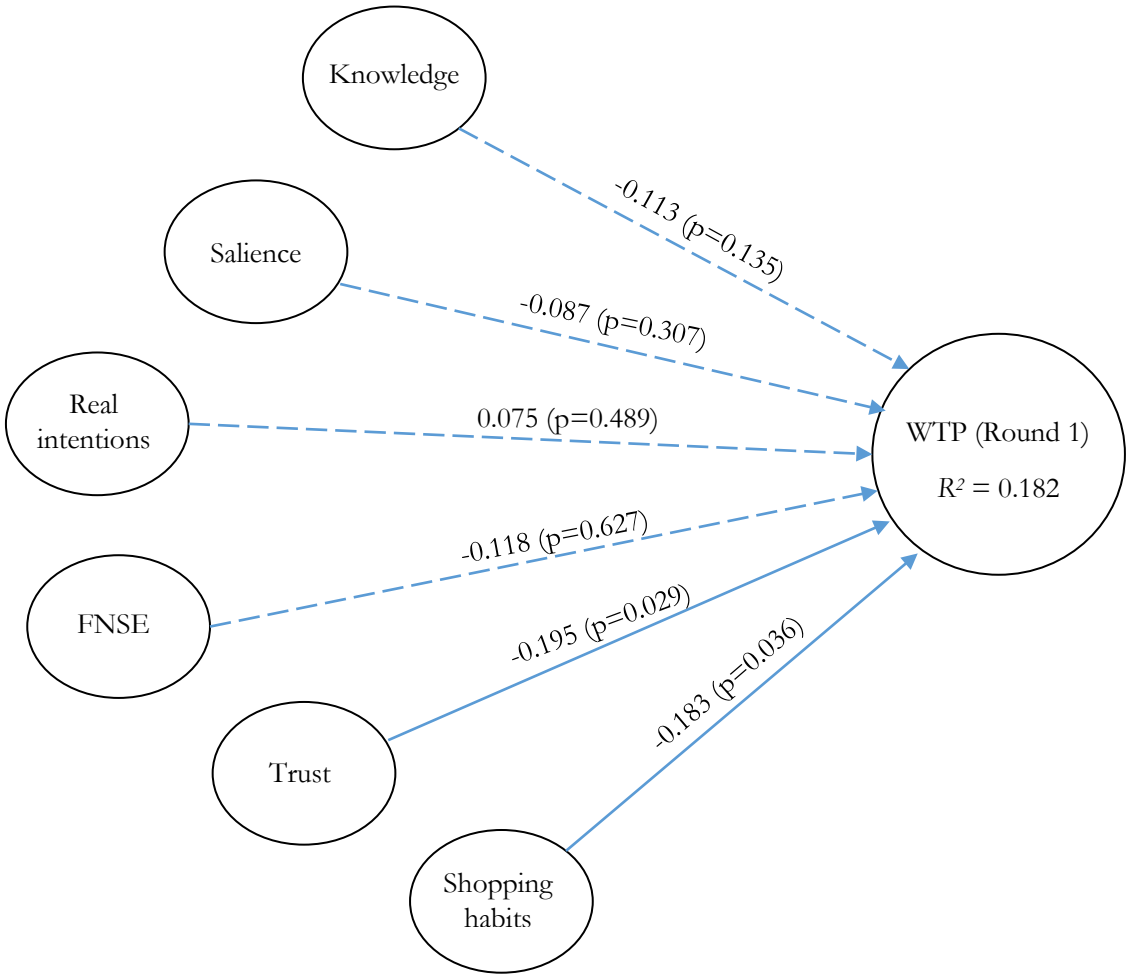


Figure 5.8 - PLS-SEM model for factors affecting consumer behaviour in round one of the experiment

Note: Solid arrows represent significant pathways and non-significant ones by dashed arrows.

The coefficient of determination, R^2, is 0.182 for the WTP endogenous latent variable (**Figure 5.8**). A very low R^2 was expected since most studies that predict human behaviour usually have R^2 values lower than 50%. R^2 of 0.182 means that six latent variables (knowledge, salience, real intentions, fear of negative social evaluation (FNSE), trust and shopping habits) weakly explain the 18.2% of the variance in the WTP variable. Thus, about 18.2% of the participants' WTP in round one was influenced by the six latent variables. Out of six latent variables, only two were statistically significant towards the participants' WTP in round 1. According to **Figure 5.8** , the hypothesised path relationship between trust and WTP in round one was statistically significant at 5% significance level. The hypothesised path relationship between shopping habits and WTP in round one was statistically significant at 5% significance level.

Moreover, Trust and shopping habits showed a negative effect on the WTP in round one. This result suggests that consumers still do not trust the RTE meat products the same way as before, and as a result, the trust variable harmed the WTP of the participants, which may be the main reason they decreased their WTP for RTE meat

products. Thus, the null hypothesis that trust has a major relevant effect and statistically significant relation with the consumers' WTP for RTE meat products after the *Listeria* outbreak was accepted. On the other hand, shopping habits also played an important role in decreasing the WTP after the outbreak. As indicated in **Figure 5.7**, most participants changed their purchasing behaviour towards RTE meat products. Most consumers stopped or reduced the frequency of buying RTE meat products after the outbreak; as a result the WTP for these products was reduced.

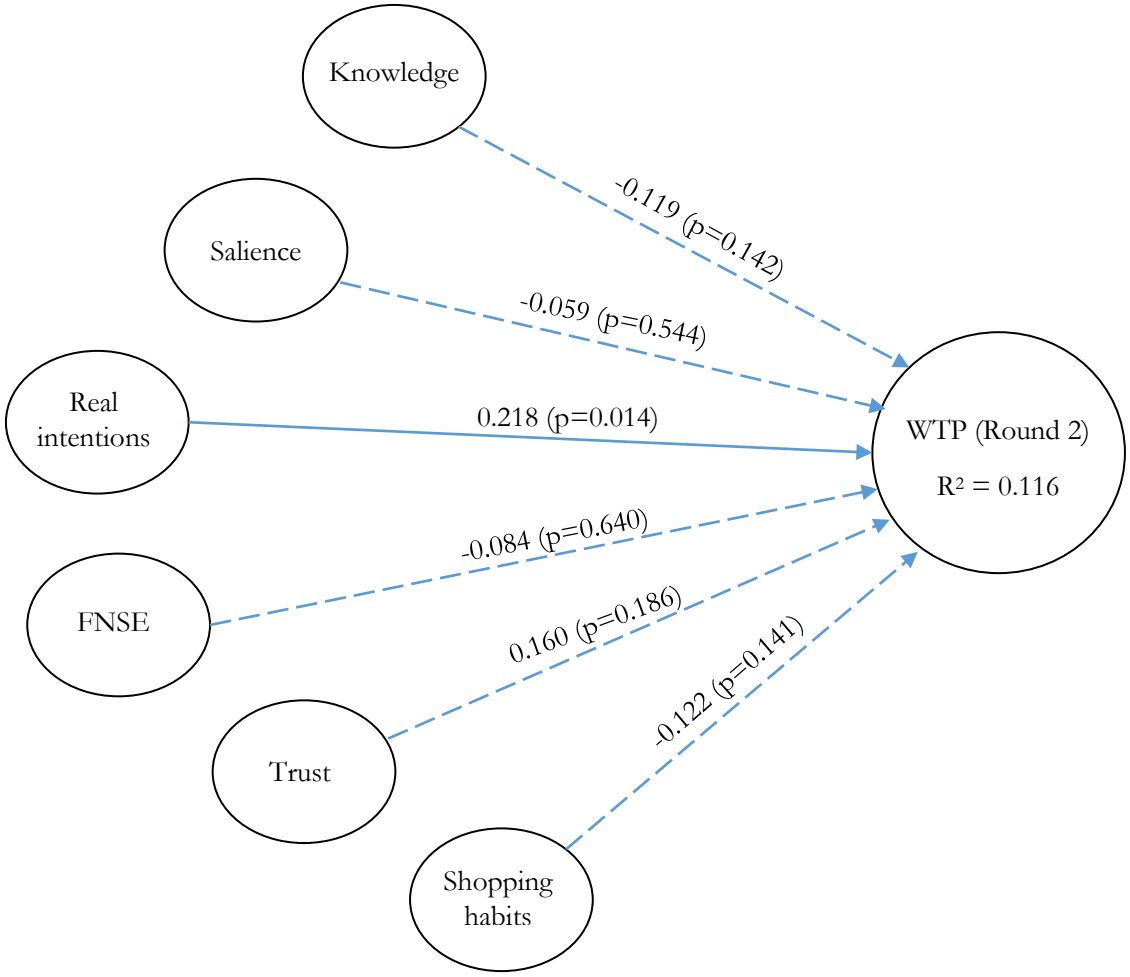


Figure 5.9 - PLS-SEM model for factors affecting consumer behaviour in round two of the experiment

Note: Significant pathways are represented by solid arrows and non-significant ones by dashed arrows.

The coefficient of determination, R^2, is 0.116 for the WTP endogenous latent variable (**Figure 5.9**). The R^2 of 0.116 means that the six latent variables (knowledge, salience, real intentions, fear of negative social evaluation (FNSE), trust and shopping habits) weakly explain the 11.6% of the variance in the WTP variable. Thus, about 11.6% of the participants' WTP in round two was influenced by the six latent variables. Out of six latent variables, only one was statistically significant towards the participants' WTP in round two. According to **Figure 5.9** , the hypothesised path relationship between the real intention and WTP in round two was statistically significant at a 5% significance level.

Moreover, real intentions showed a positive effect on the WTP in round two. This model rejects the null hypothesis since real intention had the greatest effect on the WTP compared to other variables. The main component that made the real intention to have a significant relationship with actual behaviour in this model was the education level of participants. The highly educated participants had a positive intention to purchase RTE meat products after the outbreak.

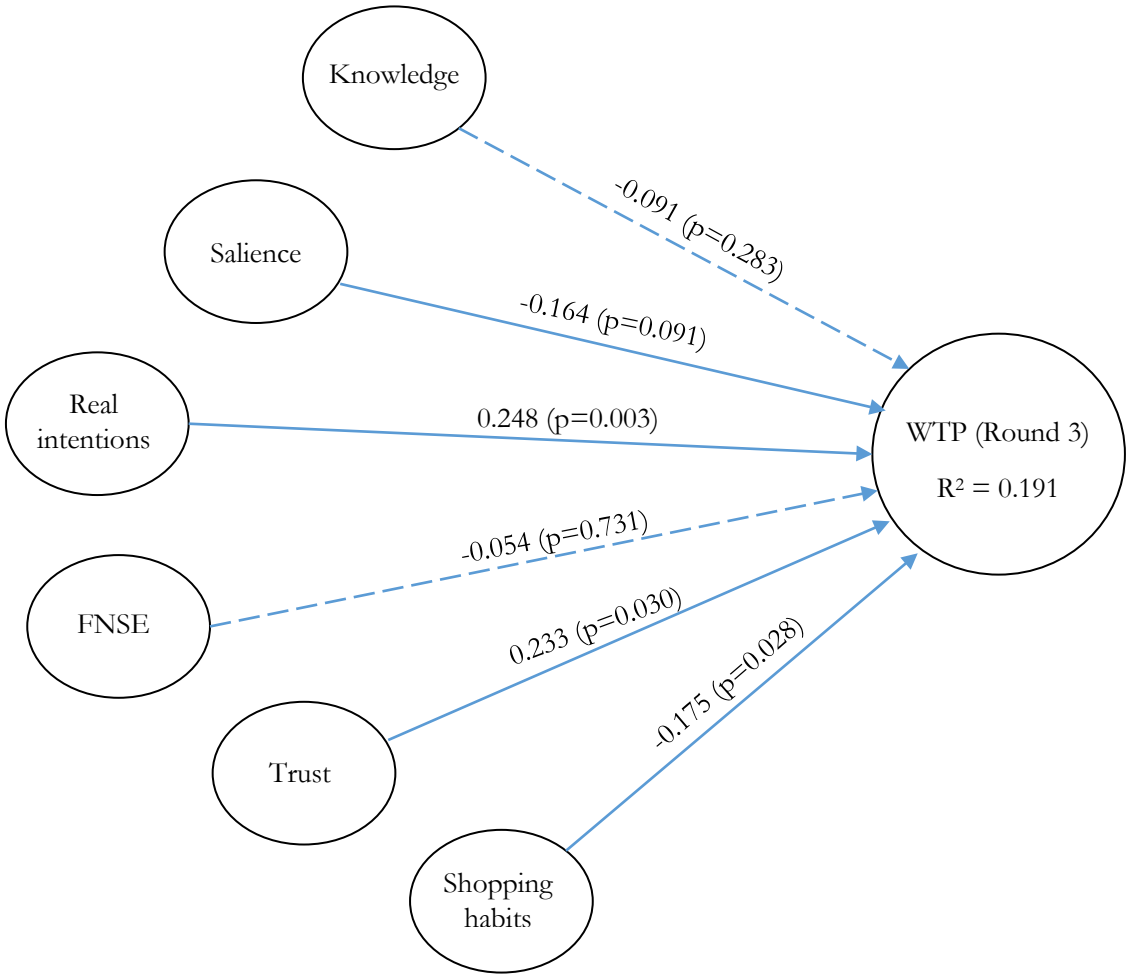


Figure 5.10 - PLS-SEM model for factors affecting consumer behaviour in round three of the experiment

Note: Significant pathways are represented by solid arrows and non-significant ones by dashed arrows.

The coefficient of determination, R^2, is 0.191 for the WTP endogenous latent variable (**Figure 5.10**). The R^2 of 0.191 means that the six latent variables (knowledge, salience, real intentions, fear of negative social evaluation (FNSE), trust and shopping habits) weakly explain the 19.1% of the variance in the WTP variable. Thus, about 19.1% of the participants' WTP in round three was influenced by the six latent variables. Out of six latent variables, only four were statistically significant towards the participants' WTP in round three. According to **Figure 5.10**, the hypothesised path relationship between real intentions and WTP in round three was statistically significant at a 5% significance level and had the highest positive effect on participants' WTP in round three than the other latent variables. The hypothesised path relationship between trust and WTP in round three was statistically significant at

a 5% significant level and had the second-highest positive effect on participants' WTP. The hypothesised path relationship between shopping habits and WTP in the round was statistically significant at a 5% significance level. The hypothesised path relationship between participants' salience and WTP in the round was statistically significant at a 10% significant level.

Moreover, salience and shopping habits had the smallest effect on the WTP in round three. Again, real intentions showed the highest positive impact on the WTP compared to other variables. Thus, the null hypothesis that trust had the greatest effect on the WTP was rejected since it was found that actual intention had the greatest effect on the WTP. In round three, participants were exposed to a positive treatment; as a result, the trust of some participants was increased slightly, as evidenced by the change in their WTP. However, salience and shopping habits did not allow most participants to improve their WTP more than decreased when exposed to the negative information.

5.5. Conclusion

This chapter showed that some participants could make irrational choices favourable to them in a particular situation and influenced by other factors such as skills, emotions, environmental constraints, etc. After the outbreak, some irrational consumers in the auction were observed, which affected their WTP for RTE meat products. Most participants indicated that they stopped consuming or reduced their product consumption that was implicated during the outbreak. Moreover, the negative information had the greatest influence on the consumer behaviour compared to the positive or balanced information after the outbreak. Negative information caused the greatest decrease in consumption of RTE meat products during and after the outbreak. After the outbreak, coloured consumers and consumers with children increased their WTP. An increase in WTP by coloured consumers and consumers with children under 18 years was expected because most marginalised consumers, especially children, tend to rely greatly on processed products due to low costs, taste, or convenience associated with RTE meat products. Even after the negative information, most coloured participants and participants with children significantly increased their WTP.

Also, highly educated participants and primary shoppers increased their WTP even after exposure to negative information about the previous outbreak. Participants who received positive information significantly increased their WTP compared to those who did not receive positive information. Lastly, real intention, trust and shopping habit had the greatest influence on WTP compared to other variables. Real intention mainly increased the WTP of participants whilst trust either decreased or increased the WTP after the recall. Since the purchasing behaviour of consumers changed after the outbreak, shopping habits had the most negative effect on WTP.

CHAPTER 6

6. Summary, conclusions and recommendations

6.1. Introduction

This study aimed to assess how consumers purchasing behaviour of the implicated and related ready-to-eat (RTE) meat product was impacted after the *Listeria* outbreak in South Africa (SA) between 2017 and 2018. To assess the post-response of consumers after a food scare, willingness to pay (WTP) data was collected during 2020 and further analysed with a Tobit regression model. The results obtained from the regression showed the variables that significantly contributed to the increase and decrease in WTP data for processed meat products after the *Listeria* outbreak that occurred three years earlier. Further, both qualitative and quantitative data were obtained from the survey and the evaluation sheet. Demographic characteristics, shopping habits, objective knowledge or attitude about food safety and salience were collected during the survey. In the evaluation sheet, participants were required to rate the relative importance of each element in the information provided during the auction experiment (Vickrey fourth price auction) and also to rate other potential factors that can affect the bidding behaviour. The data collected from the survey was further analysed using the partial least squares structural equation modelling (PLS-SEM) based on the integrated model of behavioural prediction (IMBP). The experimental auction results were linked to the data obtained from the questionnaire and evaluation to test for any relationships between different variables that could influence behaviour.

6.2. Summary of findings

Currently, there is very little to no study about the post-response of consumers after a food scare in SA. Between 2017 and 2018, SA experienced the largest outbreak of *Listeria* in RTE meat products in the world. The South African *Listeria* outbreak disrupted the global and local processed meat products supply chain. It forced all the retailers with manufacturing companies to stop producing and selling the implicated products. The consumers were immediately alerted about the outbreak and advised to discard all the implicated products in their households to avoid further illness and other related implications. Chapter 2 provided a thorough literature review of the food safety associated with foodborne disease outbreaks on RTE meat products. The safety of meat and meat products has faced many challenges, primarily because of microbial pathogens. Among the most common microbial pathogens that threaten RTE meat products, *Listeria monocytogenes* is the primary concern. These pathogens can spread in RTE meat products exposed to post-processing contamination and an environment that supports the organism's growth during storage.

As discussed in Chapter 3, the primary target population and respondents were student and non-student subjects who reside, study or work in Stellenbosch, located in the Cape Winelands District. The sample of this study consisted of both students and the working population with 50 control and 61 treatment participants. This study required different consumers who are classified as marginalised, middle-class or affluent consumers. The

experimental design was based on the frame field experiment scope, where subjects are exposed to contextual treatments with imposed rules in an auction experiment. The auction mechanism used was the Vickrey fourth price auction and facilitated through an online open-source oTree platform for social science experiments, followed by a survey and evaluation sheet. The experimental auction, survey and evaluation yielded sufficient data to address the study objectives. The Vickrey fourth price auction collected WTP data for 500g viennas after the participants received negative and positive information about the *Listeria* outbreak that occurred in South Africa between 2017 and 2018. The survey captured respondents' demographics, consumption behaviour, and consumer awareness about the *Listeria* outbreak whilst the evaluation sheet evaluated consumers regarding their perceptions about food safety in South Africa.

Chapter 4 presented participants' socio-economic profiles where various demographic characteristics were discussed. The total respondents had a larger working-class population than students. About 60% of the total respondents indicated that they are the primary shoppers of food in the household. They usually purchase processed meat products, dairy products, fruit and vegetable products and baked products. Furthermore, the participants revealed that they regularly consume RTE meat products, with about 56% of the total respondents purchasing RTE meat products 1-2 times per week. Thus, this indicated that the subjects who participated in this study were suitable for assessing the post behaviour of regular consumers of RTE meat products in SA. Whether participants were aware of the outbreak and the number of affected people was less of a concern; critical for this study was whether they knew which products were affected. Approximately 87% of respondents knew that polony was the affected product during the outbreak. Although most knew which product was involved, 500g viennas was used to create a framed field experiment analogous to the *Listeria* outbreak. The factor analysis results showed that they were most worried about the livestock and processed meat industry risk compared to other risks in the food sector. Such concern from consumers might be due to the previous food scare associated with RTE meat products in SA.

Chapter 5 showed that some participants could make irrational choices favourable to them in a particular situation and influenced by other factors such as skills, emotions, environmental constraints, etc. The first objective of this study tested the rationality of the subjects who participated in the experimental auction. We expected that rational consumers would not change their behaviour towards the implicated product after the outbreak. According to the findings, about 71% (79/111) participants stated that their behaviour changed after the *Listeria* outbreak. Furthermore, about 41% (46/111) participants did not buy the product implicated during the outbreak, and about 27% (30/111) participants did not buy it as frequently as they used to buy it before. Thus, these results were enough to reject the null hypothesis that rational consumers do not change their behaviour towards the implicated product after the outbreak. This study showed the existence of irrational consumers as a result of the food scare. The second objective was to examine the possible influences of negative and positive information about the outbreak on the participants' WTP. We expected that negative information would have the greatest influence on WTP compared to the positive information treatment. As expected, the negative information greatly influenced the participants' behaviour, and a significant decrease in WTP after participants were given negative information was witnessed. After receiving positive information, most participants increased their WTP for 500g viennas. The

change in the bid after the positive information was not as significant or extensive as the change after negative information. After the positive information treatment, some participants decreased their WTP; this shows how the negative information can dominate and significantly impact consumer food safety attitudes and shopping habits.

Other potential factors that might have played a role when deciding the WTP for 500g viennas after the negative information treatment were further analysed. In the first round, no participant received information treatment. Thus, no behaviour was influenced by the information from our experiment but might have been affected by the information that they remembered from the previous outbreak. The coloured participants WTP increased by R5.85 more than the other ethnic group for 500g viennas after the outbreak. Participants with children under 18 years of age were willing to pay R4.83 more for 500g viennas compared to participants with no children after the outbreak. The results after negative information treatment indicated that participants who are coloured, with education level equivalent to a bachelors' degree or with higher qualifications, with children under the age of 18 years, who are primary shoppers, who are not worried about the risk associated with food recall and with a positive attitude towards the food institution and industries in SA, were not sensitive towards negative information since they significantly increased their WTP for 500g viennas. On the other hand, participants who were worried about the food safety risks associated with the consumption of RTE meat products, and participants who earned R15 000 or more, decreased their willingness to pay for 500g viennas after receiving the adverse information treatment.

Participants who received positive information after receiving the negative information slightly increased their WTP. Female participants, participants with children under 18 years, primary shoppers, and those worried about the risk associated with food recalls slightly decreased their WTP after receiving both information treatments. Furthermore, participants who are coloured, less concerned about the risk associated with consumption of RTE meat products, and those with a positive attitude towards the food institutions or industries slightly increased their WTP 500g viennas after receiving both negative and positive information treatments. The last objective identified the internal factors that influence consumer behaviour after the outbreak. After the Listeria outbreak, it was expected that consumer trust would be statistically correlated to the consumers' WTP for RTE meat products. Surprisingly, real intention, trust and shopping habit had the greatest influence on WTP than other variables. Real intention mainly increased the WTP of participants whilst trust either decreased or increased the WTP after the outbreak. Consumer shopping habits had the most negative effect on WTP.

6.3. Recommendations for future research

This research had several limitations with data collection. The Western Cape was one of the provinces with the highest reported cases of *Listeria*. About 90% of *Listeria* cases during the outbreak were reported in the Cape Town district. This study was limited to people residing or working in the Cape Winelands district, and the study could not be extended to the Cape Town district due to limited resources. Future studies can expand the geographic area of the research and focus on other provinces or regions reported with high cases of *Listeria* within the country. Another limitation was the respondents, few participants participated, and the initial recommended number of respondents was not reached. The respondents of 111 subjects resulted in limited data available for analysis, which

also restricted the study with the type of model to use when analysing. We suggest for future studies that researchers use a larger number of respondents to obtain valuable results.

The methodology of this study was greatly challenged by the Coronavirus pandemic in 2020; as a result, some of the collection methods were changed to limit physical human interaction and mitigate the risks of the Coronavirus pandemic. At first, the chosen setting to collect data was a lab experiment, but the method was changed to a framed field experiment over time. The participants were expected to be invited to a computer lab where they would have participated. Still, the alternative approach was chosen for this study to mitigate the risks of the Coronavirus pandemic. The alternative method used enabled subjects to participate in this study either at their homes, institution or place of work where it is much safe. This study recommend that researchers use an experimental lab to collect data much easier and get more valuable data for future studies. Also, it is recommended that the socio-economic structure be improved and to focus on the different impacts of foodborne disease outbreaks between marginalised and affluent consumers in SA. Moreover, the predictors of environmental constraints and personal skills can be extended to reveal more drivers of revealed demand.

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APPENDICES

Appendix A - Experimental procedure to collect data for the study

Steps	Description
Step 1	Invitation to participate in this study was electronically distributed to students and the working population. The invitation was included with the consent form.
Step 2	Zoom meeting.
Step 3	Auction monitor verbally explains the Vickrey fourth price auction procedure.
Step 4	Each participant receives randomly allocated ID numbers and auction internet URL link.
Step 5	**Bidding rounds**: Participants start the auction session with 3 rounds. • **1st round**: No information treatment. • **2nd round**: Control treatment or negative information treatment. • **3rd round**: Control treatment or positive information treatment.
Step 6-7	Participants complete a questionnaire and evaluation sheet.
Step 8	The winners are announced after few weeks and the payoffs are sent to the winners.

Appendix B - Consent form

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

You are invited to take part in a study conducted by Ms Ziyanda Hadebe, from the Department of Agricultural Economics at Stellenbosch University. You were approached as a possible participant because you a regular consumer of ready-to-eat (RTE) meat products such as 'polony', 'viennas', bacon, sausages and ham. You are also classified as either a marginalized consumer, middle – class consumer or affluent consumer as specified in the Socio-Economic Measurement (SEM).

1. PURPOSE OF THE STUDY

The consumer response to the *Listeria* outbreak in SA was noticeable and reasonable, but the post-food scare effects are still predicted. It is not certain to what degree the outbreak affected the rational decisions of consumers when buying RTE meat products, especially the implicated ones. Thus the experimental auction that will be played will capture and quantify the level of trust that South African consumers have towards RTE meat products after the outbreak of *Listeria*.

2. WHAT WILL BE ASKED OF ME?

If you agree to participate in this study, you will be asked to click a tick box to consent to participate in the auction, complete the questionnaire and an evaluation sheet. The questionnaire will collect demographic characteristics, shopping habits, objective knowledge or attitude about food safety, the level of trust that South African consumers have towards ready-to-eat meat products, and the fear of negative social evaluation. One practice round will be played before the actual auction experiment. You are required to play a Vickrey fourth price auction with 3 rounds. Each experiment rounds have different information that will be provided before you bid. You will be required to bid for 500g viennas after being provided with the necessary information for that round and the winners will receive the 500g viennas vouchers from a local food retailer. Each experiment session is expected to take an hour. Due to the COVID-19 pandemic, we cannot conduct this study in a computer lab at Stellenbosch University. Still, you can participate in this study experiment at home, workplace or institution through an online communication platform such as zoom and play the auction experiment through an open online source platform called o-Tree.

3. POSSIBLE RISKS AND DISCOMFORTS

The participant may probably experience discomfort, emotional distress or range of negative emotions due to the past trauma associated with the Listeria outbreak in South Africa. This possible risk can be reduced by doing a debriefing session before and after the experiment to provide information on Listeria. If the risk is severe or persists we will refer the participant(s) to counselling or therapy. The minimal inconvenience such as time is required to participate in this study. Since the auction experiment will take place online, we are aware that you will also use data. Thus, the participant is required to sacrifice an hour of their time and data to participate in the whole auction experiment successfully. Compensation for your time and data will be made available and paid in the form of a voucher which will be emailed to you to mitigate the risks of COVID-19 infections. Take note, if you initially indicated in the auction invitation received through emails that you will use work place and/or private institution data or Wi-Fi that does not require you to pay for Wi-Fi or data to participate in this study, you will be excluded in the data compensation and only receive the participation payment.

4. POSSIBLE BENEFITS TO PARTICIPANTS AND/OR TO THE SOCIETY

As much as consumers are aware of how a food scare can cause illnesses, especially due to a listeria outbreak, we also want to show how the willingness to pay can fluctuate due to a food scare. Participants can observe their changes in purchasing behaviour after the food scare on ready-to-eat meat products and since the results will be shared to all the participants, you will also get to observe how other participants or consumers behave after a food scare. Marketing companies, food manufacturers, and consumers will be able to observe changes in purchasing behaviour (willingness to pay) after the food scare on ready-to-eat meat products. Such will emphasise the importance of food safety and how a food scare can influence consumer purchasing behaviour. Marketing companies and food manufacturers will be able to observe the willingness to pay changes in the published articles to understand the factors that influence purchasing behaviour and why purchasing behaviour changes as a result of a food scare. Also since information based on listeria will be shared with the participants, the more consumers become aware of food scares such as microbiological contamination and how to reduce such incidents especially when handling food, most people will consume safe food and limit foodborne disease as well as cross contaminations.

5. PAYMENT FOR PARTICIPATION

Each participant can receive a total payment up to R70 per hour, depending on whether the participant used his/her own data or not and also if the participant is a working staff from Western Cape Department of Agriculture (WCDoA).WCDoA participants will not receive any payments for data and time as well as 500 g viennas voucher if the participant(s) win in the auction experiment. The R70 per hour includes a compensation for time used which is R20/hr and R50/hr for data used. This compensation will be received in a form of a food voucher from a local food retailer. If you will use a work place or private institution data or Wi-Fi, you will only receive a R20 food voucher. Only participants who win in the auction experiment will receive 500g viennas payments in a form of a

food voucher from a local food retailer. All the payments will be received after the auction is done and have answered the questionnaire and evaluation sheet. If the participant withdraw from the auction, they will not receive any payments or compensation.

6. PROTECTION OF YOUR INFORMATION, CONFIDENTIALITY AND IDENTITY

Any information you share with me during this study and possibly identify you as a participant will be protected. This will be done by using unique identification numbers provided to the participants before the experiment commences. This unique ID number does not reflect the person's name and surname as well as IDs or contact information. Furthermore, the venue where the experiment will take place will be booked for the entire session with the university's permission. In this venue, only the participants is allowed in until the experiment is done and in that way, we protect the identity of the participating individuals and avoid disturbance. Thus no participants or organisations will be identified in the final research report. The data obtained will be secretly stored in devices such as external drives, requiring a password to access the data. The data will also be stored in SharePoint where only authorized individuals will be able to access it. Only the main study investigator and study supervisor (Dr Jan Greyling) will have access to the data. After data and necessary information is completely collected the participant does not have the option to opt-out of their information being shared. The information collected for this study will be used for future publications and the data will also be shared with the Western Cape Department of Agriculture for other research purposes in future. The results of the study will be published and no participants' names, surnames, contact details and/or IDs will be included in the publication.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you agree to participate in this study, you may withdraw at any time without any consequence. You may also refuse to answer any questions you don't want to answer and remain in the study. Suppose the participant experience emotional distress/psychological trauma due to the Listeria information provided or questions asked in the questionnaire(s) during the experiment. In that case, the participant is advised to immediately withdraw from the experiment and take counselling or therapy if necessary. All costs associated with the participant's counselling or therapy sessions will be the participant's responsibility. The researcher may withdraw you from this study if you show or tell your WTP bids to other participants during the experiment.

8. RESEARCHERS' CONTACT INFORMATION

If you have any questions or concerns about this study, please feel free to contact Ms Ziyanda Hadebe at 19296525@sun.ac.za, and/or the supervisor Dr Jan Greyling at jancg@sun.ac.za.

9. RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

DECLARATION OF CONSENT BY THE PARTICIPANT

As the participant I confirm that:

- I have read the above information and it is written in a language that I am comfortable with.
- I have had a chance to ask questions and all my questions have been answered.
- All issues related to privacy, and the confidentiality and use of the information I provide, have been explained.

By clicking in the below tick box, you agree to take part in this research study, as conducted by Ms Z.P. Hadebe.

☐

DECLARATION BY THE PRINCIPAL INVETIGATOR

As the **principal investigator,** I hereby declare that the information contained in this document has been thoroughly explained to the participant. I also declare that the participant has been encouraged (and has been given ample time) to ask any questions. In addition I would like to select the following option:

☐	The conversation with the participant was conducted in a language in which the participant is fluent.
☐	The conversation with the participant was conducted with the assistance of a translator (who has signed a non-disclosure agreement), and this "Consent Form" is available to the participant in a language in which the participant is fluent.

Appendix C - Online experiment invitation

AUCTION EXPERIMENT INVITATION

We invite you to participate in an auction experiment of which you can participate at your home or place of work through zoom and online open source platform called oTree. You will have the opportunity to earn processed meat products vouchers. Participating in the experiment will require only an hour of your time, and you will not lose money by participating. There are no entry fees or requirements to enter in this auction experiment but you will be required to sacrifice time and data/Wi-Fi to participate. Participating compensation will be provide to you through emails in a form of a voucher after the experiment. The experiment will be displayed in an online platform where you will select the amount of which you value the products displayed thus there is no real money that will be used in the auction. The main purpose of this experiment is to measure the willingness-to-pay (WTP) for ready-to-eat meat products especially after a food scare in South Africa. If you're interested, please fill in your contact details for further information in the following spaces:

Name

Surname

Cell phone number

Email

Occupation

This auction experiment will take place in three days and the following are the available timeslots that you can pick to participate in this study: *(Note: Each timeslot allows for a maximum of 40 participants and each participant can only select one timeslot)*

Monday (07 December 2020) 15:00 - 16:00	
Tuesday (08 December 2020) 11:00 - 12:00	
Tuesday (08 December 2020) 15:00 - 16:00	
Wednesday (09 December 2020) 14:00 - 15:00	

Which of the types of internet connection (data or Wi-Fi) will you use to participate in this study?

Own data (you will buy the data with your own money to participate)	
Work place Wi-Fi	
Private institution Wi-Fi (e.g., Stellenbosch University)	

Appendix D - Questionnaire

UNIVERSITEIT • STELLENBOSCH • UNIVERSITY

Faculty of AgriSciences

Department of Agricultural Economics

Ms Z.P Hadebe: Master thesis student

Supervisor: Dr JC Greyling

Assessing consumer post-response to food safety scare in South Africa using behavioural game theory

QUESTIONNAIRE

Please answer the following questions below by making (X) in the appropriate box:

All information will be treated with strict confidentiality.

Participant allocated study ID number ……

SECTION 1: Demographic characteristics

1. Please indicate your gender

Male	
Female	
Non-binary	

2. How old are you?

3. Please indicate your ethnic group

White	
Black African	
Coloured	
Indian	
Other	
Prefer not to say	

4. Please indicate your nationality

5. Please indicate your home language.

Zulu	
Xhosa	
Afrikaans	
English	
Northern Sotho	
Tswana	
Sesotho	
Tsonga	
Swati	
Venda	
Ndebele	
Other	

6. Please indicate your highest level of education completed

Less than matric	
Matric	
Certificate or diploma	
Bachelor's degree	
Master's degree or doctorate	

7. What is your current occupation?

Student	
Manager	
Professional (Science, health, education, business, technology, legal, social and cultural)	
Technicians (Science, health, education, business, technology, legal, social and cultural)	
Clerical support workers	
Service, sales and armed forces (Personal care, sales, protective services and armed force workers)	
Craft and related trades workers	
Plant and machine operators and assemblers	
Agricultural, forestry and fishery labourers (farmers and farm workers)	
Cleaners and helpers	
Labourers in mining, construction, manufacturing and transport	
Other occupation	

8. Please indicate your monthly income after tax?

NB: If student please indicate how much you receive monthly from your parents, bursary allowance or any other source of income per month below.

R0 – R 4 999	
R5000 – R 14 999	
≥ R15 000	

9. Do you have children of your own under the age of 8 years?

Yes		
No		

10. Do you have children of your own between 8 and 18 years old?

Yes	
No	

11. Please indicate the number people living in your household or student house?

Living alone	
2	
3	
4	
5	
> 5 members	

12. Which township or suburban area you currently living in?

13. If student are you living in a……..

University residence	
Private accommodation (single)	
Private accommodation (sharing)	

SECTION 2: Shopping habits

14. Are you the main food buyer in your household?

Yes	
No	

15. Which type of ready-to-eat food items do you purchase most often? You can select more than one.

Meat products (e.g. viennas)	
Dairy products (e.g. cheese)	
Fruit and vegetable products (e.g. salads)	
Baked products (Sandwiches)	
None of the above	

16. How often do you buy and consume ready-to-eat meat products?

Never	
1 – 2 times per week	
1 – 2 times per month	
1 – 2 times per year	

17. Which ready-to-eat meat product do you buy often? You can select more than one.

'Polony'	
'Viennas'	
Sausages	
Bacon	
Ham	

18. Are the ready-to-eat meat products purchased for personal consumption or mostly for consumption by other household members such as children, spouse or housemates?

Personal consumption	
Consumption by other household members	

19. In declining order of importance please indicate why you purchase ready-to-eat meat products. Rank each element from **one** (very important) to **five** (least important).

Taste	
Convenience	
Nutritional quality	
Cost	
Safe for consumption	

SECTION 3: Knowledge or attitude towards food safety

20. Please indicate your level of agreeability with the following statements:

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
When purchasing ready-to-eat (RTE) meat products, I do take the safety of the product into account.					
Eating expired RTE meat products in good physical condition does carry a health risk					
Raw meat products if cooked properly are much safer relative to processed meat products					
The preservation techniques and packaging of processed meat products makes them less susceptible to sickness pathogens					
Some RTE meat products are safer to consume than others.					
RTE meat products in my view are of poor quality					

SECTION 4: Main consumer views or opinion on ready-to-eat meat products (Salience)

21. Please select the most appropriate answer to the statement below:

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
In my view all RTE meat products are of poor quality					
The quality of RTE meat products differ substantially between brands					
The quality of RTE meat products differ substantially between different retail stores					

I eat RTE meat products out of necessity, not choice					
Eating RTE meat products is healthy					

SECTION 5: Listeria outbreak in South Africa

22. Were you aware of the past Listeria outbreak in South Africa?

Yes	
No	

23. Which product was implicated?

'Polony'	
'Viennas'	
Sausages	
Bacon	
Ham	
Do not know	

24. In which year(s) did the outbreak occur?

2015 – 2016	
2017 – 2018	
2016 – 2017	
2018 – 2019	
Do not know	

25. How many cases and deaths were confirmed due to the outbreak?

~ 687 reported cases and 180 deaths	
~ 1060 reported cases and more than 200 deaths	
~ 840 reported cases and more than 100 deaths	
Do not know	

26. Which province had the lowest number of confirmed cases of the Listeria outbreak?

KwaZulu-Natal Province	
Northern Cape Province	
Gauteng Province	
Western Cape Province	
North – West Province	
None of the above	
Do not know	

27. Did the Listeria outbreak change your purchasing behaviour of ready-to-eat meat products?

Yes	
No	
I don't know	

28. Did your purchasing behaviour change before or after the product recall?

Before	
After	
I don't know	

If before the recall briefly explain why?

29. Are you a victim of the Listeria outbreak, in other words, did you fall sick as a result of consuming contaminated food?

Yes	
No	

30. Before the Listeria outbreak, have you ever fallen ill to a foodborne illness caused by a pathogen other than Listeria?

Yes	
No	

31. Did any of your family members, close friends and relatives fall ill to the Listeria pathogen or any other food borne pathogen?

Yes	
No	

SECTION 6: Trust

32. All ready-to-eat (RTE) meat products such as 'bacon" and "viennas" are safe for consumption if cooked above 70 degrees Celsius?

Strongly disagree	
Disagree	
Neutral	
Agree	
Strongly agree	

33. Do you still buy the product that was implicated during the Listeria outbreak?

Yes	
No	
Sometimes but not as frequently	

34. During the outbreak, did you stop buying the implicated product of the specific brand or did you entirely stop for all similar products irrespective of the brand?

Stopped purchasing in a specific brand but continued consuming the product from a different brand.	
Stopped purchasing all the similar products including the implicated products.	
Did not stop buying the implicated products and similar products.	

35. If the implicated RTE meat product that was recalled during the South African Listeria outbreak was a poultry product not a beef product. Would you have…?

Stopped purchasing poultry RTE products but continued consuming beef RTE products.	
Stopped eating all the RTE meat products irrespective whether poultry or beef.	
Stopped eating only the implicated poultry RTE product and continued consuming poultry RTE products and beef RTE products which were not implicated during the outbreak.	

36. Indicate the level of trust of the following product:

	Strongly distrust	Distrust	Neutral	Trust	Strongly trust
'Polony'					
'Viennas'					
Sausages					
Bacon					
Ham					

37. Indicate the level of trust of the following product:

	Strongly distrust	Distrust	Neutral	Trust	Strongly trust
Suppose that RTE meat products are processed and sold on the farm					
Suppose that RTE meat products are processed by well-known producers or big producers and sold in supermarkets such as local food supermarkets, etc.					

38. Suppose you become aware of the outbreak of a lethal pathogen in some ready-to-eat meat products produced in a neighbouring country of South Africa. Would it change your purchasing behaviour of South African RTE meat products?

Yes	
No	

SECTION 7: Fear of negative social evaluation (FNSE)

39. Assessment of fear of negative social evaluation:

	not at all a characteristic of me	partially not a characteristic of me	neutral	characteristic of me	extremely characteristic of me
I worry about what other people will think of me even when I know it doesn't make any difference.					

It bothers me when people form an unfavourable impression of me.					
I am frequently afraid of other people noticing my shortcomings.					
I worry about what kind of impression I make on people.					
I rarely worry about what kind of impression I am making on someone.					
I am afraid that others will not approve of me.					
I am concerned about other people's opinions of me.					
When I am talking to someone, I worry about what they may be thinking about me.					
I am usually worried about what kind of impression I make.					
If I know someone is judging me, it tends to bother me.					
Sometimes I think I am too concerned with what other people think of me.					
I often worry that I will say or do wrong things					

Appendix E - Evaluation sheet

EVALUATION SHEET

1. **Rate the relative importance of each element from the information treatments that influence WTP.**

	Not important	Slightly important	Moderately important	Important	Very important
Negative information treatment elements					
Nationwide scope of recall.					
Number of the implicated products recalled.					
Number of confirmed illnesses.					
Known deaths					
Balanced information treatment elements					
Nationwide scope of recall.					
Number of the implicated products recalled.					
Number of confirmed illnesses.					
Known deaths					
Ready-to-eat (RTE) meat products safe if cooked above 70 degrees Celsius.					
Number of reported case are well within the expected range.					
Listeriosis is very rare.					
Food safety regulations keeps *L. monocytogenes* at less than 100 CFU/g.					
No traces of Listeria.					
Different country information elements					
Global number of listeria outbreaks.					
Rate of listeria outbreak events involving more than one country.					

2. Factor analysis of other potential influences on bidding behaviour such as risk perception.

Question contents	Strongly disagree	Slightly disagree	Disagree	Neutral	Slightly agree	Agree	Strongly agree
Very worried about the food safety of livestock.							
Very worried about the food safety of ready-to-eat (RTE) meat products.							
Not buying any RTE meat products.							
Trying to avoid eating RTE meat products.							
Not buying any meat whether processed or not.							
Not ordering dishes with RTE meat products in restaurants.							
I don't try food again for a long time after a recall.							
Other consumers will be slow to buy RTE meat products again.							
The food industry needs more safety regulations.							
The department of health does a great job keeping the food supply safe.							
The department of agriculture does a great job keeping the food supply safe.							
The meat industry cares about consumers.							
Farmers do a great job keeping the food supply safe.							
Food companies don't care enough about food safety.							
The South African food supply chain is the safest in the Africa.							

The South African food supply chain is the safest in the world.							
Meat producers treat livestock well.							
Wholesalers and retailers do a great job removing recalled foods.							

Appendix F - Factor loadings, construct reliability and validity in WTP round 1 PLS-SEM model

Constructs	Reflective indicators	Factor loadings	Cronbach's Alpha	rho_A	Composite reliability	Average variance extracted
Real intention	**Coloured**	1,000	1,000	1,000	1,000	1,000
Fear of negative social evaluation	**FNSE1**	0,500	0,940	0,815	0,934	0,547
	FNSE10	0,869				
	FNSE11	0,743				
	FNSE12	0,635				
	FNSE2	0,701				
	FNSE3	0,694				
	FNSE4	0,823				
	FNSE5	0,692				
	FNSE6	0,827				
	FNSE7	0,795				
	FNSE8	0,814				
	FNSE9	0,707				
knowledge	**KN5**	1,000	1,000	1,000	1,000	1,000
Salience	**S5**	1,000	1,000	1,000	1,000	1,000
Shopping habits	**SH8**	1,000	1,000	1,000	1,000	1,000
Trust	**TR3**	0,631	0,720	0,737	0,848	0,655
	TR8	0,905				
	TR9	0,865				
Willingness to pay (Round 1)	**WTP**	1,000	1,000	1,000	1,000	1,000

Appendix G - Overall fit of the estimated WTP round 1 PLS-SEM model

	Saturated Model	Estimated Model
SRMR	0,078	0,078
d_ULS	1,268	1,268
d_G	0,557	0,557
Chi-Square	296,351	296,351
NFI	0,768	0,768

Appendix H - Fornell-Larcker Criterion for checking discriminant validity in WTP round 1 PLS-SEM model

	FNSE	Knowledge	Real intentions	Salience	Shopping habits	Trust	WTP(Round 1)
FNSE	0,740						
Knowledge	0,073	1,000					
Real intentions	-0,271	0,032	1,000				
Salience	0,010	0,126	-0,117	1,000			
Shopping habits	-0,093	-0,032	0,248	0,117	1,000		
Trust	0,070	0,061	-0,389	0,186	-0,387	0,809	
WTP(Round 1)	-0,178	-0,148	0,235	-0,126	0,281	-0,327	1,000

Appendix I - Factor loadings, construct reliability and validity in WTP round 2 PLS-SEM model

Constructs	**Reflective indicators**	**Factor loadings**	**Cronbach's Alpha**	**rho_A**	**Composite reliability**	**Average variance extracted**
Real intention	**Edu_level**	1,000	1,000	1,000	1,000	1,000
Fear of negative social evaluation	**FNSE10**	0,875	0,937	0,927	0,938	0,579
	FNSE11	0,708				
	FNSE12	0,703				
	FNSE2	0,663				
	FNSE3	0,709				
	FNSE4	0,759				
	FNSE5	0,711				
	FNSE6	0,816				
	FNSE7	0,861				
	FNSE8	0,768				
	FNSE9	0,768				
knowledge	**KN2**	1,000	1,000	1,000	1,000	1,000
Salience	**S4**	1,000	1,000	1,000	1,000	1,000
Shopping habits	**SH1**	1,000	1,000	1,000	1,000	1,000
Trust	**TR5**	0,773	0,726	0,752	0,828	0,549
	TR6	0,826				
	TR10	0,625				
	TR11	0,724				
Willingness to pay (Round 2)	**WTP**	1,000	1,000	1,000	1,000	1,000

Appendix J - Fornell-Larcker Criterion for checking discriminant validity in WTP round 2 PLS-SEM model

	FNSE	Knowledge	Real intentions	Salience	Shopping habits		
FNSE	0,761					**Trust**	**WTP(Round 2)**
Knowledge	0,157	1,000					
Real intentions	0,039	0,002	1,000				
Salience	0,181	0,056	-0,220	1,000			
Shopping habits	-0,090	-0,112	-0,176	-0,150	1,000		
Trust	-0,101	-0,073	-0,074	0,073	0,177		
WTP(Round 2)	-0,110	-0,133	0,237	-0,099	-0,102	0,741	
						0,135	1,000

Appendix K - Overall fit of the estimated WTP round 2 PLS-SEM model

	Saturated Model	**Estimated Model**
SRMR	0,072	0,072
d_ULS	1,100	1,100
d_G	0,516	0,516
Chi-Square	282,758	282,758
NFI	0,751	0,751

Appendix L - Factor loadings, construct reliability and validity in WTP round 3 PLS-SEM model

Constructs	**Reflective indicators**	**Factor loadings**	**Cronbach's Alpha**	**rho_A**	**Composite reliability**	**Average variance extracted**
Real intention	**Edu_level**	1,000	1,000	1,000	1,000	1,000
Fear of negative social evaluation	**FNSE10**	0,854	0,937	0,968	0,942	0,596
	FNSE11	0,746	0,937			
	FNSE12	0,675	0,937			
	FNSE2	0,716	0,937			
	FNSE3	0,771	0,937			
	FNSE4	0,808	0,937			
	FNSE5	0,738	0,937			
	FNSE6	0,783	0,937			
	FNSE7	0,842	0,937			
	FNSE8	0,760	0,937			
	FNSE9	0,783	0,937			
knowledge	**KN2**	1,000	1,000	1,000	1,000	1,000
Salience	**S5**	1,000	1,000	1,000	1,000	1,000
Shopping habits	**SH10**	1,000	1,000	1,000	1,000	1,000
Trust	**TR6**	1,000	1,000	1,000	1,000	1,000
Willingness to pay (Round 3)	**WTP**	1,000	1,000	1,000	1,000	1,000

Appendix M - Fornell-Larcker Criterion for checking discriminant validity in WTP round 3 PLS-SEM model

	FNSE	Knowledge	Real intentions	Salience	Trust	WTP(Round 3)	shopping habits
FNSE	0,772						
Knowledge	0,169	1,000					
Real intentions	0,013	0,002	1,000				
Salience	0,016	0,114	-0,199	1,000			
Trust	-0,040	0,018	0,042	0,367	1,000		
WTP(Round 3)	-0,097	-0,128	0,274	-0,125	0,218	1,000	
shopping habits	0,104	0,078	0,088	-0,082	-0,194	-0,198	1,000

Appendix N - Overall fit of the estimated WTP round 3 PLS-SEM model

	Saturated Model	Estimated Model
SRMR	0,055	0,055
d_ULS	0,466	0,466
d_G	0,270	0,270
Chi-Square	153,189	153,189
NFI	0,840	0,840

Appendix O - Description of the explanatory variables used in the regression modes

Variables	Description	Measurements	Expected sign
Positive_info	Positive information treatment WTP	WTP values	+
Age	Age of the participants	Number of years	+/-
Female	Gender of the participants	D = 1 if female D = 0 if male	+/-
Coloured	Ethnic group for participants	D = 1 if coloured D = 0 if otherwise	+/-
Edu_Level	The level of education	D = 1 if bachelors' degree or masters/Phd level D = 0 if otherwise	+/-
Occupation	Student or working	D = 1 if working D = 0 if student	-
Income	Income that each participants earn	D = 1 if earning more than R15 000 D = 0 if earning less than R15 000	-
Children_18	Participants with children under the age of 18 years	D = 1 if have children under 18 years of age D = 0 if otherwise	-
Primary_shopper	The main grocery shopper	D = 1 if main shopper D = 0 if otherwise	+/-
Meat_industry_risk	Risk associated with meat and meat products industry	Likert scale numbers	+/-
RTE_consumption_risk	Risk associated with consumption of RTE meat products	Likert scale numbers	+/-
Recall_risk	Risk associated with food recall	Likert scale numbers	+/-
Institutional_risk	Distrust in food industry	Likert scale numbers	+/-