CHINESE CONSUMER DECISION-MAKING AND NOVEL FOOD PRODUCTS

By

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ABSTRACT

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Consumers are shaping the food and agricultural system, thus a better understanding of their food preferences and purchasing behavior is needed in order to provide decision supports for agricultural producers and agribusinesses. Experimental methods provide an alternative to investigate consumer preference and demand for innovative food products, allowing for explicitly modelling the cognitive and behavioral mechanisms that influences individual decision-making. This dissertation leverages discrete choice experiments to better understand the consumer food decision-making process and also informs methodological issues associated with stated preference methods.

The first essay assesses the effects of three ex-ante hypothetical bias mitigation methods on Chinese consumer's stated online food shopping behavior: a cheap talk script, the solemn oath and honesty priming. Using data from choice experiments, my analysis finds no significant differences in willingness to pay (WTP) values for all product attributes between the various mitigation methods and a control group, implying that hypothetical bias is not likely a significant concern when using internet-based choice experiments to elicit marginal WTP values for online food product characteristics. I discuss how e-commerce can better address consumer needs and explain the importance of my findings for study design and future research on consumer online food shopping behavior.

Acceptance of food products from these animals is expected to be controversial and requires a thorough understanding of consumer preferences. The second essay explores the role of

personality, measured via the Big Six personality traits, on consumer acceptance of a genetically modified pork product in the US, China and Italy. I find that the effect of personality is most evident in US consumers with five out of six personality traits explaining preferences for genetically modified pork. Openness is the only trait that consistently explains consumer acceptance in the three countries, and conscientiousness is found to be a good predictor in Western cultures. This result reinforces the importance of capturing psychological characteristics of consumers to understand controversial food acceptance and highlights the differential impact of personality across cultures.

Food valuation studies have employed a wide range of product quantities in designing their experiments, assuming that individual preferences are constant, not affected by the framing effect of product quantity. However, this assumption may not hold from the perspective of mental budgeting. The third essay investigates whether and why experimental quantities employed by food valuation studies affect consumer food choice behaviors. Two DCE designs are evaluated: one being the traditional design with 500 grams; the other allowing the unit to be matched with respondent's self-reported quantity per purchase. I find that in the traditional design, consumers' price sensitivities and the probability to opt-out from making a purchase decrease as their actual purchase quantities (and default budgets) increase. These discrepancies in choice behavior are mitigated in the matched design. As most respondents purchase more than 500 grams in real life, the marginal WTPs for most product attributes are biased upward in the traditional design. I also propose a novel design that provides more relevant preference estimates and could be incorporated in the various experimental settings.

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KEY TO ABBREVIATIONS

DCE	Discrete Choice Experiment
WTP	Willingness To Pay
MXLE	Mixed Logit Model With An Error Component
OECE	Open-ended Choice Experiments

INTRODUCTION

Over the past centuries, the transformation of human society can be summarized by advancements in industrialization, urbanization, and globalization. These three aspects of modernization are closely related, and taken together, bring challenges of global food security, food safety and climate change. Urbanization increases demand for agricultural products while decreasing the amount of farmland and farm labor. Industrialization affects the environment and ultimately contributes to climate change, as evidenced by higher temperatures and extreme weather conditions. A longer agri-food value chain resulting from globalization implies difficulties in ensuring food safety given the interaction of multiple actors separated by vast distance and potentially delayed impacts. To alleviate these threats, a number of technological innovations in the food sector have been introduced. For example, E-commerce directly connects producers to consumers and transforms agricultural supply chain. The CRISPR-Cas9 gene-editing pig which minimizes potential biological risks, and has a higher percentage of lean meat was invented, in hope of improving productivity and food safety. The use of Blockchain technology in food traceability allows for tracking food products in a fast, secure and decentralized manner, improving transparency in the food industry.

However, not all promising technologies are embraced by the market. Consumers, disconnected from agricultural and food production due to large-scale urbanization, show a low level of trust and acceptance of new food and farm technologies. Meanwhile, consumer preferences and demand for food products are changing to a great extent, and becoming more complex. This change is not only happening in emerging markets, but also in developed economies. A rising middle class as a result of greater industrialization and

urbanization in China is seeking more resource intensive products such as meat and dairy. North American and European consumers are increasingly concerned about the sustainability of food production and are demanding more environmentally and animal friendly products. In addition to socio-demographics, consumer food consumption choices can be explained by economic, psychological, behavioral and cultural factors. This heterogeneity in consumer choice behavior calls for in-depth studies of consumer food preference and demand, in both emerging and developed economies.

With the advent of experimental methods, researchers are better able to bring insights from psychology and behavioral economics to understand individual preference and demand for innovative food products, thus informing food polices and marketing strategies. A key concern when employing stated preference methods, such as discrete choice experiments, is the robustness and reliability of estimates that are derived. Obtaining robust and reliable estimates of consumer choice behavior requires careful considerations of experimental and study design. This dissertation investigates consumer valuation of various novel food attributes through the use of discrete choice experiments, and also informs how to better design consumer food valuation studies. This dissertation consists of three essays which use discrete choice experiments to understand consumer food purchasing behaviors. Given the scope of this work, independence of research objectives across the various essays, differences in study design and data, each chapter begins with a stand-alone introduction and concludes with a section highlighting relevant study design, industry and policy implications.

Chapter 1 evaluates the effectiveness of three ex-ante hypothetical bias mitigation methods on Chinese consumer's stated preference for online pork products: a cheap talk

script, the solemn oath and honesty priming. No significant differences in WTP values for all select product attributes (origin, product rating, number of reviews) between the various mitigation methods and a control group were found. This result implies that hypothetical bias is not likely a concern when implementing certain studies using online choice experiments to elicit marginal WTP values for online food product attributes.

Chapter 2 explores how personality, measured via the Big Six personality traits, affects consumer preference for a genetically modified pork product in the US, China and Italy. This cross-country investigation finds that the effect of personality is most evident in US consumers with five out of six personality traits explaining preferences for genetically modified pork. Openness was the only trait that consistently explained consumer acceptance in the three countries, and conscientiousness was found to be a good predictor in Western cultures. My results indicate the importance of using individual psychological characteristics to understand controversial food preference and highlights the differential impact of personality across cultures.

Chapter 3 investigates the effect of experimental quantities presented in a discrete choice experiment on consumer food choice behavior in light of mental budgeting. Two designs are employed: one being a widely used design based on 500 grams of beef product; the other allowing the unit to be customized or matched based on respondent's self-reported quantity. The results indicate that in the widely used design, consumers' price sensitivities and the probability to opt-out from making a purchase decrease as their purchase quantities (and default budgets) increase. These discrepancies in choice behavior are mitigated in the matched design. The difference in choice behavior translates to significant differences in WTPs for most product attributes. This study documents how experimental quantity affects

consumer food choice decisions and contributes to the literature by providing a novel experimental design for use in food valuation studies.

CHAPTER 1

Are Ex-Ante Hypothetical Bias Calibration Methods Context Dependent? Evidence from Online Food Shoppers in China

1.1 Introduction

Hypothetical DCE are extensively used by applied researchers to study consumer preferences and demand for public and private goods. These studies are often used to develop marketing strategies that satisfy consumer needs and inform policies that affect consumer well-being. The method, however, often comes under scrutiny for hypothetical bias, which is the difference between the values that are elicited in a hypothetical context, such as a survey, and those elicited in a real context, such as an actual market (Harrison, and Rutström 2008). If such bias exists, the reliability and validity of DCE results come into question.

Hypothetical bias has been widely studied. Consumer applications include the valuation of public goods or services in environmental economics (Bishop, and Heberlein 1979; List, and Gallet 2001; Murphy, Stevens, and Weatherhead 2005), food and agricultural economics (Lusk, and Schroeder 2004; Carlsson, Frykblom, and Lagerkvist 2005; Ready, Champ, and Lawton 2010), transportation (Hensher 2010) and health care applications (Özdemir, Johnson, and Hauber 2009). Results from these studies generally indicate that in a hypothetical context, the willingness to pay (WTP) for both private and public goods tend to be overstated (Kling, Phaneuf, and Zhao 2012). Concerns with hypothetical bias have motivated a number of authors to explore the effectiveness of different techniques to mitigate such type of bias. These techniques include ex-ante mitigation methods such as the cheap talk script (Cummings, and Taylor 1999; List 2001; Aadland, and Caplan 2003), solemn oath (Jacquemet et al. 2011; Stevens, Tabatabaei, and

Lass 2013), and honesty priming (de-Magistris, Gracia, and Nayga (2013) as well as ex-post mitigation approaches such as follow-up certainty scales (Champ et al. 1997; Morrison, and Brown 2009).

While both ex-ante and ex-post approaches have been discussed in the literature (Loomis 2014), there is still no consensus on which type of method is most effective at reducing hypothetical bias. Given that ex-ante methods are becoming increasingly popular in consumer research and need to be incorporated into the design phase of a study, there is a lack of information regarding their efficacy and performance in varying applications. In addition, while previous studies have mainly studied the effectiveness of different ex-ante hypothetical bias techniques reproducing off-line food markets, it is still not known whether such methods are effective in simulated "online food markets". Yet this seems an important question to answer given the rapid growth of internet food purchases worldwide. To fill this void, this study uses an online DCE survey to investigate the effects of three ex-ante hypothetical bias mitigation methods (cheap talk, the solemn oath and honesty priming) on Chinese consumer's stated pork shopping behavior, one of the most commonly purchased meats in China's online food markets (Nielsen 2015).

This study advances the literature on consumer food choices and behavior in a number of ways. First, we focus on consumer online food shopping behavior in an emerging economy. Online shopping is not only becoming increasingly popular among consumers in developed countries, with sales reaching 1.86 trillion worldwide in 2016, and the global average rate of penetration surpassing 50% in 2017 (Statista 2017a,b), but it is also becoming prevalent in emerging economies. For instance, China has the largest e-commerce market in the world, with online sales growing more than 30% to 589.59 billion

dollars in 2015 over 2014 (Nielsen 2016). The Ministry of Commerce in China reports that internet sales of fresh foods reached 5.76 billion dollars in the first three quarters of 2015, which is more than half of all the online food sales during 2014. Given the rapid growth of internet purchases, understanding consumer online shopping behavior, and how it compares to traditional retail channels, is important in order to address consumer needs. Second, this paper provides some evidence on the efficacy of ex-ante hypothetical techniques in simulated "online food markets". Given the proliferation of online food shopping, and the use of hypothetical DCEs in food consumption studies, a better understanding of the performance or need for these ex-ante calibration methods in this context is needed.

The remainder of this article is organized as follows. First, we provide some background on consumer online shopping behavior and discuss the most commonly employed ex-ante hypothetical bias mitigation tools. Following, we describe the experimental design, research hypothesis, and econometric models implemented in our study. We then present our results, and conclude by discussing how e-commerce can better address consumer needs and explaining the importance of our findings for study design and future research on consumer online food shopping behavior.

1.2 Background

1.2.1 Consumer Online Shopping Behavior

The proliferation of e-commerce has stimulated studies in online shopping behavior. Internal factors such as demographics, internet experience, normative beliefs and culture, shopping orientation and motivation, as well as psychological perceptions have been found

to affect consumer acceptance of online shopping (Zhou, Dai, and Zhang 2007, Yoon 2009, Clemes, Gan and Zhang 2014). External factors such as product information have also been shown to affect consumer adoption of e-commerce (Park and Kim 2003), with the format of internet information being a positive driver of online shopping and consumer satisfaction in China. Jiang, Yang and Jun (2013) find that customer reviews in online platforms, in particular, are effective tools at saving consumers' information processing time and effort.

Significant differences in purchasing behavior exists between online and offline shoppers. Shankar, Smith, and Rangaswamy (2003) compared consumer satisfaction and store loyalty between online and offline shoppers and found that while there were few differences in satisfaction between the groups, online customers were more loyal since online stores offered more accessible information. Research has also found that price sensitivity differs between online and offline shoppers and varies depending on product category (Degeratu, Rangaswamy and Wu 2000; Chu et al. 2010; Melis et al. 2015). Online shoppers tend to be more price sensitive with respect to non-food items and less price sensitive to online food purchases including meat and dairy products (Chu, Chintagunta, and Cebollada 2008; Chu et al. 2010). Chu, Chintagunta, and Cebollada (2008) argue that the reason for lower price elasticity in online groceries is that consumers are willing to pay a premium for the information and associated convenience. Indeed, numerous studies have shown that the primary motivation for online grocery shopping is convenience (Hiser, Nayga, and Capps, 1999; Morganosky and Cude 2000; Rohn and Sawminathan 2004). A study by Hand et al. (2009) also supports this idea by linking situational factors that decrease consumer's perceived shopping convenience and flexibility (such as having a baby and not having enough time to shop), to the adoption of internet grocery purchases.

The process of purchasing food online is also affected by consumer's own buying experience. Melis et al. (2015) suggest that when consumers start buying groceries online, they tend to rely more on their offline shopping experiences, and as they become more experienced they are more driven by product characteristics and other attributes of online buying platforms such as level of assortment and variety offered.

While these studies explore characteristics and drivers of online shopping, few have evaluated consumer online food choice behavior. What role does product origin information play in online food purchasing decisions? How does product information affect food choices online? How do consumers behave in online purchasing scenarios, and how does study design affect demand estimates? These are some of the unanswered questions in the literature which this study informs.

1.2.2 Ex-Ante Hypothetical Bias Mitigation Methods

Unlike ex-post methods that typically rely on the use of follow-up questions and recoding of the data to address hypothetical bias, ex-ante methods are incorporated into the study design. One ex-ante survey design strategy is to explicitly discuss the problem of hypothetical bias with respondents, which Cummings and Taylor (1999) first referred to as a "cheap talk" scheme. Their result from laboratory experiments indicates that a cheap talk script can eliminate hypothetical bias. A social psychology explanation is that the cheap talk script makes subjects "effortfully" attempt to correct for the hypothetical nature of the survey. Since Cummings and Taylor (1999), there have been many studies employing the cheap talk method to environmental, food and agricultural economic issues (Lusk 2003; Carlsson, Frykblom, and Lagerkvist 2005; Murphy, Stevens, and Weatherhead 2005; List,

Sinha, and Taylor 2006; Tonsor, and Shupp 2011). List (2001) complemented Cummings and Taylor's findings by noting that a cheap talk script failed to eliminate hypothetical bias in subjects with market experience regarding the good of interest. Following Cummings and Taylor (1999) and List (2001), Lusk (2003) tested the effect of cheap talk on consumer's WTP for a food product. The result shows that cheap talk was effective at reducing WTP for most survey participants; however, in accordance with List (2001), cheap talk did not reduce WTP for knowledgeable consumers. In addition to subject experience and experience with the good, the cheap talk literature suggests that its effectiveness may be sensitive to script length and payment amounts. Poe et al. (2002) used a shortened version of the cheap talk script in a voluntary contribution survey and found that the short script had no effect. Brown, Ajzen, and Hrubes (2003) found that a long cheap talk script was successful in a survey but only for higher payment amounts (e.g. $10), and noted cheap talk could under-correct the bias at low payment amounts (e.g. $1). The results from Murphy, Stevens, and Weatherhead (2005) also suggest that cheap talk may eliminate hypothetical bias, but only for respondents who face higher payments. However, Blumenschein et al. (2008) found that cheap talk had no significant impact on reducing hypothetical bias. Ehmke, Lusk, and List (2008) tested whether hypothetical bias is location dependent by comparing real and hypothetical votes on a dichotomous choice referendum in China, France, Indiana, Kansas and Niger, and found significant differences in hypothetical bias across locations. The difference between a "Yes" vote in a hypothetical versus a real setting decreased by 13% for Chinese participants, 49% for Indiana and 23% for subjects in Kansas; this number increased for subjects in Niger.

One explanation for the presence of hypothetical bias is attributed to a lack of commitment from a respondent to tell the truth (Jacquemet et al. 2011). This argument is based on evidence from social psychology that tests the effect of making a promise (Albarracìn et al. 2005; Durantini et al. 2006; Joule, Girandola, and Bernard 2007). Recent studies have investigated the effect of an oath script in environmental studies (Jacquemet et al. 2010, 2011, 2013; Carlsson et al. 2013), and food surveys (de-Magistris, and Pascucci 2014). Jacquemet et al. (2011) suggest that under oath, bidders seem to take both the budget constraint and participation constraint more seriously than with a cheap talk script. Jacquemet et al. (2010) found that making a promise can decrease or even eliminate the existence of hypothetical bias. Similarly, Carlsson et al. (2013) shows that by using an oath script, the share of zero willingness to pay responses and extremely high willingness to pay responses decreases. This approach, however, has been noted for some limitations, including the potential for participants to be bothered by the "heavy handness" of the method (de-Magistris, Gracia, and Nayga 2013).

Another ex-ante calibration method, known as "honesty priming" has been proposed in the literature. The driving force behind honesty priming is the nonconscious activation of mental representation proposed in the auto-motive model by Bargh (1990). According to Bargh and Chartrand (1999), automatic thought processes involve reflexive responses to certain triggering conditions. These processes require only that a stimulus event or object be detected by an individual's sensory system. Once that triggering event is detected, the process runs to completion without an individual's awareness. The effectiveness of honesty priming, however, has been debated. Rasinski et al. (2005) found that participants who were exposed to honesty-related words in a vocabulary task admitted

to having engaged in more socially sensitive behaviors involving excessive alcohol consumption than participants who were exposed to neutral words. Pashler, Rohrer, and Harris (2013) who used the same design, however, found that honesty priming had no detectable effects on reported alcohol-related behavior. Few studies have evaluated the effectiveness and validity of honesty priming in applied economics research; one exception is the work of de-Magistris, Gracia, and Nayga (2013).

Other studies have assessed the effects of combining and comparing various techniques to reduce hypothetical bias. Jacquemet et al. (2013) evaluated the effect of cheap talk and oath, and concluded that the two are complementary—cheap talk overcomes a bidder's lack of experience with the good which makes some people think they are telling the truth when in actuality they are not. But it is the oath, not cheap talk scripts, that increases the odds of truth-telling. While cheap talk helps respondents to better identify what their preferences are, the oath seems to induce more of them to truthfully reveal them. Similar to Jacquemet et al. (2013), de-Magistris and Pascucci (2014) found lower hypothetical WTP estimates using an oath script compared to a cheap talk treatment or a control. Using a real CE as a base, de-Magistris, Gracia, and Nayga (2013) found evidence of hypothetical bias using a cheap talk script, but found no discrepancy between values from a hypothetical CE with honesty priming and WTP values from a real DCE.

Despite previous work comparing the effectiveness of various ex-ante calibration methods, and the proliferation of online retailing, little research has been conducted assessing the efficacy of these techniques in online surveys, and particularly regarding online purchases. In light of the findings from List (2001) and Lusk (2003) discussed above, should we expect differences in WTP across various treatments due to familiarity with the

shopping environment?

1.3 Experimental Design

In this study, we use an online DCE to simulate an online pork purchasing situation. Research on hypothetical bias in online surveys is particularly important given the increase in the use of internet surveys to elicit consumer WTP due to the relatively low cost, quick completion times, and concordance with mail-in surveys (Tonsor, and Shupp 2011; Carlsson et al. 2013; Fleming, and Bowden 2009; Nielsen 2011; Van Loo et al. 2011). The data were collected in April 2016 from a sample of 1146 Chinese consumers. Participants were recruited by Qualtrics, a professional market research agency, and were screened to ensure that they were over 18 years of age and had either an online pork purchaser experience (in the past 3 months) or a purchase intention.

Four attributes were used to describe the different types of pork loin products: price, country of origin, consumer product rating, and the number of reviews (Table 1.1). Selection of the attributes was rooted in the online shopping literature as well as consumer focus group discussions. Each of these attributes was described by different levels, which were calibrated using data from the two leading e-commerce platforms in China: Alibaba and JD. A number of choice experiment studies document significant effects of country of origin on consumer valuation for meat products (Loureiro and Umberger 2007; Pouta et al. 2010). At the time of this study, Alibaba provided 112 fresh pork loin products on its platform, 84 of which were domestically produced, 15 were imported from Spain, 7 from Denmark, 4 from the US, and 2 from France. Likewise, there were 21 pork loin products available in JD. Accordingly, four levels were selected to describe country of origin: China,

Spain, Denmark and the US; the last three being among the top 5 pork exporters to China (Chen, Ortega, and Wang 2015).

Table 1.1 Attributes and attribute levels used in choice design

Attributes	Attribute levels
Price(RMB/500g)	30 45 60 75
Country of origin	China US Denmark Spain
The number of reviews	47 103 502 2089
The number of ratings	3.0 4.0 4.5 5.0

Customer product ratings and number of reviews have been shown to be important determinants of consumer's online purchasing decisions (Chatterjee 2001; Lee, Park, and Han 2008). Rating is the overall evaluation of the pork loin by customers who've previously bought the product; this rating typically ranges from 0 to 5 in most online outlets. The levels for this attribute in our experiment range from 3 to 5, given that products in China with a rating below 3.5 are seldom available. Number of reviews is the number of customers who have purchased and submitted a rating for the product. We based the levels of this attribute on data collected from both Alibaba and JD; levels range from 47 to 2098. Product price is one of the main determinants of product choice and many DCE studies evaluate price in order to derive money metric measures of willingness to pay. Price levels

in our design range from RMB[1]30 to 75 /500g of pork loin, which reflect product prices available in both online retailers.

The choice experiment, comprised of a series of choice tasks each with two product alternatives and a no-purchase option, was designed utilizing a Bayesian sequential design (Sándor, and Wedel 2001; Scarpa, Campbell, and Hutchinson 2007; Van Wezemael et al. 2014; Caputo et al. 2017). In the initial phase, a D-optimal choice design with null priors was created to collect preliminary data among a limited number of consumers not selected for the final study. This pilot study was performed in February 2016 and provided the priors necessary to generate the final Bayesian optimal choice design using the software Ngene. The final design (D-error of 0.05) comprised of 27 choice tasks was blocked so that each participant evaluated nine choice tasks in total (3 blocks), so as to limit their cognitive burden and reduce fatigue effects. The order that the choice tasks were presented was randomized in order to mitigate any ordering effects. A sample choice task is presented in Figure 1.1.

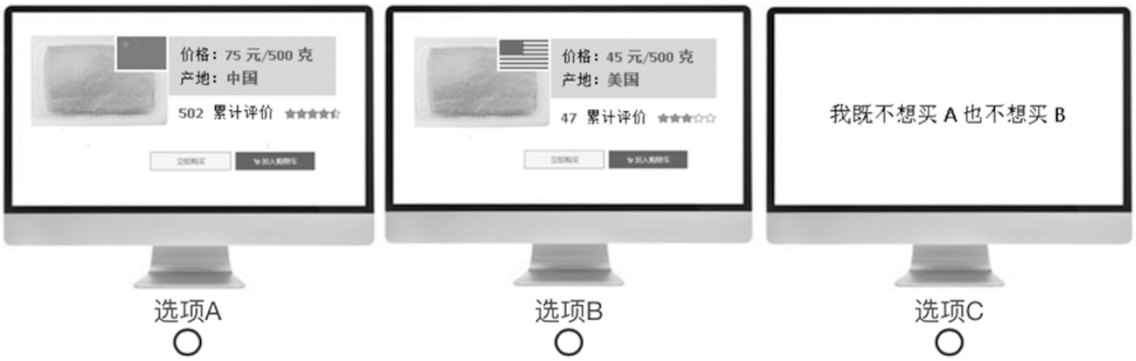

Figure 1.1 Sample choice task

1. At the time of the study, 1RMB= 0.155 USD.

1.4 Experimental Treatments and Research Hypotheses

We test for the effectives of ex-ante calibration methods in reducing hypothetical WTP values by using a between-sample approach. Each participant was randomly assigned to one of 5 treatments: the standard and widely-used hypothetical DCE (T1, control), a cheap talk script (T2), the solemn oath (T3), an honesty priming task (T4) and a neutral priming task (T5). The neutral priming treatment is introduced to test and control for any effects caused by the sentence scrambling exercise. The cheap talk treatment (T2) follows a similar design to Cumming and Taylor (1999), the oath treatment (T3) follows that of Jacquemet et al. (2011; 2013), while the honesty and neutral priming treatments (T4, T5) follow de-Magistris, Gracia, and Nayga (2013). The various treatments were translated into Mandarin Chinese, vetted by researchers for relevance and backwards translation was used to ensure accuracy.

With this design and set of treatments, we are able to build a set of testable research hypotheses to help inform our main research question. The first hypothesis compares WTP between the cheap talk script and the control treatment, and is defined as follows:

$H0_1$: $(WTP^{Cheap\ talk} - WTP^{Control}) \geq 0$

$H1_1$: $(WTP^{Cheap\ talk} - WTP^{Control}) < 0$

A rejection of $H0_1$ indicates that cheap talk reduces hypothetical bias in individual's WTP as has been shown by Cummings and Taylor (1999), List (2001), and Aadland and Caplan (2003).

Similarly, in order to test the effect of the oath and honesty priming, we also tested the following hypotheses:

$H0_2$: $(WTP^{Oath} - WTP^{Control}) \geq 0$

$H1_2$: $(WTP^{Oath}\text{-}WTP^{Control}) < 0$

$H0_3$: $(WTP^{Honesty\ priming}\text{-}WTP^{Control}) \geq 0$

$H1_3$: $(WTP^{Honesty\ priming}\text{-}WTP^{Control}) < 0$

A rejection of $H0_2$, and $H0_3$ indicates that the solemn oath, and honesty priming task reduce hypothetical bias in individual's WTP.

Additionally, following de-Magistris, Gracia, and Nayga (2013) we also explore whether the neutral priming task differs from the control treatment as well as the honesty priming treatment by testing the following hypotheses:

$H0_4$: $(WTP^{Neutral\ priming}\text{-}WTP^{Control}) \geq 0$

$H1_4$: $(WTP^{Neutral\ priming}\text{-}WTP^{Control}) < 0$

$H0_5$: $(WTP^{Honesty\ priming}\text{-}WTP^{Neutral\ priming}) \geq 0$

$H1_5$: $(WTP^{Honesty\ priming}\text{–}WTP^{Neutral\ priming}) < 0$

A rejection of $H0_4$ and $H0_5$ indicates activation of honesty concepts and effectiveness of honesty priming at reducing hypothetical bias.

1.5 Econometric Analysis and Model Specification

To test our hypothesis concerning the effects of ex-ante hypothetical mitigation methods on WTP values, we specified a utility function based on Lancaster's theory of consumer demand modelled within a random utility framework (Lancaster 1966). Following random utility theory (McFadden 1974, 105-142), DCEs rely on the assumption that the utility of individual *n* choosing alternative *j* in choice situation *t* can be expressed as

$$U_{njt} = V_{njt} + \varepsilon_{njt} \quad (1.1)$$

where V_{njt} is the systematic or representative portion of the utility function which depends on the experimentally designed product attributes for alternative j, and ε_{njt} is the stochastic (unobserved and random) component. In order to transform the random utility model into a choice model, certain assumptions regarding the functional form of V_{njt} and the joint distribution of ε_{njt} are required.

In this study, the data analysis includes estimation of a mixed logit model containing an error component with utilities specified in WTP-space. In addition to accounting for heterogeneity in consumer preferences, the MXLE accounts for effects associated with both the no-purchase option and correlated random effects across utilities between experimentally designed alternatives (see Scarpa, Ferrini, Willis 2005 for more details about the model, and Caputo, Scarpa, and Nayga 2017 for a recent application in food choices). Models specified in WTP-space relax the assumption of a fixed price coefficient (Scarpa, Thiene, and Train 2008). Hence, the advantage of this approach is that coefficients can directly be interpreted as marginal WTP values (Scarpa, and Willis 2010; Caputo, Scarpa, and Nayga 2017). As pointed out by Caputo, Scarpa, and Nayga (2017), it is a more feasible approach when comparisons across treatments are made than one based on marginal utilities (e.g., preference space estimation).

For all of the treatments, the utility that individual *n* derives from choosing option *j* in choice situation *t* can be specified as follows:

$$U_{njt} = \theta_n (-PRICE_{njt} + \omega_{n1}CHINA_{njt} + \omega_{n2}US_{njt} + \omega_{n3}DEN_{njt} + \omega_{n4}RAT_{njt} + \omega_{n5}REV_{njt} + ASC + \eta_{njt}) + \varepsilon_{njt} \quad (1.2)$$

where θ_n is a random positive scalar representing the price/scale parameter; *PRICE* is a continuous variable populated with the four price levels in the design; $CHINA_{njt}$, US_{njt}, and

DEN_{njt} are dummy variables for the experimentally designed levels of the country of origin attribute. Hence, they take a value of 1 when the product carries such attribute levels, and 0 otherwise. RAT_{njt} and REV_{njt} are continuous variables indicating the experimentally designed rating and log of number of reviews, respectively; ASC is the alternative specific constant of the no-purchase option; ωs are the coefficients of the estimated WTP values; η_{njt} is the zero mean, normally distributed error component; and ε_{njt} is the unobserved error term which follows a Gumbel (extreme value type I) distribution.

Following de-Magistris, Gracia, and Nayga (2013) and Bazzani et al (2017) we test for differences across treatments by pooling data and specifying an extended utility function including a set of dummy variables, each representing a specific treatment. The data pooling was executed based on a comparison across treatments: control vs. cheap talk/oath/honesty priming/neutral priming as well as honesty priming vs. neutral priming. Therefore, we identified the treatment as a *dTrea* binary variable, taking the value 1 for the first treatment in the analyzed comparisons and 0 otherwise:

$$U_{njt} = \theta_n [-PRICE_{njt} + \omega_{n1}CHINA_{njt} + \omega_{n2}US_{njt} + \omega_{n3}DEN_{njt} + \omega_{n4}RAT_{njt} + \omega_{n5}REV_{njt} + ASC + \delta_1(CHINA_{njt} \times dTrea) + \delta_2(US_{njt} \times dTrea) + \delta_3(DEN_{njt} \times dTrea) + \delta_4(RAT_{njt} \times dTrea) + \delta_5(REV_{njt} \times dTrea) + \eta_{njt}] + \varepsilon_{njt} \quad (1.3)$$

where δ_1, δ_2 , δ_3, δ_4 and δ_5 respresent the respective treatment effect on the experimentally designed attributes. As discussed in Bazzani et al (2017), the significance of the estimated δs and their signs establish the effect of the treatment on the marginal WTP estimate of interest. Hence, they determine if and how the marginal WTP for the various attributes differs across the treatments of interest. We specified one extended utility function for each of the comparisons to be tested, for a total of 5 extended utility functions.

With these extended utility functions, we were able to test our set of hypotheses in order to determine the effect of the ex-ante methods on mitigating hypothetical bias.

1.6 Data

A total of 172, 239, 244, 245 and 246 respondents completed each of the five treatments, respectively. Socio-demographic and pork purchasing statistics are reported in Tables 1.2 and 1.3. Results of statistical tests (χ^2 test p-values) suggest that the five samples are not significantly different in terms of age, education, household size, household income, household food expenditure, pork purchasing frequency and place, as well as household pork consumption. The majority of respondents across all treatments range in age from 18 to 40 years, and have the equivalent of a bachelor's degree in education. Nearly 50 percent of respondents have a monthly household income of more than RMB 13,000, and typically purchase pork once per week at a supermarket. Given the profile of online shoppers, individuals in our sample tend to have higher education and income levels compared with traditional pork shoppers from other studies (Ortega et al. 2011; Chen, Ortega, and Wang 2015; Yan, Yu, and Zhou 2016).

Table 1.2 Individual and household characteristics

Characteristic	T1[a]	T2	T3	T4	T5
Age:					
18-40	83.14%	85.77%	84.84%	84.90%	84.15%
40-60	16.28%	13.81%	13.93%	13.88%	14.63%
> 60	0.58%	0.42%	1.23%	1.22%	1.22%
p-value[b]= 0.98					
Education:					
Secondary school	2.91%	5.02%	4.10%	3.67%	4.47%
Undergraduate	90.70%	86.19%	90.98%	88.98%	88.21%
Graduate	6.39%	8.79%	4.51%	6.94%	7.32%
p-value= 0.80					
HH size:					
<4	54.07%	50.63%	56.97%	51.84%	47.15%
4-10	45.93%	49.37%	43.03	45.76	52.85
>10	0.00%	0.00%	0.00%	0.40%	0.00%
p-value= 0.35					
Monthly HH income (RMB):					
<5000	1.74%	0.42%	4.10%	3.27%	2.44%
5000-8999	12.21%	9.62%	9.43%	10.61%	11.79%
9000-12999	23.84%	20.08%	23.36%	22.04%	19.92%
13000- 16999	33.72%	35.15%	27.87%	29.39%	36.18%
17000- 20999	20.35%	22.59%	17.62%	22.02%	19.92%
>=21000	8.14%	12.13%	17.62%	12.65%	9.76%
p-value= 0.18					
Weekly food purchase expenditure (RMB):					
200	8.72%	2.93%	3.69%	4.49%	4.88%
201-350	18.02%	18.83%	15.98%	18.78%	17.07%
351-500	26.16%	23.85%	25.41%	22.04%	25.61%
501-650	33.72%	36.40%	36.48%	30.61%	34.15%
651-800	7.56%	13.39%	13.52%	14.69%	10.98%
> 800	5.81%	4.60%	4.92%	9.39%	7.32%
p-value= 0.31					

Notes: [a] Treatments correspond to control group (T1), cheap talk (T2), oath (T3), honesty priming (T4) and neutral priming (T5), respectively. [b] p-values correspond to test of equality across treatments.

Table 1.3 Pork consumption characteristics

Characteristic	T1[a]	T2	T3	T4	T5
Pork purchase location:					
Wet market	33.72%	33.89%	38.11%	35.92%	33.33%
Supermarket	51.16%	48.54%	45.49%	50.2%	49.6%
Online shop	15.12%	17.57%	16.4%	13.47%	17.07%
p-value[b]= 0.84					
Pork amount per purchase (KG):					
<=0.5	13.37%	12.55%	15.16%	12.65%	16.26%
0.5-1	52.91%	47.7%	47.54%	46.94%	48.37%
1.1-1.5	22.67%	28.87%	25.00%	25.31%	26.43%
1.6-2	10.47%	9.62%	11.07%	13.06%	8.13%
> 2	0.58%	1.26%	1.23%	2.04%	0.81%
p-value= 0.88					
Pork purchase frequency:					
Once a day	10.47%	7.95%	7.38%	12.24%	11.79%
Once per week	45.35%	55.65%	50.41%	44.49%	52.44%
Once every 2 weeks	35.47%	30.54%	34.43%	37.55%	29.67%
Once per month or less	8.72%	5.86%	7.79%	5.71%	6.1%
p-value= 0.29					
Weekly HH pork consumption (KG):					
1-1.5	17.44%	14.23%	18.03%	16.33%	16.67%
1.6-2	25.00%	19.25%	19.67%	18.37%	14.23%
2.1-2.5	18.02%	20.50%	22.54%	19.18%	16.26%
2.6 -3	20.35%	19.67%	14.75%	18.37%	19.11%
3.1-3.5	11.63%	18.41%	14.34%	17.55%	23.58%
3.6-4	5.23%	5.02%	7.38%	8.16%	6.91%
> 4	2.33%	2.93%	3.28%	2.04%	3.25%
p-value= 0.33					

Note: [a] Treatments correspond to control group (T1), cheap talk (T2), oath (T3), honesty priming (T4) and neutral priming (T5), respectively. [b] p-values correspond to test of equality across treatments.

With respect to choice behavior, we report the frequency of participants selecting the purchase and no purchase options across the five treatments (Table 1.4). Cheap talk, honesty priming, and neutral priming have a higher percentage of the respondents who selected to purchase a pork alternative in the 9 choice task questions than the control group. The differences regarding the no-purchase option among control group, cheap talk, oath, honesty priming, and neutral priming, respectively, are statistically significant. Pairwise

tests indicate that honesty priming is different from other treatments regarding the frequency of "no purchase" choices at the 10% significance level.

Table 1.4 Choices across treatments

	T1[a]	T2	T3	T4	T5
Purchase option	59.32%	63.05%	55.82%	73.68%	69.96%
No-purchase option	40.68%	36.95%	44.18%	26.32%	30.04%
Pearson Chi2(4)=9.07					
p-value[b]=0.06					

Note: [a]Treatments correspond to control group (T1), cheap talk (T2), oath (T3), honesty priming (T4) and neutral priming (T5), respectively. [b]p-values correspond to test of equality across treatments.

1.7 Results

The estimation results from the MXLE model specified in WTP-space with correlated parameters are reported in Table 1.5. Results from the control group indicate that consumers value domestic pork at RMB 9.31 over the same product originating from Spain (base level). We estimate that consumers are willing to pay RMB 12.27 for a one-unit increase in the product rating. This result highlights the fact that rating, as the reference of the product's quality, is valued by online consumer who could not see, smell or touch the real product. The number of reviews is also valued by consumers, especially those who consider purchasing the product with a low number reviews. Again, holding all else equal, if the number of reviews of the pork loin is 47, consumer's WTP for a one unit increase is RMB 0.12 and this decreases to RMB 0.01 when the number of reviews is 502[2]. In this respect, an increase in the number of review provides much more marginal value when a product has a lower number of reviews. The standard deviation of the error component is

2. Given the log specification of this attribute, WTP values are computed for specific values of number of reviews.

significant in all models. This indicates that there is significant unobserved error correlation between the product alternatives, and significantly more unobserved variation in the perception and substitutability between the product alternatives, compared to the no-purchase option (Scarpa, Willis, and Acutt 2007; Kragt, and Bennett 2012).

Table 1.5 Results in WTP space with correlated parameters

	T1[a]	T2	T3	T4	T5
Mean values					
US	0.98	2.98	4.61	2.87	1.44
	(4.01)	(2.98)	(3.55)	(3.50)	(2.99)
CHINA	9.31**	5.01	7.14*	2.20	0.95
	(4.43)	(3.50)	(3.68)	(3.38)	(3.59)
DEN	7.11	3.77	5.43	3.78	3.09
	(5.13)	(3.51)	(4.43)	(3.65)	(3.85)
REV	5.64***	5.98***	7.58***	6.31***	6.61***
	(1.73)	(1.28)	(1.41)	(1.28)	(1.35)
RAT	12.27***	13.46***	11.02***	8.87***	9.68***
	(2.41)	(1.85)	(1.90)	(1.83)	(1.91)
ASC_{nobuy}	-1.59**	-1.46**	-0.91*	-2.54***	-2.26***
	(0.68)	(0.59)	(0.47)	(0.52)	(0.54)
Standard deviations					
US	6.71	6.89	12.23*	11.67*	9.24*
	(6.99)	(4.30)	(6.41)	(6.07)	(5.56)
CHINA	22.63**	24.27***	25.87***	21.75***	26.90***
	(7.19)	(3.79)	(5.44)	(5.04)	(4.89)
DEN	36.07***	26.05***	43.69***	23.35***	36.45***
	(5.67)	(5.70)	(12.69)	(8.31)	(9.83)
REV	14.47**	12.14***	14.22**	13.03***	13.25***
	(6.50)	(4.28)	(6.74)	(3.14)	(2.73)
RAT	18.06***	19.08**	17.05***	16.80***	18.21***
	(4.98)	(9.55)	(6.12)	(4.83)	(3.99)
η_{ijt}	119.96***	120.59*	110.44**	103.04***	115.50***
	(37.67)	(63.41)	(44.32)	(37.26)	(22.80)
N	1548	2151	2196	2205	2214
Log-likelihood	-1271.11	-1697.68	-1828.71	-1747.86	-1757.05
AIC	2564.22	3417.36	3679.43	3517.72	3536.09

Notes: [a] Treatments correspond to control group (T1), cheap talk (T2), oath (T3), honesty priming (T4) and neutral priming (T5), respectively. *** values statistically different from zero at 1 percent significant level, a ** values statistically different from zero at 5 percent significant level and a * values statistically different from zero at 10 percent significant level. Models estimated in Nlogit 5.0 utilizing 1000 draws for the simulations. Correlation matrix available from authors upon request.

Assessing differences across treatments, the results show that the average point estimate of the marginal WTP for product rating is higher in the control group compared to the oath, honesty priming and neutral priming treatments, with the lowest WTP found in the honesty priming treatment. Nevertheless, consumers in the cheap talk treatment were willing to pay RMB 1.19 more for a one-unit increase in product rating than in the control group. Compared to the control group, WTP for the number of reviews was higher for consumers in all of the treatments, with respondents under oath exhibiting the highest WTP for additional increase in the number of reviews. Similar to the control group, consumers in the cheap talk and oath treatments preferred domestic pork the most, followed by Danish and American products.

To determine if the differences noted above are statistically significant, we conduct hypothesis tests of equality across treatments. Following Bazzani et al (2017) and de-Magistris, Gracia, and Nayga (2013), we separately pooled the control group sample with the cheap talk, oath, honesty priming and neutral priming treatments, respectively. Results are reported in Table 1.6.

Table 1.6 Statistical tests of equality

Hypothesis Tests	Coeff.	Std. Error	p-value
$H0_1$: ($WTP^{Cheap\ talk}$-$WTP^{Control}$) ≥0			
dTrea*US	0.01	0.16	0.97
dTrea*CHINA	-0.19	0.15	0.20
dTrea*DEN	-0.18	0.16	0.25
dTrea*REV	0.03	0.04	0.53
dTreat*RAT	0.04	0.05	0.42
$H0_2$: (WTP^{Oath} -$WTP^{Control}$) ≥0			
dTrea*US	0.10	0.15	0.51
dTrea*CHINA	-0.05	0.15	0.76
dTrea*DEN	-0.11	0.16	0.49
dTrea*REV	0.02	0.04	0.66
dTreat*RAT	-0.09	0.05	0.09
$H0_3$: ($WTP^{Honesty\ priming}$-$WTP^{Control}$) ≥0			
dTrea*US	0.12	0.15	0.44
dTrea*CHINA	-0.18	0.15	0.21
dTrea*DEN	-0.04	0.16	0.81
dTrea*REV	0.05	0.04	0.20
dTreat*RAT	-0.01	0.05	0.86
$H0_4$: ($WTP^{Neutral\ priming}$-$WTP^{Control}$) ≥0			
dTrea*US	0.05	0.15	0.72
dTrea*CHINA	-0.19	0.15	0.22
dTrea*DEN	-0.10	0.16	0.53
dTrea*REV	0.06	0.04	0.12
dTreat*RAT	-0.02	0.05	0.65
$H0_5$: ($WTP^{Honesty\ priming}$-$WTP^{Neutral\ priming}$) ≥0			
dTrea*US	0.05	0.15	0.82
dTrea*CHINA	-0.02	0.16	0.89
dTrea*DEN	0.05	0.17	0.79
dTrea*REV	-0.01	0.05	0.83
dTreat*RAT	-0.03	0.07	0.62

Note: Models estimated in Nlogit 5.0 utilizing 1000 draws for the simulations.

Our finding generally suggests that the equality hypothesis could not be rejected for all treatments, which means that the estimated marginal WTPs in the various treatments are not statistically different from the control group. As for the cheap talk script, our findings are in accordance with List (2001) and Lusk (2003), who suggested that the cheap talk was not able to reduce marginal WTPs for experienced consumers, and in contrast with other studies documenting lower marginal WTPs when using a cheap talk script (Cummings, and Taylor 1999; Carlsson, Frykblom, and Lagerkvist 2005; Blumenschein et

al. 2008). As mentioned above, our sample selection strategy required that our respondents have a pork purchasing experience in the last 3 months and actually, more than 90% of the respondents purchased pork at least once every 2 weeks[3]. Hence, similar to the findings of Lusk (2003), familiarity and experience with the product may be driving our results.

In addition, our result from Chinese online shoppers also does not support the notion that the oath resulted in lower stated marginal WTPs as found in Jacquemet et al (2013) and de-Magistris, and Pascucci (2014). The oath approach asks respondents to swear on their honor that they will respond truthfully and its effect may be susceptible to the respondent's cultural context. In this regard, de-Magistris, Gracia, and Nayga (2013) argue that oath-taking may not be taken seriously by certain people for a variety of reasons such a cultural background and norms. Thus, it is reasonable to assume that the oath may be ineffective at reducing hypothetical bias in certain settings.

Finally, unlike de-Magistris, Gracia, and Nayga (2013), our data shows no statistically significant difference in marginal WTPs for all attributes between honesty priming, neutral priming, and our control treatment. However, while de-Magistris, Gracia, and Nayga (2013) found that honesty priming helps mitigate hypothetical bias, the robustness of this result remains an unanswered question due to the limited amount of research in this area.

To further investigate differences in consumer valuation across treatments, we also calculated the total WTPs of different product profiles and compared them across treatments. Table 1.7 reports the total WTPs for ten product profiles along with the

[3]. According to our data, 91.28%, 94.14%, 92.21%, 94.29% and 93.9% of the respondents in T1, T2, T3, T4 and T5, respectively buy pork at least once every 2 weeks.

corresponding confidence intervals. Overlapping confidence intervals provide evidence that total WTPs are not significantly different between the control treatment and the various mitigation techniques (e.g. Caputo, Scarpa, Nayga 2017). To illustrate, for a domestic (Chinese) product with 219 reviews and a rating of 4.8, deviations in total mean WTP from the control treatment can range from 2.26 for cheap talk to 21.39 for honesty priming. While point estimates of mean total WTP are relatively lower in the honesty priming treatment, they are similarly low in the neutral priming treatment and overlapping confidence intervals suggest that these are not different. These findings hold across various product profiles (both domestic and imported), calling into question the effectiveness of the mitigation techniques in our specific context.

In light of these findings, we caution readers from concluding that these ex-ante mitigation tools are ineffective at reducing hypothetical bias. Rather, what our results suggest is that hypothetical bias is likely reduced or absent due to the nature and context of the experiment. Our study uses the Internet as a medium to deliver the choice experiment to online shoppers, which, given our design simulates rather closely the online shopping experience. Our statistical tests and analysis provide a high degree of confidence that hypothetical bias is not likely a significant concern in studies using internet-based choice experiments to elicit WTP values for online products where the subject has had a recent experience or a purchase intention. A definitive conclusion regarding the degree to which hypothetical bias is present in these types of studies would require a comparison between hypothetical and real choice experiment. Executing an incentivized field study of this nature is rather impractical, given the financial and logistical constraints regarding product

delivery to subjects. In the next section, we provide alternate research avenues that can be pursued to assess consumer online purchasing behavior using stated preference methods.

Table 1.7 Total WTPs for 10 product profiles

	Control (T1)		Cheap Talk (T2)		Oath (T3)		Honesty Priming (T4)		Neutral Priming (T5)	
Product Profile	**mean**	**95% C.I**	**mean**	**95% C.I**	**mean**	**95% C.I**	**mean**	**95% C.I**	**mean**	**95% C.I**
China (219, 4.8)[a]	78.05	[44.64, 108.97]	80.31	[58.64, 101.47]	78.37	[55.40, 99.60]	55.76	[33.19, 76.36]	58.82	[35.95, 80.88]
China (47, 3)	52.97	[29.88, 73.99]	52.55	[37.01, 67.71]	53.13	[37.25, 67.76]	36.67	[20.97, 51.27]	38.69	[23.12, 54.15]
China (47, 5)	77.23	[45.21, 108.38]	79.07	[57.50, 100.31]	75.41	[52.96, 96.35]	53.65	[31.16, 51.27]	56.26	[33.46, 78.19]
China (2089, 3)	60.97	[33.23, 87.12]	62.15	[44.08, 79.35]	65.92	[47.53, 83.44]	46.06	[26.91, 62.43]	49.32	[31.12, 67.71]
China (2089, 5)	85.23	[48.60, 119.66]	88.67	[65.18, 112.25]	88.20	[64.14, 111.53]	63.04	[38.12, 85.59]	66.89	[41.57, 91.11]
US (219, 4.8)	71.10	[40.96, 101.08]	79.48	[58.54, 99.21]	75.88	[53.69, 97.57]	56.70	[34.45, 77.56]	58.38	[34.47, 80.75]
US (47, 3)	46.02	[25.74, 66.93]	51.72	[37.10, 65.70]	50.63	[35.59, 65.92]	37.60	[22.12, 53.13]	38.26	[21.88, 53.85]
US (47, 5)	70.28	[41.11, 99.88]	78.23	[57.52, 98.08]	72.92	[51.44, 94.61]	54.59	[32.11, 75.65]	55.83	[32.00, 77.89]
US (2089, 3)	54.02	[28.88, 78.39]	61.32	[44.10, 77.27]	63.42	[45.61, 81.73]	46.99	[27.58, 64.76]	48.88	[29.71, 67.18]
US (2089, 5)	78.28	[44.73, 111.90]	87.83	[65.06, 109.76]	85.71	[61.62, 109.65]	63.97	[39.19, 86.71]	66.45	[40.64, 91.21]

Note: [a] Numbers in parenthesis corresponds to the number of reviews and product rating in the product profile, respectivel

1.8 Conclusions

Choice experiments are commonly used to analyze preferences for food products, but results from many of these studies come under scrutiny due to hypothetical bias. This problem has motivated research to identify and test tools that can mitigate or eliminate hypothetical bias. This study investigates the efficacy of different ex-ante hypothetical bias mitigation methods in hypothetical choice experiments in online food products. We assess three mitigation techniques (cheap talk, oath, and honesty priming) in a new context by modeling Chinese consumer's choice of pork purchased online. Results suggest that, generally, product rating and the number of reviews have a significant positive impact on consumer's utility or value. Across the five treatments, the mean marginal WTPs for the various product characteristics under evaluation are not significantly different from the control group. In terms of differences across the three ex-ante mitigation techniques, our results contrast those of previous studies on this research area (Cummings and Taylor 1999; de-Magistris, Gracia, and Nayga 2013; Jacquemet et al. 2013; de-Magistris, and Pascucci 2014). This is likely due to the substantial differences in the nature and context of our experimental setting. In fact, unlike previous studies, we utilize a web-based choice experiment to elicit consumer preferences for food products purchased online. Hence, participants faced CE questions in an environment that closely mirrored actual online shopping situations. Moreover, our subjects were experienced consumers that had purchased pork online or had a purchase intention. Taken all together our findings indicate that ex-ante hypothetical bias mitigation strategies in our case do not yield results that are significantly different from standard hypothetical choice experiments, implying that this type of bias may be context dependent.

Modern consumers are not only demanding healthy and sustainable food products, but also convenience in the form of lower prices and delivery innovations. This new trend has recently led

a number of companies to market their food products online and develop forms of vertical integration (e.g., Amazon's recent acquisition of Whole Foods in the United States). Therefore, results from this study also have implications for how e-commerce can better address consumer needs, especially in an emerging economy. Chinese online shoppers in this study had significant, positive WTP values for both product rating and the number of reviews. This result has consequences for nascent companies entering the fresh food online market, who have limited number of product reviews. It would be beneficial for these companies to direct marketing efforts to increase product rating and incentivize consumers to share their experience on online platforms. To this end, developing a base of consumer reviews soon after product launch would provide consumers with valuable information and help increase market share.

Although our results show the importance of product rating and the number of reviews as determinants of product choice, the mechanism behind how these two factors affect consumer choice remains unclear. Further research focusing on the effect of review content and reviewer characteristics on consumer choice behavior will contribute to the development of food e-commerce. Additional research regarding hypothetical bias in online web-surveys is needed. Research addressing issues of attribute non-attendance through either standard or innovative methods such as eye-tracking technology can better inform consumer decision making and information processing strategies when conducting online consumer research.

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CHAPTER 2

Personality Traits and Consumer Acceptance of Controversial Food Technology: A Cross-country Investigation of Genetically Modified Animal Products

2.1 Introduction

In recent decades a number of food innovations have been proposed to address the growing challenges of global food security and climate change. The safety and effectiveness of new food technologies have been proven by overwhelming scientific evidence and professional judgment (Nayga 1996), however, consumers are still opposed to many of these innovations, even among those widely used in modern agriculture (Lusk, Roosen and Bieberstein 2014). A prominent example is the use of biotechnology in food production. Controversy abounds over the growing use of genetic modification since the first genetically engineered food, the Flavr Savr tomato, appeared in US grocery shelfs in 1994. For example, the AquAdvantage salmon, the only genetically modified (GM) animal in the US, took almost 20 years to get FDA's approval due to strong consumer and industry backlash (Naik 2010). Recent breakthroughs in gene editing are expanding the range of biotechnology applications in animal agriculture (Doudna and Charpentier 2014). However, successful adoption of biotechnology for animal agriculture will ultimately depend on having a thorough understanding of consumer preferences.

When modeling preferences, the consumer is often treated as an "optimizing black box". Inputs include product attributes, market information, historical experience, socioeconomic factors, and budget and product availability constraints (McFadden 1986). The direct output of the black box is market behavior which often measured in a purchase decision. With the advent of experimental methods, researchers are able to explicitly model the cognitive mechanism in the black box that influences behavior. Studies have found that information, perceived risk, trust and belief, as well as knowledge play a significant role in consumer evaluation of GM food (House et

al. 2004; Costa-Font and Mossialos 2007; Dean and Shepherd 2007; Huffman et al. 2007; Rousu et al. 2007; Costa-Font, Gil and Traill 2008; Prati, Pietrantoni and Zani 2012; McFadden and Lusk 2015; Bardin et al. 2017). Despite these potential explanations, the role that personality plays in consumer acceptance of novel and controversial foods remains relatively unexplored.

Personality, defined as the traits that are the relatively enduring patterns of thinking, feeling, and behaving (Roberts 2009), has been found to be a stable and consistent predictor for consumer choice. Although not fixed over an individual's life cycle, personalities do appear to be stable at least among adults (Heckman 2011). In fact, genetics research suggests a substantial portion of personality is inherited, with some fluctuations from study to study (Bouchard and Loehlin 2001; Caspi, Roberts and Shiner 2005). Changes in personalities of working-age adults are generally small and such changes are proven to have no significant effect on individual economic and social decisions (Cobb-Clark and Schurer 2012). In addition to its stability, the importance of personality in explaining various economic and life outcomes has been highlighted (Almlund et al. 2011; Human et al. 2013). As shown by Becker et al. (2012), personality has as much explanatory ability as standard economic preferences in terms of employment and health performance. Marketing studies have indicated that personality is also associated with innovative buying behavior (Robertson and Myers 1969; Im, Bayus and Mason 2003). Less arrogant individuals have been found to be more likely to try new brands or new products (Jacoby 1971). With regard to food consumption, the heterogeneity in eating habits, dietary intake, and food choice can be explained by personality traits to a large extent (Goldberg and Strycker 2002; Lunn et al. 2014; Byrnes and Hayes 2015; Keller and Siegrist 2015; Yangui, Costa-Font and Gil 2016; Spinelli et al. 2018). For example, Schifferstein and Ophuis (1998) note that personality influenced consumer demand for organic food products. Similarly, Bazzani et al. (2017) found that participants with more caring

personalities tend to prefer locally produced foods, while more extroverted individuals typically discount it. Previous work also suggests that outgoing, sympathetic and organized consumers tend to make more healthy food choices than neurotic individuals (Keller and Siegrist 2015). Personality has also been recently tied to consumer preferences for a specialty food product (Medjool dates), with consumers exhibiting higher levels of openness and neuroticism paying more attention to production method when making purchasing decisions (Peschel et al. 2019). Although researchers have used the concept of personality to investigate consumer food choice, few have investigated the effect of personality traits on individual valuation of novel and controversial food products.

This paper explores the role of personality on consumer demand for a GM animal product using a hypothetical choice experiment. With this approach, we are able to inform and explain consumer valuation of an innovative food product that is commercially viable but not yet on the market (Park et al. 2001; Zheng et al. 2017; Burkard et al. 2018). Moreover, personality is found to be useful in segmenting consumer markets such that the product can be positioned to the targeted group who has the highest potential willingness to pay (WTP) (Shank and Langmeyer 1994). Therefore, this study will inform novel food marketing strategies through a better understanding of preferences and market segmentation.

The paper contributes to the existing literature in various ways. First, we assess consumer acceptance of a GM animal product. Although currently limited, recent advances in biotechnology will potentially result in the availability of GM animals for human consumption. For example, researchers have used gene editing techniques to create pigs with improved animal welfare and health outcomes, potentially reducing economic losses to the pork industry (Zhang et al. 2017; Burkard et al. 2018). While consumer attitudes towards animal products fed GM feed has been

documented (Lusk, Roosen and Fox 2003; McCluskey et al. 2003; Tonsor, Schroeder and Fox 2005), very few studies have focused on acceptance of GM animal products themselves. Exceptions include Chern et al. (2002) and James and Burton (2003) who estimated consumer WTP for GM animal products using a contingent valuation approach. Their results indicated that respondents were much more concerned about GM technology that involves animal genes being used in food products, suggesting consumer may have different preferences for animals fed GM feed and GM animal products themselves. In the nearly two decades since both studies were conducted, more advanced valuation methods have been proposed and new technologies have been developed which calls for a thorough investigation on consumer acceptance of GM animal products.

Second, given recent technological breakthroughs in GM pigs, a staple source of animal protein in various countries, we assess consumer preferences for GM pork in the US, China and Italy. While differences regarding GM food purchases have been documented between US and European consumers (Chern et al. 2002; Lusk et al. 2005), less attention has been given to Chinese consumers despite their significant market size. Chinese consumers have been found to be more knowledgeable about biotechnology than their European counterparts, and less knowledgeable than US consumers (Zhang et al. 2010), suggesting potential heterogeneity in consumer WTPs for GM pork products across China, US and Europe.

Third, we investigate the role of personality on consumer acceptance of a GM pork product. Despite a scientific consensus on the safety of GM foods, there exists a gap between public perception and scientific knowledge. As a result, a number of studies have focused on how information, trust as well as consumer attitudes can influence demand for GM foods (Frewer, Scholderer and Bredahl 2003; Lusk et al. 2004; Huffman et al. 2004; Chen and Li 2007). A recent

study by McFadden and Lusk (2015) finds that prior belief as well as cognitive ability will affect the way people process scientific information on GM food. Although personality is found to be a more stable, robust behavior predictor, little attention has been given to understanding the role that personality plays in GM food choices. One exception is the work of DeLong and Grebitus (2018) who finds that individuals that are more organized and have greater self-control tend to prefer labelling of GM products. In this respect, it is reasonable to assume that personality plays an important role in consumer valuation of biotechnology in animal products.

In the consumer food choice literature, several questions remain unanswered regarding preferences for biotechnology. Which facets of personality have the strongest influence on consumer demand for GM animal products? Can personality predict choices of GM products across cultures? As suggested by Heckman (2011) and Heckman and Kautz (2012), the inclination to be organized, responsible, and hardworking has the strongest power at predicting labor market outcomes. Whether this holds true in predicting food choices regarding biotechnology is not currently known. Answers to these questions have significant implications for animal agriculture industries and new product development, and are the contributions of this study.

2.2 Background

The most widely used model of personality is the Five Factor model, also known as the Big Five personality traits, which measure five personality factors independently and at the broadest level of abstraction (John and Srivastava 1999). These five personality dimensions are known as Openness (to experiences), Conscientiousness, Extraversion, Agreeableness, and Neuroticism. These factors correspond to a series of individual characteristics. For example, someone with a high level of Conscientiousness is more likely to be organized and dependable, while individuals

with a high level of Extraversion are incline to be sociable and lively. The "Agreeableness" factor assesses the tendency to be sympathetic, cooperative and caring.

The Five Factor model has become increasingly popular due to several reasons. First, these personality traits are quite stable, particularly after early adulthood (Cobb-Clark and Schurer 2012; Cubel et al. 2016). Changes in personality traits seem to be very gradual and determined by biological maturation instead of life experience (McCrae and Costa 1999; Caspi, Roberts and Shiner 2005). An analysis employing a panel dataset of high school students in Wisconsin starting from 1964 to 1992 found that personality predicted earnings for both men and women, and part of gender differences in incomes could be explained by personality (Mueller and Plug 2006). Moreover, the Five Factor model is a robust measure across cultures and samples (Barrick and Mount 1991; Cubel et al. 2016). The universality of the Big Five is supported by many cross-cultural studies. McCrae and Terracciano (2005) stablished the universality of the Big Five personality traits by comparing individual personality traits from 50 cultures representing six continents. Additionally, using a self-report measure of the Big Five which was translated into 29 languages in 56 nations, Schmitt et al. (2007) reached a similar conclusion. As a result, growing evidence from economics and psychology has shown that this model of personality structure is strong at predicting various economic and social outcomes (Becker et al. 2012; Human et al. 2013). With respect to food, the model has been adopted to study the links between personality and eating habits, dietary intake and food choice (Goldberg and Strycker 2002; Lunn et al. 2014). For example, Keller and Siegrist (2015) find that Swiss individuals who scored high in Neuroticism tend to adopt emotional eating behavior, consuming more sweet and savory food, while conscientious people consume more fruits, vegetable and salad. Bazzani et al. (2017) using a sample of Italian consumers found that more caring personalities tend to prefer locally produced food, while more

extroverted individuals typically discount it. Currently there is little evidence on how personality traits can explain consumer food choice across countries.

The Five Factor model was enriched with the addition of one more dimension—Agency, which captures personality traits related to dominance and forcefulness (Lachman and Weaver 1997). This is often referred to as the Big Six approach (Grebitus Lusk and Nayga 2013). With one additional dimension, the extended model generally splits the traits from the Big Five more narrowly (Almlund et al. 2011; Grebitus Lusk and Nayga 2013). Thus, the Big Six approach inherits the features carried by the Five Factor model, but it is also more comprehensive. The Big Six approach has been applied in many different fields as well as in food preference research (Grebitus Lusk and Nayga 2013; DeLong and Grebitus 2018).

2.3 Methods

2.3.1 Experimental Design

To elicit consumer preference for a GM animal product, a hypothetical choice experiment about a pork loin purchasing decision was administered. This approach presents participants with multiple decision scenarios and asks them to select the product option or alternative that they most prefer. Each decision is comprised of two product alternatives, with experimentally designed attribute levels, and a no purchase option. Pork loin was chosen as the product of interest given that it is a commonly consumed meat product across the countries of interest, and consumers in these regions are familiar with this type of pork cut. In addition to whether the product was GM, the selection of choice experimental attributes was based on the relevant literature which suggested that traceability (whether the product could be traced back through the supply chain to its origin of production) and price were two very important factors influencing consumers' meat shopping

behavior (Loureiro and Umberger 2007; Zhang, Bai and Wahl 2012; Menozzi et al. 2015). Thus, the three attributes used in the product profile were price, traceability and whether the animal was genetically modified (production method) (Table 2.1). The price attribute was specified to have four different levels varying across countries. Within each country, price levels were determined to reflect product prices available on the real market. Price levels range from $2.24/pound to $5.99/pound in the US, RMB 16 ($2.32)/500gram to RMB 40 ($5.81)/500gram in China and €2.24 ($2.41)/500gram to €5.99 ($6.44)/500gram in Italy. The choice tasks were designed in the software Ngene following Street, Burgess, and Louviere (2005). The product attributes and corresponding levels were first used to develop an orthogonal fractional factorial design reducing the original 16 (4^1 x 2^2) attribute level combinations to 8. Employing the generators described by Street and Burgess (2007), 8 choice tasks or decision scenarios were developed (design D-efficiency of 96.6%). In the survey, each participant evaluated these 8 choice tasks. A sample choice task used in the US survey is presented in Figure 2.1. To mitigate any ordering effects, the order that the choice tasks were presented was randomized.

Table 2.1 Attributes and attribute levels used in choice design

Attributes	Attribute levels
Production Method	Genetically modified Non-genetically modified
Traceability	Traceable Non-traceable
Price (LCU/lb. equivalent)	$2.24/ ¥16/ €2.24 $3.49/ ¥24/ €3.49 $4.74 /¥32/ €4.74 $5.99/ ¥40/ €5.99

Genetically modified	Non-genetically modified	If options A and B were all that were available, I would not purchase pork loin
Non-traceable	Traceable	
$3.49 /pound	$4.74 /pound	
Option A	Option B	Option C

Figure 2.1. Sample choice task used in the US survey

2.3.2 Personality Measurement

In order to measure consumer's personality profile, we implemented the Midlife Development Inventory (MIDI) scale questions developed by Lachman and Weaver (1997) based on existing personality inventories (Trapnell and Wiggins 1990). The MIDI scale is able to capture individual personality in an economical and reliable way, with a completion time typically less than 5 minutes (Lachman and Weaver 1997; Grebitus, Lusk and Nayga 2013; Bazzani et al. 2017). The scale is comprised of six personality traits which are elicited by participants evaluating a series of 31 adjectives (Table 2.2). Responses were on a Likert-type scale from one (not at all) to four (a lot), asking participants to indicate how well the adjective describes them. The score of each personality trait was computed by finding the mean of the relevant adjectives (Lachman and Weaver 1997).

Table 2.2 Big six personality trait descriptors in the MIDI scale (Lachman and Weaver 1997)

Personality Trait	Characteristics
Agency	Self-confident, forceful, assertive, outspoken, dominant
Agreeableness	Helpful, warm, caring, soft-hearted, sympathetic
Openness	Creative, imaginative, intelligent, curious, broadminded, sophisticated, adventurous
Neuroticism	Moody, worrying, nervous, (non)calm
Extraversion	Outgoing, friendly, lively, active, talkative
Conscientiousness	Organized, responsible, hardworking, (non)careless

2.3.3 Consumer Preference Models

In the modeling of a consumer pork purchasing decision, an indirect utility function based on Lancaster's theory of consumer demand was specified (Lancaster 1966). Following random utility theory (McFadden 1974, 105-142), choice experiments rely on the assumption that the utility of individual *n* choosing alternative *j* in choice situation *t* can be expressed as:

$$U_{njt} = V_{njt} + \varepsilon_{njt} \quad (2.1)$$

where V_{njt} is the representative portion of the utility function, which depends on the experimentally designed product attributes for alternative j, and ε_{njt} is the stochastic and unobserved component.

First, we estimate a mixed logit model with utilities specified in WTP space. Models specified in WTP-space relax the assumption of a fixed price coefficient (Scarpa, Thiene, and Train 2008) and the estimated coefficients can directly be interpreted as marginal WTP values (Scarpa, and Willis 2010; Caputo, Scarpa, and Nayga 2017). The utility function in WTP space can be described as:

$$U_{njt} = \theta_n\left(-PRICE_{njt} + \beta_{n1}GMO_{njt} + \beta_{n2}TRACE_{njt} + ASC\right) + \varepsilon_{njt} \quad (2.2)$$

where θ_n is a random positive scalar representing the price/scale parameter; $PRICE_{njt}$ is a continuous variable populated with the four price levels in the design; GMO_{njt} and $TRACE_{njt}$ are dummy variables for the GM and product traceability attributes. They take a value of 1 when the product carries such attribute, and 0 otherwise; *ASC* is the alternative specific constant of the no-purchase option; βs are the random coefficients of the estimated WTP values; ε_{njt} is the random error term which follows a Type I Extreme Value distribution.

To investigate the role of personality in consumer demand for GM pork product, we interacted each personality trait with the product attributes. Following Grebitus, Lusk and Nayga (2013) and Bazzani et al. (2017), each personality trait is mean-centered by subtracting the sample mean from the personality scores of each individual.

$$U_{njt} = \theta_n \begin{pmatrix} -PRICE_{njt} + \beta_{n1}GMO_{njt} + \beta_{n2}TRACE_{njt} + ASC \\ + \gamma_1 Agency_n * GMO_{njt} + \gamma_2 Agreeableness_n * GMO_{njt} \\ + \gamma_3 Openness_n * GMO_{njt} + \gamma_4 Neuroticism_n * GMO_{njt} \\ + \gamma_5 Extraversion_n * GMO_{njt} + \gamma_6 Conscientiousness_n * GMO_{njt} \\ + \gamma_7 Agency_n * TRACE_{njt} + \gamma_8 Agreeableness_n * TRACE_{njt} \\ + \gamma_9 Openness_n * TRACE_{njt} + \gamma_{10} Neuroticism_n * TRACE_{njt} \\ + \gamma_{11} Extraversion_n * TRACE_{njt} + \gamma_{12} Conscientiousness_n * TRACE_{njt} \end{pmatrix}$$

$$+\varepsilon_{njt} \quad (2.3)$$

where γ_is are the coefficients of the interaction terms between the GMO and TRACE attributes and the six personality traits. These coefficients are assumed to be invariant among the

population and measure the impact of the various personality traits on consumer WTP for product attributes. The other variables and coefficients are specified as in equation (2).

2.4 Results

Data for this study was collected via an online survey of consumers in the US, China and Italy in May 2017. The survey was composed of the aforementioned choice tasks, MIDI scale questions, socio-demographics and information on household pork consumption as well as purchasing behaviors. The survey was designed in English and then translated into Chinese and Italian, respectively. All participants were recruited by Qualtrics, a professional market research agency, and were screened to ensure that they were over 18 years of age and have purchased pork products in the past three months. On average, US and Italian respondents took 15 minutes to complete the survey, while Chinese consumers spent an additional 4 minutes. The response rate was approximately 69%, resulting in 945, 945 and 954 observations in the US, China and Italy, respectively.

2.4.1 Descriptive Analysis

Socio-demographic characteristics and pork purchasing information for consumers in the US, China and Italy are presented in Table 2.3. On average, American consumers were female (60%), 46 years old, had a college degree and an annual household income of $50,000. American respondent's household mainly purchased pork from the supermarket, and consumed 1-3 pounds of pork per week. The majority of the respondents in China possessed a college degree, had an average household income of ¥120,000 per month, and typically purchased pork 2-3 times per week, mainly from wet markets or supermarkets. A slight majority of Italian respondents were

female (52%). In terms of age, the average Italian respondent was 42 years old, which is younger than the US but older than China (37 years old). Most Italian consumers completed secondary school, had a mean annual household income of €30,000, and purchased pork once a week, mainly from a supermarket.

Table 2.3 Demographics and pork purchasing characteristics

	US	China	Italy
Demographics			
Female (%)	60.00	49.95	52.41
Age (years old)	45.87	36.71	42.11
Education (%)			
Primary school	5.50	0.11	0.10
Secondary school	27.09	14.39	66.56
College and graduate	63.80	85.4	33.02
Other	3.60	0.11	0.31
HH yearly income (%)			
Lower class	42.86	14.82	20.96
Middle class	43.39	36.82	70.66
Upper class	13.75	48.36	8.38
HH size (person)	4.76	5.46	5.04
Pork purchase& consumption			
HH pork purchasing frequency (%)			
Everyday	2.65	12.38	1.26
2-3times per week	12.38	57.04	19.60
Once a week	27.41	21.16	40.67
Bi-weekly	24.02	6.14	21.38
Monthly	26.56	2.54	12.06
Less than once a month	6.98	0.74	5.03
HH pork purchasing location (%)			
Wet market	N/A	42.33	N/A
Supermarket	79.15	40.32	53.35
Supercenter	11.53	N/A	15.62
Warehouse club	4.34	N/A	N/A
Specialty store	1.16	16.62	1.89
Butcher shop	2.75	N/A	28.72
Online shop	0.11	0.42	N/A
Other	0.95	0.32	0.42
HH weekly pork consumption (%)			
Low	24.76	10.37	41.83
Medium	58.73	58.62	48.22
High	16.51	31.01	9.95
Number of observations	945	945	954

Note: HH stands for household. According to the US Census, Pew Research Center and Mckinsey Company, we define yearly household income lower than $39,999 in the US, 60,000 RMB in China and 16,000 € in Italy as lower income class; $40,000 - $119,999 in the US, 60,000 RMB - 106,000 RMB in China, 16,000 € - 60,000 € in Italy as middle income class; and households with more than $120,000 in the US, 106,000 RMB in China, and 60,000 € in Italy as upper income class. Additionally, we define low household weekly pork consumption as less than 1 lb. in the US and Italy and less than 500grams in China; medium between 1- 3 lbs. in the US and Italy and 500 gram -1,500 grams in China; and high as more than 3 lbs. in the US and Italy and over 1,500 gram in China.

The personality measurement (the MIDI scale) used in this study was found to be consistent and robust. All Cronbach alpha values are greater than 0.50[4]. Studies have suggested that values above 0.50 are acceptable (Davis 1964; Bazzani et al. 2017). The average alpha value over the six personality traits is around 0.70 in the US and Chinese samples, and 0.64 in the Italian sample (Table 2.4). This indicates that the MIDI scale used in our study is a reliable, internally consistent tool in measuring the personality traits for all three countries. In addition, we also calculated the correlation among the six personality traits, most correlations in the US sample are weak ranging from 0.01 to 0.46 in absolute value. A similar weak correlation pattern was also found in the Italian sample; the magnitude of correlations varied between 0.01 and 0.52. For the Chinese sample, personalities are slightly more correlated than the other two samples, but correlations are largely below or around 0.60. Overall, the correlation among personalities are not strong in our three samples, leading to the conclusion that the MIDI scale captures personalities in a broad and distinctive manner. Table 2.5 reports the calculated means and standard deviations for the six personality traits as well as values obtained from relevant studies for comparison purposes. Across the three countries, most averages range from 2.5 to 3.5, showing that people generally exhibit all six traits to some extent. Individuals scored the lowest for Neuroticism (2.33 in the US, 1.98 in China and 2.43 in Italy) and highest in Agreeableness (3.56 in the US, 3.46 in China and 3.35 in

4. Cronbach alpha is an estimate of the reliability of psychometric scales. The value ranges from 0 to 1, with higher numbers indicating increased reliability.

Italy), suggesting that participants from all three countries, on average, identified themselves more as helpful, warm and caring, and less as moody, worrying and nervous people. This finding is consistent with previous studies (Lachman and Weaver 1997; Grebitus, Lusk and Nayga 2013; Zhai et al. 2013; Bazzani et al. 2017). Assessing differences across countries, Chinese subjects were most dominant and forceful (Agency), Italian participants were most moody, worried and nervous (Neuroticism) while American respondents had the highest average indexes for Agreeableness, Openness, Extraversion and Conscientiousness.

Table 2.4 Cronbach alpha values of the personality traits

Personality trait	Lachman and Weaver (1997)	US sample	China sample	Italy sample
Agency	0.79	0.78	0.70	0.62
Agreeableness	0.80	0.79	0.82	0.72
Openness	0.77	0.67	0.67	0.61
Neuroticism	0.74	0.72	0.67	0.64
Extraversion	0.78	0.60	0.70	0.59
Conscientiousness	0.58	0.65	0.65	0.67

Table 2.5 Average scores for personality traits

Personality trait	US		China		Italy	
	Our sample	DeLong and Grebitus (2016)	Our sample	Zhai et al. (2013)	Our sample	Bazzani et al. (2017)
Agency	2.60	2.53	2.82	N/A	2.71	N/A
	(0.68)	N/A	(0.50)	N/A	(0.48)	N/A
Agreeableness	3.56	3.27	3.46	3.52	3.35	3.18
	(0.36)	N/A	(0.38)	(0.48)	(0.33)	N/A
Openness	3.24	2.91	3.01	3.34	3.05	2.98
	(0.37)	N/A	(0.34)	(0.49)	(0.34)	N/A
Neuroticism	2.33	2.14	1.98	2.78	2.43	2.35
	(0.70)	N/A	(0.55)	(0.52)	(0.55)	N/A
Extraversion	3.39	2.86	3.36	3.26	3.28	3.17
	(0.30)	N/A	(0.32)	(0.55)	(0.27)	N/A
Conscientiousness	3.27	3.41	3.12	3.38	3.23	3.12
	(0.52)	N/A	(0.46)	(0.55)	(0.47)	N/A

Note: Standard deviations, when available, are presented in parenthesis.

2.4.2 Consumer WTP Estimates

The estimation results from the mixed logit model specified in WTP space with correlated parameters are reported in Table 2.6. Model 1 was estimated using equation (2) while Model 2 includes the personality interaction terms, as shown in equation (3). Models were separately estimated for each country. To account for the cross-country differences in purchasing power, we adjusted the model results using the Big Mac purchasing power parity index[5]. Many studies have made use of the Big Mac index and proven that it can accurately track real exchange rates over time (Funke and Rahn 2005; Parsley and Wei 2007).

We adopted a mixed logit model since it allows for random taste, but such power significantly relies on prior distributional assumption about the preferences (McFadden and Train,

5. We first converted the estimates in China and Italy into US dollars per pound using the average exchange rate at the time the data was collected, so the estimates in all countries could have a consistent unit. Following we used the 2017 Big Mac index to adjust for purchasing power parity.

2000; Train 2016; Caputo et al. 2018). Upon testing various distributions, we specified normally distributed parameters for the GM and traceability coefficients in all three data sets[6]. Results from Model 1 (Table 2.6) indicates strong heterogeneity in consumer preference for GM and traceability as the estimated standard deviations for both attributes differ significantly from zero in the three samples. To explain such heterogeneity and investigate the role that personality traits play in consumer food choice, a model specification interacting personality traits with the two food attributes was estimated. The inclusion of personality in our model specification improves performance as noted by improvements in loglikelihood value and Akaike Information Criterion (AIC). While these improvements are modest, our analysis finds significant interaction terms of the personality traits. This result indicates that personality traits explain consumer preferences for GM pork across countries.

In terms of consumer demand for GM pork, the US sample has an average WTP of $-2.38 per pound with a standard deviation of $2.82, suggesting that approximately 80% of the respondents in the US dislike and would not purchase GM pork. Compared to a conventional pork product, Chinese consumer WTP for GM pork is about $5.01 lower, showing a relatively large discount for GM pork. Of the three countries, Italian consumers have the lowest valuation of GM pork with the average WTP being $-17.65 per pound. European consumers generally have a more negative attitude about GM food product than other regions including the US and Asia (Chern et al. 2002; Lusk, Roosen and Fox 2003). Consumer preference for traceability differs significantly across countries. In general, Italian consumers were found to have the highest WTP for traceability,

6. We explored different distributions in modelling consumer preference for GM pork, namely, normal, lognormal, censored normal and Johnson S^B distributions. Based on model performance and the literature, we specified normally distributed parameters for GM and traceability in all three data sets.

followed by consumers in China and the US. The average respondent was willing to pay a premium of $0.15 in the US, $2.52 in China and $13.19 in Italy for traceable pork.

The effects of personality traits on consumer preferences for GM pork are given by the interaction terms from Model 2 (Table 2.6). We first focus on the estimation result from the US sample, and then extend the discussion to cross-country comparisons. With respect to US consumers, five out of the six personality traits affect their WTP for the GM attribute. Consumers who are more dominant and forceful (Agency) than average, have a higher valuation of GM pork. Agency measures the degree of feeling in control or in power of things, and GM technology is created by humans rather than nature which makes those individuals feel they can manipulate the food production process. Respondents with a higher tendency of being helpful and agreeable, have an even larger discount for GM pork than average. As expected, Openness and Extraversion both exert a significant positive impact on GM pork demand. To further examine the effects of personality, we conduct *a priori* segmentation based on the personality scores and test for differences in WTP values across consumers exhibiting high and low values of the traits (Table 2.7). The findings are largely consistent with the estimation result of Model 2.

Our analysis finds significant cross-country differences in the impact of personality traits on consumer WTP for GM pork. Preference for GM food pork is explained by most personality traits in the US sample. In contrast, GM preferences are only explained by one personality trait in the Chinese sample, and by two traits in Italian consumers. Openness is the only personality that has a significant influence on Chinese consumer WTP for GM pork, and its effect is consistent with the US's finding which shows that open individuals tend to value GM food more favorably. Openness also exerts a positive effect on Italian consumer demand for GM pork and this effect is largest among the three countries ($0.72 in Italy, $0.46 in the US and $0.15 in China). Therefore,

Openness is the only personality trait that is a good predictor of GM food choice across our three countries.

Table 2.6 Estimates from the mixed logit models in WTP space (US $/pound)

	Model 1			Model 2		
	US	**China**	**Italy**	**US**	**China**	**Italy**
Mean						
GMO	-2.38***	-5.01***	-17.65***	-2.38***	-5.01***	-17.65**
	(0.12)	(0.26)	(1.50)	(0.12)	(0.25)	(1.51)
TRACE	0.15*	2.52***	13.19***	0.15*	2.50***	13.18***
	(0.08)	(0.15)	(1.13)	(0.08)	(0.15)	(1.14)
Agency*GMO				0.30**	-0.02	0.19
				(0.13)	(0.02)	(0.26)
Agreeableness*GMO				-0.51**	-0.02	-0.04
				(0.25)	(0.03)	(0.42)
Openness*GMO				0.46*	0.15***	0.72*
				(0.25)	(0.03)	(0.38)
Neuroticism*GMO				-0.06	0.02	-0.05
				(0.11)	(0.01)	(0.19)
Extraversion*GMO				0.50*	0.01	0.40
				(0.29)	(0.03)	(0.47)
Conscientiousness*GMO				-0.57***	-0.03	-0.74***
				(0.16)	(0.02)	(0.26)
Agency*TRACE				-0.02	0.02	-0.12
				(0.07)	(0.01)	(0.15)
Agreeableness*TRACE				0.14	-0.01	0.10
				(0.14)	(0.02)	(0.25)
Openness*TRACE				0.33**	0.01	-0.04
				(0.14)	(0.02)	(0.23)
Neuroticism*TRACE				0.05	-0.01	-0.20*
				(0.06)	(0.01)	(0.11)
Extraversion*TRACE				-0.07	0.00	-0.54*
				(0.16)	(0.02)	(0.28)
Conscientiousness*TRACE				0.01	0.01	0.69***
				(0.10)	(0.01)	(0.15)
ASCnobuy	-4.17***	-0.14***	-0.52***	-4.17***	-0.14***	-0.52***
	(0.06)	(0.00)	(0.05)	(0.06)	(0.00)	(0.05)
Standard deviation						
GMO	2.82***	4.43***	15.59***	2.74***	4.27***	15.27***
	(0.14)	(0.28)	(1.59)	(0.14)	(0.29)	(1.56)
TRACE	1.23***	2.66***	8.60***	1.21***	2.62***	8.30***
	(0.10)	(0.21)	(0.61)	(0.07)	(0.20)	(0.61)
Log likelihood	-5970.70	-5881.49	-5633.44	-5945.95	-5853.70	-5613.07
AIC/N	1.581	1.558	1.478	1.578	1.554	1.476

Note: *, ** and *** denote variables significant at 10%, 5% and 1% respectively. Standard errors are presented in parenthesis. Model results were transformed to US dollar per pound using the exchange rate when the survey was conducted. Similarly, values were adjusted using the Big Mac purchasing power parity index published by The Economist.

Table 2.7 WTPs for GM pork and traceability by personality (US $/pound)

		US		CHINA		ITALY	
		GMO	TRACE	GMO	TRACE	GMO	TRACE
Agency	Low (L)	**-2.69**	0.10	**-5.29**	2.43	-18.34	13.35
	High (H)	**-2.16**	0.19	**-4.69**	2.65	-16.97	13.16
Agreeableness	L	**-2.21**	0.11	-5.07	2.47	-17.90	12.99
	H	**-2.53**	0.19	-4.97	2.59	-17.38	13.55
Openness	L	**-2.61**	**0.05**	**-5.41**	2.49	**-18.29**	13.26
	H	**-2.18**	**0.25**	**-4.35**	2.59	**-16.72**	13.25
Neuroticism	L	-2.49	0.11	-5.28	2.66	-17.39	**13.65**
	H	-2.28	0.20	-4.82	2.42	-17.92	**12.85**
Extraversion	L	-2.50	0.11	-5.13	2.45	-17.67	13.29
	H	-2.30	0.19	-4.92	2.60	-17.62	13.19
Conscientiousness	L	**-2.21**	0.13	-5.00	2.48	-17.65	**12.61**
	H	**-2.56**	0.17	-5.04	2.57	-17.66	**14.10**

Note: Low means the score of personality trait is lower than the average of the sample, high indicates the score is greater than the mean. If the difference in WTP values between Below and Above is statistically significant at 95% level, both values are in bold. All WTP values were transformed to US dollar per pound using the exchange rate when the survey was conducted. Similarly, values were adjusted using the Big Mac purchasing power parity index published by The Economist.

2.5 Discussion and Implications

Our study finds that, on average, consumers have a negative WTP for GM pork in the US, China and Italy. Given the limited number of studies assessing consumer WTP for GM animal products, we compared our result with the studies assessing general GM foods. Research has demonstrated that the US consumers are willing to pay $-0.41 per pound for GM fed beef, between $-0.10 to $-3.90 for GM rice, and from $-1.33 to $-1.93 for GM sugar (Lusk, Roosen and Fox 2003; Yue, Zhao and Kuzma 2015; Lewis Grebitus and Nayga 2016). Thus, we believe our estimate of US consumer WTP for GM pork to be reasonable. In China, Gao et al. (2019) indicate that consumers have a slightly negative WTP for GM juice. But our results for Chinese consumers are perhaps not surprising as evidence already shows that consumers consider GM plant-based products in a less negative way than GM animal products (Costa-Font, Gil and Traill 2008). Of the three countries, Italian consumers discount GM products the most in our study. A possible explanation is that

consumer acceptance is lower in a more restrictive policy environment (Pakseresht, McFadden and Lagerkvist 2017) and generally speaking, GM regulations in Italy or Europe are stricter than in the US or China (Bernauer and Meins 2003; Nap et al. 2003). In addition, for European consumers, the perceived benefit of GM food does not improve their attitudes towards GMOs (Siegrist 2000), while US consumers are more optimistic and acceptable of such benefits (Lusk et al. 2004).

In terms of consumer preference for traceability, our findings are generally consistent with the literature which shows that European consumers are willing to pay more for traceable meat than North American consumers (Cicia and Colantuoni 2010). The traceability premium in the US sample, however, was lower compared with previous studies (Dickinson and Bailey 2002; Loureiro and Umberger 2007); we believe this is because the current food traceability system is more established and has become much more available for consumers. We found moderately higher WTP for traceability in the Chinese sample than those in Ortega et al. (2011) and Bai, Zhang and Jiang (2013). This is probably driven by the rising middle class in China who cares more about food safety.

This study assessed consumer valuation of GM and traceable pork products in the US, China and Italy. Our findings have implications for GM product development and marketing of novel and controversial food products. Strong negative reaction toward GM pork could encourage non-GM companies to label their products as non-GM so as to distinguish their products. While negative valuation of GM pork was found across countries, US consumers have the least negative WTP, followed by China and Italy, implying the likely order of acceptance of novel and controversial products across these markets. As such, market viability and adoption of these types of products will require careful introduction into target markets.

It is well known that personality can predict certain human behaviors. In light of this, a large body of literature explores the relationship between personality traits and life as well as economic outcomes. Several studies highlight the importance of personality in constructing consumer preference and explaining heterogeneity in individual behavior. Despite the considerable amount of research, few have investigated the psychological drivers of consumer valuation of novel and controversial products with stated preference approaches. Our finding on the effects of personality on consumer demand for GM pork suggests that individuals who are reliable, organized and careful dislike the use of biotechnology in pork production, which remains a controversial issue. This finding parallel that of DeLong and Grebitus (2018) who found that more conscientious people were supportive of GM labeling. In contrast, we find that more open and extraverted consumers have a higher valuation of GM pork. This latter finding is similar to that of Byrnes and Hayes (2013) and Bazzani et al. (2017) who note that social individuals are more likely to seek novel and uncommon aspects in food consumption.

By assessing the role of personality traits in explaining heterogeneity in consumer preferences for GM pork, our results suggest that personality traits could be adopted as an efficient segmentation tool in GM product marketing. Research finds that individual personality traits can be predicted, especially in the digital era. In fact, researchers have used user's online experiences and social media profiles as a source of information to conduct this type of personality-based marketing. By analyzing the information from the content of social media posts, in addition to the size and density of user's online social networks from sites such as Facebook and Twitter, researchers find that the Openness trait can easily be predicted with a high degree of accuracy (Back et al. 2010; Goldbeck et al. 2011). Studies have shown a strong positive correlation between the degree of Openness and the size of a user's social media network and the time spent in social

media platforms (Schrammel, Koffel and Tscheligi 2009). This allows for messaging on GM foods to be targeted to individuals based on their social media usage. This type of personalized marketing strategy has been proven to be effective by Hirsh, Kang and Bodenhausen (2012).

How psychological characteristics and their influences vary across cultures is not yet well understood in the literature. Our findings support those of Schmitt et al. (2007) who collected personality data from 56 nations/regions including the US, Italy, Hongkong and Taiwan. They show that individuals in the US are most extraverted, agreeable, conscientious, and that respondents in Hong Kong and Taiwan have the lowest level of Openness. While much attention has been given to the explanatory ability of personality in human behavior in a single cultural context, few studies have combined both to conduct a cross-country investigation on the effect of personality. Our study informs the literature by comparing the ability of personality traits to explain consumer food preference heterogeneity across countries. We find that some traits (like Agency in the US) have significant effects on preferences for GM pork among consumers in a specific country, suggesting that marketing strategies will need to be tailored to different markets. Thus, we caution the use of personality traits in market segmentation under different cultural contexts and assumptions. As such, there is a need for more studies that evaluate the role of the six personality traits in explaining preferences and acceptance of novel and controversial food products in additional countries and contexts.

2.6 Conclusion

For novel and controversial products with potential benefits to society to be widely adopted ultimately depends on consumer acceptance. This study finds that consumers are reluctant to purchase controversial foods such as genetically modified animal products. This preference,

however, is noticeably heterogeneous. In our study, we observed cross-cultural differences in acceptance. Italian consumers have the lowest valuation of a GM animal product, followed by China, and the US. On the other hand, Italian consumers valued that product's traceability the most, followed by consumers in China and the US. We tested the effect of personality traits on consumer preferences and found that personality indeed plays an important role in food purchasing behavior. The effect of personality is most evident in US consumers with five out of six personality traits playing a statistically significant role in explaining preferences for GM pork. Openness was the only trait that consistently predicted consumer valuation of GM pork in all the three countries. This implies that Openness is a robust trait in predicting consumer GM preference across cultures. Another personality trait found to be an evident predictor of acceptance in the two Western countries was Conscientiousness.

Our findings provide important knowledge to be applied when developing future applications of biotechnology and therefore are relevant for developers and marketers of GM animal products. Given consumer apprehension of novel and controversial food products, and high degree of preference heterogeneity, market segmentation strategies are needed to ensure viability of these products. Our results are helpful for food marketers and reinforce the need to use psychological characteristics of consumers to understand food product acceptance. Cross-country differences in acceptance imply the need to carefully consider culture when designing marketing strategies for GM animal products. The distinguishing characteristics of consumers with the Openness and Conscientiousness personality traits can be helpful in identifying potential target markets. However, our analysis cautions the use of personality traits in market segmentation under different cultural contexts and assumptions. These insights are useful for developing marketing strategies and we hope that it stimulates additional research into determinants of consumer

acceptance for novel and controversial food products. Given the increasing internationalization of the food supply chain, additional work is needed to investigate how consumers view other emerging food attributes (and the preference relationship between attributes) across countries and cultures.

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CHAPTER 3

On the Effect of Experimental Quantity in Consumer Food Choice Behaviors

3.1 Introduction

Stated preference valuation methods such as contingent valuations, discrete choice experiments, and experimental auctions have been extensively employed in many fields of applied economics to support policy design and evaluation (Carson 2000). Results obtained from stated preference methods are utilized to inform policy and decision makers about consumer preference and willingness to pay (WTP) for non-market goods or services. Despite its policy relevance and wide applications, a number of fundamental issues in stated preference techniques are often rarely talked about (Hess and Rose 2009). One example is experimental quantity used in the design of stated preference methods. To illustrates, Table 3.A1 lists the experimental quantities used in all food discrete choice experiment (DCE) studies published in the top journals in the agricultural economics field since 2000. Respondents in these studies are typically presented with several experimentally designed alternatives based on a researcher-predetermined quantity and are then asked to evaluate and make choices. It is noted that, even when focusing on the same type of product and population, studies use different experimental quantities when designing choice tasks (see Table 3.A1 in the appendix). Questions that then arise are which experimental quantity should be selected for experimental design, and does the use of a predetermined and sometimes arbitrary quantity affect consumer choice behavior and how?

In fact, a central principle in economic theory is that individuals are rational and have constant preferences (McFadden 2006), suggesting that consumers would select the most preferred alternative regardless of the number of units being used in a choice scenario. Besides, most stated preference methods have theoretical foundations in Lancaster's (1966) approach to consumer

theory where goods and services comprise bundles of attributes that consumers value (Johnston et al. 2017), with empirical common ground in random utility modeling (Manski 1977). The underlying functional structure of random utility model is indirect utility function which doesn't explicitly account for quantity demanded[7]. Given these arguments, stated preference valuation researchers are free to use whichever experimental quantity that may facilitate experimental design and implementation. However, this approach relies on unrealistic food purchasing situation and can be proven problematic.

Unlike insurance or car buying decisions where the alternative's quantity is typically one (individuals generally buy one insurance policy or one car per purchase), the quantity of alternatives in food choices can be many as food shoppers are heterogeneous in their purchase quantities (Chernev 2008). The increasing opportunity cost of time also increases consumers' purchase quantities in their grocery trips. Based on a specific unit of quantity that researchers define, the design hardly reflects the heterogeneity in consumers' purchase quantities in a real-world setting despite that capturing consumer's prior purchasing habits in experimental designs is important, as these are known to influence decision making (Swait et al. 2002; Adamowicz and Swait 2012; Caputo et al. 2018).

On the other hand, mental budgeting suggests that for cognitive or self-control reason, people set mental or physical budgets for different categories before consumption and then behave accordingly by tracking budgets (Heath and Soll 1996). Given a hard budget, consumer behaves differently depending on how much the choice decision would cost. If the cost is small, consumers care less about the decision. But if a decision costs a large proportion of the budget, individual

7. In discrete choice analysis, indirect utility function are in fact termed "conditional indirect utility functions" because it is conditional on choice *j* (Davis 2001).

becomes serious about it. In terms of food whose demand is generally inelastic, the budget reflects how much food is needed, namely, the quantity of food product. This implies that facing choice tasks with a research-predetermined quantity, people with different budgets and therefore different purchase quantities would react differently. And the use of different quantities shown in Table 3.A1 matters. More generally, there is ample evidence to suggest that preferences are not stable, instead, they are constructed depending on the context where they are elicited (Slovic, 1995; Camerer and Loewenstein 2003). For example, individual bids higher when presented with actual item than in the image or text display (Bushong et al. 2010). Subjects adhere to their current or previous decisions (status quo choice) more frequently than would be predicted by the theory of rational choice (Samuelson and Zeckhauser 1988). If consumers do have context dependent preferences, the distinction between a researcher-predetermined quantity in stated preference experiments and the quantity consumers actually purchase can cause systematic differences in consumer choice behavior between experiment and reality. Therefore, what consumers select in experiments with a research-predefined quantity may not reflect their real preferences. When we have to rely on experimental methods to conduct policy analysis or to assess market potential, the result obtained from such experiments may not be reliable.

This study investigate whether and how the use of a pre-determined experimental quantity affects consumer food choice behavior. We illustrate this by employing DCE as it is a widely used stated preference technique (Jacquemet et al. 2019) but our findings would have implications for other types of stated preference methods. Specially, we evaluate two DCE designs: one being the traditional design with a pre-determined quantity as shown in Table 3A.1; the other allowing the unit to be customized based on respondent's self-reported quantity per purchase so that the experiment is consistent with consumer's real shopping situation. Our results highlight the

importance of experimental quantity in the design of food valuation studies and also reveal significant differences in consumer choice behavior as well as the WTP values between the two designs.

By testing the effect of a pre-determined experimental quantity in food valuations, we make three primary contributions to the literature on consumer choice behavior and stated preference experiments. While food valuation studies have routinely preset a quantity in their experimental designs, whether and how this affects experimental outcomes is unknown. Do consumers have quantity dependent preference? Is food choice behavior affected by the experimental quantity that consumers are asked to evaluate? Are WTP values linearly correlated to experimental quantity? Answers to these questions have significant implications for the design of stated preference experiments which are increasingly employed to inform policies and to assess new value-added traits. Furthermore, we explain the effect of experimental quantity based on mental budgeting. The existence of mental accounting and its effects on consumer choice process have been well documented (Prelec and Loewenstein 1998; Benartzi and Thaler 1995; Grinblatt and Han 2005; Cheema and Soman 2006; Milkman and Beshears 2009). Despite its significance, few have adopted mental budgeting concept to understand consumer decision-making processes in stated preference valuation methods and use it to facilitate experimental design.

One of the key challenges when designing such experiments is to frame the experimental settings in a way that mirrors what people experience in a real-world situation. Based on mental budgeting, we propose and validate a novel DCE design where the experimental unit is framed according to individual's real purchase quantity. While researchers have incorporated multiple units' in experimental auctions (List and Lucking-Reiley 2000; Rousu et al. 2008; Akaichi et al 2012; Elbakidze et al. 2013), few have extended this notion to the application of DCEs. One

exception is open-ended choice experiments(OECE) (Corrigan et al. 2009; Elbakidze et al. 2014), an approach widely used in the marketing literature, which presents respondents with several products at different price levels and asks them which product they would like to buy and how many. However, OECE differ from DCE in several aspects. Unlike DCE, OECE typically contain just one attribute, provide count data instead of a mutually exclusive choice, and do not enforce trade-offs between multiple attributes. And OECE have been applied much less frequently than DCE in the field of agricultural and food economics. As such, proposing a novel DCE design that addresses consumers' actual purchase quantity is of great importance.

A large body of environmental valuation studies using stated preference methods to investigate whether respondent's WTP is responsive to differing quantities of the good being evaluated. Since Kahneman and Knetsch (1992), there has been mixed findings regarding scope sensitivity (Carson and Mitchell 1993; Green and Kahneman 1994; Bateman et al. 2004; Lew and Wallmo 2011). Since these studies generally focus on the public goods such as lakes and endangered animals, their findings would probably be driven by respondents' moral satisfaction or warm glow. Whether scope sensitivity is found on private goods is not yet well understood. Thus, we contribute to the literature by investigating this issue on a food product and find significant differences in WTP across quantities. The remainder of this paper is structured as follows. In the next section, we provide a background on mental accounting and formalize our research hypotheses. We then describe the method, econometric analysis and data used in our study. Following, we present our estimation results and conclusions.

3.2 Mental Budgeting and Research Hypotheses

Mental budgeting[8] is defined as the set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities (Thaler 1999). In contrast to neo-classical representations of consumer behavior, mental accounting assumes that money is non-fungible and people think of value in relative rather than absolute terms (Thaler 1985). A major component of mental accounting is the assignment of activities to specific accounts (Thaler 1999). Both the sources and uses of funds are labeled in real as well as in mental accounting systems. People group their expenditures into "mental accounts" and make decisions within the context of those narrowly defined budgets (Thaler and Shefrin 1981; Thaler 1985). Consumers use mental accounting as mental accounts to help them rationalize expenditures and enhance self-control (Shefrin and Thaler 1992), to derive greater pleasure from their spending (Loewenstein and O'Donoghue 2006), and also to relieve the burden of decision-marking (Simon 1947). Mental accounting has been broadly found in the science of consumer decision-making, including hypothetical and experimental settings (Heath and Soll 1996; Thaler 1999; Soster, Monga and Bearden 2010), real-world situations (Card and Ransom 2011; Beatty et al. 2014; Abeler and Marklein 2017), food studies (Milkman and Beshears 2009; Hastings and Shapiro 2013, 2018) and in non-food applications (Feldman 2010; Benhassine et al. 2015; Farhi and Gabaix 2017; Nauze 2018). Compared with the most studied fields such as finance and investment, mental accounting strategies are less studied in food purchasing decisions. With regard to food purchasing and consumption, Milkman and Beshears (2009) have shown that when given discount coupons, consumers tend to spend more and purchase items that they don't buy usually in online grocery shopping. Hastings and Shapiro (2013) estimated that people are more likely to purchase food out

8. Mental budgeting and mental accounting are used interchangeable.

of SNAP transfer rather than their own cash. These studies confirm the existence of mental accounting in food consumption. Moreover, they inform how the size of mental budget would affect consumer food purchasing behavior that cannot be explained in a traditional neoclassical model.

Because of behavioral mental accounting, deviating from the default sub-budget is psychologically costly to consumers (Farhi and Gabaix 2017; Hastings and Shapiro 2018). A rigid mental account means the total budget on a category of goods is inelastic. Such a predetermined and inelastic budget alters consumer behaviors systematically. As predicted in Heath and Soll (1996), to maintain the default expenditure level, when a budget is too low, consumers will avoid buying goods in a given category. However, when people budget too much, they may overconsume goods that they desire less. Similarly, Kahneman and Tversky (1984) found that most people are willing to travel to save $5 when the item costs $15 but not when it costs $125.

A prediction of mental budgeting is that when consumers face a purchase decision that requires a large (small) or full amount of their ex-ante budget, they will perceive the decision more (less) expensive, thus being more (less) sensitive to price. In terms of food expenditures, budgets largely reflect consumption or purchase quantities. Therefore, we hypothesize that (**H1**) consumers who buy smaller quantities (with a relatively smaller budget) would consider the experimental products more expensive as the price may be higher than their mental budgets. In contrast, prices would be perceived as cheaper for consumers with larger purchase quantities and corresponding budgets.

Next, we present how price sensitivity affects consumer choice behavior using a randomly utility theory framework (McFadden 1974). The utility of individual i selecting alternative j in choice task t can be written as follows:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \quad (3.1)$$

where V_{ijt} is the component of utility that is observable by researchers and ε_{ijt} is a stochastic error term. According to Lancaster's theory (1966), V_{ijt} could be derived from the characteristics of the experimental product.

$$V_{ijt} = ASC_j + \beta_i X_{ijt} + \alpha_i P_{ijt} \quad (3.2)$$

where ASC_j is alternative-specific constant (opt-out), X_{ijt} is a product quality attribute vector, and P_{ijt} is the price attribute. β_i and α_i measure individual preference for X_{ijt} and price sensitivity, respectively. Consider a choice task composed of three alternatives $T = \{alt1, alt2, alt3\}$ where $alt1, alt2$ are product alternatives and $alt3$ is a no purchase alternative (opt-out). Since only differences in utility matter, we normalize ASC_1 and ASC_2 to zero. If ε_{ijt} is distributed extreme value, independently over i, j, and, importantly, t, then, the choice probabilities are:

$$A_{ijt} = \frac{e^{V_{ijt}}}{\sum_{j=1}^{3} e^{V_{ijt}}} = \frac{e^{\beta_i X_{ijt} + \alpha_i P_{ijt}}}{\sum_{j=1}^{3} e^{V_{ijt}}} \quad , \text{ j} = 1 \text{ or } 2$$

$$A_{i3t} = \frac{e^{V_{i3t}}}{\sum_{j=1}^{3} e^{V_{ijt}}} = \frac{e^{ASC_3}}{\sum_{j=1}^{3} e^{V_{ijt}}} \quad (3.3)$$

Without loss of generality, we assume that $alt1$'s price is higher than $alt2$'s, i.e. $P_{i1t} > P_{i2t}$. Taking the derivative of the choice probability with respect to α_i,

$$\frac{\partial A_{i1t}}{\partial \alpha_i} = \frac{e^{V_{i1t}} e^{V_{i2t}} (P_{i1t} - P_{i2t}) + e^{V_{i1t}} e^{V_{i3t}} P_{i1t}}{\left(\sum_{j=1}^{3} e^{V_{ijt}}\right)^2} > 0 \qquad (3.4)$$

We can obtain that individuals who have a less negative α_i, being less price sensitive, are more likely to select the more expensive alternative, which is $alt1$ in this case. Similarly, the larger α_i, the stronger the tendency to avoid $alt3$ (the no purchase alternative), as shown below.

$$\frac{\partial A_{i3t}}{\partial \alpha_i} = -\frac{e^{V_{i3t}} [e^{V_{i1t}} P_{i1t} + e^{V_{i2t}} P_{i2t}]}{\left(\sum_{j=1}^{3} e^{V_{ijt}}\right)^2} < 0 \qquad (3.5)$$

From equation (4) and (5), we form the hypotheses that (**H2**) less price sensitive individuals (which have larger purchase quantities) tend to choose the expensive alternative within a given choice set, and (**H3**) they prefer product alternatives over not purchasing any products. These hypotheses are also consistent with the predictions of mental accounting theory. Given a pre-determined budget which is costly to deviate from, consumers with larger purchase quantities/budget prefer to buy and choose the expensive alternative so as to mitigate the deviation.

Given the above differences in consumer choice behavior, WTP which involves a ratio where the denominator is the price coefficient can be expected to differ as well. Hence, we hypothesize that (**H4**) consumers with larger budgets/quantities would have higher WTP values when they are restricted to buy alternatives that have smaller quantities than their usual purchase, requiring less spending.

3.3 Method

3.3.1 Product Selection and DCE Design

Among stated preference methods, a DCE is adopted to test our research hypotheses on the experimental quantity's effect on consumer behavior. DCE is a popular stated preference technique (Jacquemet et al. 2019) given its theoretical consistency, providing participants the opportunity to opt-out of making a choice and the ability of researchers to calculate trade-offs among a broad set of attributes. As such we design and implement a beef DCE on Chinese consumers. Beef, traditionally a less sought protein, is now the fastest growing meat in China, surpassing the demand growth of more widely eaten meats like pork. Beef consumption in China increased by 22.3% from 6.45 million tons in 2011 to 7.89 million tons in 2017, with per capita consumption projected to top 9 pounds in 2019 (Li, Yan and Zan 2018). Coupled with limited Chinese domestic production, China emerged as the world's second largest beef importer; China's net beef imports in China are expected to be 0.5 million tons by 2020 (Li, Yan and Zan 2018).

Since imports have been a significant source of China's beef supply, we include country of origin as one of the product attributes in the experimental design. Levels for country of origin include domestic (China), US, Australia and Canada, with the latter three being major beef trading partners with China. In addition to country of origin, a novel product attribute, Blockchain traceability, is taken into consideration. Recent advancements in enhanced digital traceability has enabled food retailers like Walmart in the US and JD in China to adopt Blockchain methods to trace food products such as mango, pork and beef. The traceability systems based on Blockchain technology have been characterized as reliable, authentic and transparent (Tian 2016). Since the profitability of this innovative technology will finally depend on how much consumers value it, we evaluate consumer WTP towards Blockchain traceable beef products. We also assess

tenderness which is the most important palatability attribute of beef (Lusk et al. 2001) and other studies have also supported the importance of tenderness in beef purchasing decision (Loureiro and Umberger 2007; Gao and Schroeder 2009). Finally, product price is included as it is a major determinant of product choice and can be used to derive the WTP values. Price levels used in the design reflect market prices at the time of this study and range from 28 RMB/500gram to 73 RMB/500gram. More notably, inclusion of a price attribute allows for the testing of our research hypotheses. Table 3.1 provides a summary of the selected product attributes and attribute levels.

Table 3.1 Attributes and attribute levels in the experiment

Attributes	Levels
Country of origin	Domestic the U.S. Australia Canada
Blockchain traceability	Blockchain traceable Traceable
Price (RMB/500gram)	28 43 58 73
Tenderness	Has tenderness claim Has not tenderness claim

Given the attributes and attribute levels selected, a full factorial design would require 4,096 ($4^4 \times 2^4$) different choice tasks. To reduce the number of choice tasks shown to respondents during the survey, we generate an optimal orthogonal in difference design (D-efficiency 95.82%) following Street, Burgess and Louviere (2005), Street and Burgess (2007). First, a fractional factorial design is employed to construct the first alternative in choice tasks, and then we use design generator to construct the second choice alternative. The final design consists of 16 choice tasks

which were separated into 2 blocks (8 choice tasks per block). Each choice task includes two product alternatives with experimentally designed attribute levels and an opt-out alternative. The opt-out alternative, which better simulates a real market situation in which consumers may not select to buy a product, allows us to test our research hypotheses. The order in which the 8 choice tasks were presented was randomly varied across subjects.

3.3.2 Survey and Study Design

Prior to evaluating the choice tasks, respondents answered questions on their beef purchasing and consumption habits including how much beef they usually buy per purchase, without anticipation about the following survey questions. Respondents' answers to beef purchase quantity are based on their usual purchasing habit, and any strategic responses to the question is few likely. The information on beef quantity per purchase was then used to develop a split-sample design and randomly assign participants into two groups: control and treatment. In the control group, regardless of the quantity they actually buy, all respondents evaluated choice tasks where the quantity of product alternatives are pre-determined by researchers and restricted to be 500 grams of beef. As such we refer to it as the mismatched design and it reflects how the vast majority of DCEs are structured. In the treatment group, on the other hand, the choice tasks were framed based on each individual's previously stated purchase quantity[9]; we refer to this as the matched design because the experimental quantity here reflects what consumer actually purchase in a real setting. By doing so, we hope preferences elicited in the design best reflects consumer purchasing decision in real-world situation. To illustrate, if a person noted usually buying 1,000 grams of beef per

9. A dropdown list of 20 different purchase quantities ranging from 100 grams to 2,000 grams was used to ease the cognitive burden for respondents.

shopping occasion, the matched design would generate the choice tasks with beef product alternatives being on a basis of 1,000 grams. To reflect how the unit of product alternative affects purchasing costs, the matched design included both a unit price and total price. For modelling purposes, we utilized the same unit price levels in the control and treatment estimation. Sample choice tasks are shown in Figure 3.1.

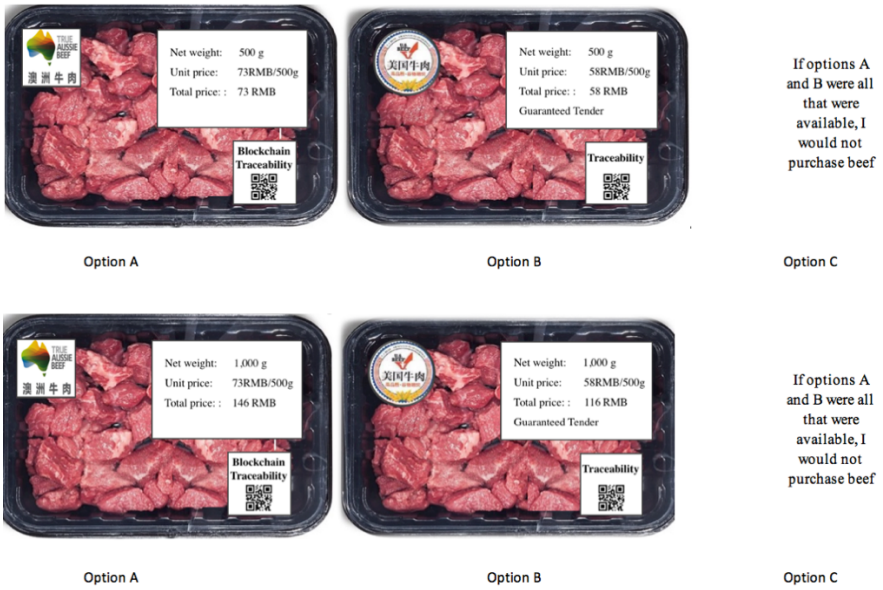

Figure 3.1 Sample choice tasks

Note: The upper panel represents mismatched design and the lower panel is matched design.

3.4 Econometric Analysis

In discrete choice analysis, consumer's utility function can be specified in either preference or WTP space (Train and Weeks 2005). Models in preference space specify the distribution of coefficients in the utility function and derive the distribution of WTP which involves a ratio where the denominator is the price coefficient. In contrast, by re-parameterizing the utility function, the coefficients in WTP space are the marginal WTPs for each attribute, allowing analyst to specify and estimate the distributions of WTP directly (Scarpa, Thiene, and Train 2008). Since the effects of price and the opt-out on consumer utility can be isolated in preference space, we first estimate

models in preference space to test our research hypotheses **H1** and **H3.** In order to test **H4**, we then turn our attention to models in WTP-space as they provide more behaviorally plausible distribution of WTPs (Train and Weeks 2005; Scarpa, Thiene and Train 2008).

To formally test the aforementioned hypotheses, a quantity indicator q_i is created where x is individual's stated purchase quantity in the real-world.

$$q_i = \begin{cases} -1, & x < 500\ g \\ 0, & x = 500\ g \\ 1, & 500 < x \leq 1{,}000\ g \\ 2, & 1{,}000 < x \leq 1{,}500\ g \\ 3, & 1500 < x \leq 2{,}000\ g \end{cases}$$

We interact the quantity indicator with price attribute and characterize V_{ijt} as:

$$V_{ijt} = \alpha_i Price_{ijt} + \alpha^q\ (Price_{ijt} * q_i)$$
$$+ \beta_{1i} Blockchain_{ijt} + \beta_{2i} Tender_{ijt} + \beta_{3i} US_{ijt} + \beta_{4i} AUS_{ijt} + \beta_{5i} CAN_{ijt} + ASC_{ijt} \quad (3.6)$$

where $Price_{ijt}$ is a continuous variable populated with the four price levels in the experimental design; $Blockchain_{ijt}$ and $Tender_{ijt}$ are dummy variables for the Blockchain traceability and tenderness attributes; US_{ijt}, AUS_{ijt} and CAN_{ijt} are dummy variables for country of origin, indicating whether the beef comes from the U.S., Australia and Canada, respectively. ASC_{ijt} is an alternative-specific constant capturing the utility of not making a purchase (opt-out). β_1 ,…, β_5 and α_i are taste parameters. α^q determines if and how mental budgeting, represented by purchase quantity, affects individual price sensitivity. And we expect α^q to be

greater than zero. If individual usually buys less than 500 grams of beef, he/she is more sensitive to price. The sensitivity to price decreases as the real purchase quantity (therefore budget) increases.

The first hypothesis in Section 2 (**H1**) can be tested by formalizing the following:

H_{01}: $\alpha^q > 0$ and

H_{11}: $\alpha^q \leq 0$

We test **H2** by comparing the frequency of participants selecting the most expensive alternative across different quantity groups. In addition, we interact the quantity indicator with the alternative-specific constant to investigate the effect of experimental quantity on opt-out behavior. The indirect utility function can be written as:

$$V_{ijt} = \alpha_i Price_{ijt} + \gamma^q \, (ASC_{ijt} * q_i) + \beta_{1i} Blockchain_{ijt} + \beta_{2i} Tender_{ijt} + \beta_{3i} US_{ijt} + \beta_{4i} AUS_{ijt} + \beta_{5i} CAN_{ijt} + ASC_{ijt} \quad (3.7)$$

γ^q captures the effect of purchase quantity on the choice to opt-out. As we discussed previously, under the mismatched group, individuals who buy a smaller (larger) quantity with a higher (lower) level of price sensitivity would be more (less) likely to not make a purchase. This hypothesis (**H3**) can be confirmed by testing the sign of γ^q.

H_{03}: $\gamma^q < 0$ and

H_{13}: $\gamma^q \geq 0$

The rejection of H_{01}, H_{03} under the mismatched design would confirm our conceptual hypotheses. For the validity of our novel design, we would expect that both α^q and γ^q are statistically insignificant for the matched group as the unit is customized according to the self-reported purchase quantity. The utility specifications in equation (6) and (8) are estimated in preference space using a mixed logit model that allows for individual-specific, random taste variation. Mixed logit models have the capacity to approximate any true underlying random utility model (Train 2009). In addition to preference heterogeneity, consumers' preferences for a given attribute are likely to be related to their preferences for another attribute (Hess & Train 2017). For example, the preference for traceability may correlate with the desire to buy imported beef product. As such, we impose correlations among taste coefficients when estimating the mixed logit models.

To test the last research hypotheses, we estimate the following utility expression in WTP space:

$$V_{ijt} = \theta_i(Price_{ijt} + \omega_{1i}Blockchain_{ijt} + \omega_{2i}Tender_{ijt} + \omega_{3i}US_{ijt} + \omega_{4i}AUS_{ijt} + \omega_{5i}CAN_{ijt} + ASC) \quad (3.8)$$

where θ_i is a random positive scalar representing the price/scale parameter; ωs are the random coefficients of the estimated marginal WTP values. If the actual purchase quantity is greater than the researcher pre-determined quantity, **H4** can be confirmed by rejecting H_{04}:

H_{04}: $\omega^{Mismatched} < \omega^{Matched}$ and

H_{14}: $\omega^{Mismatched} \geq \omega^{Matched}$

When researchers prespecified an experimental quantity that is greater than the amount respondent actually buys, **H4** can be confirmed by rejecting H_{14}

3.5 Data

A sample of Chinese consumers was recruited by Qualtrics, a professional market research company, in November 2018. All respondents were excluded a priori if they were younger than 18 years of age, were not the primary household grocery shopper or didn't purchase beef in the last month. A total of 759 valid observations were collected with 383 and 376 individuals belonging to the control and treatment groups, respectively.

Results of statistical tests (Table 3.2) suggest that the two sub-samples are not significantly different in terms of age, gender, education, income, household size or beef purchasing and consumption pattern. This result implies that these variables don't lead to the difference in consumer choice behavior between the mismatched and matched design. Nearly 50 percent of respondents were female, had an average age of 36 years and reported having 4 to 5 people in their households. The majority of study participants had a college degree, a monthly household income of more than RMB13,000, and purchase beef at least once a week in a traditional retail channel (wet market or domestic supermarket). The average beef purchase quantity was approximately 800 grams per purchase, which is greater than the 500 grams used in the mismatched design.

Table 3.2 Descriptive analysis

		Mismatched (N=383)	Matched (N=376)	Δp-value
Age		35.20	36.84	0.47
Female	%	58.22	54.52	0.30
Average beef price		38.62	39.18	0.79
Most preferred origin	%			0.76
	China	43.34	43.88	
	US	15.93	13.30	
	Canada	16.45	16.76	
	Australia	24.28	26.06	
Traceable beef freq.	%	65.32	62.20	0.11
Tender beef freq.	%	71.84	72.67	0.08
Heard about Blockchain	%			0.92
	Yes	85.90	85.37	
	No	10.18	10.11	
Blockchain purchase	%			0.19
	Yes	44.15	45.95	
	No	30.32	33.94	
Quantity per purchase	gram	808	809	0.94
Beef weekly consumption	%			0.65
	0- 1,000 grams	30.03	30.06	
	1,001- 2,000 grams	31.60	37.50	
	2,001- 3,000 grams	20.89	18.08	
	3,001- 4,000 grams	8.35	7.71	
	> 4,000 grams	9.14	6.64	
HH monthly income	%			0.24
	< 9,000 yuan	0.26	0	
	9,000- 1,4,999 yuan	1.04	2.13	
	15,000-22,999 yuan	4.18	4.26	
	≥23,000 yuan	6.79	6.38	
Highest education	%			0.35
	High school	4.44	4.26	
	College	84.86	88.03	
	Graduate	10.70	7.71	
HH size		4.49	4.54	0.39
Number of children		1.80	1.83	0.26

Note: P-value is used to test the difference between the two designs.

With respect to choice behavior, we report the frequency of participants selecting the most expensive and opt-out alternatives across sub-samples in Table 3.3. Consumers in the mismatched group who buy less than 500 grams were found to select the most expensive beef alternative least frequently. The frequency of choosing the most expensive option in the mismatched design

increases as the self-stated purchase quantity, implying the default budget, increases. Such pattern was not found in the matched group where consumers face choice decisions based on their usual purchase quantity. In terms of the frequency of opt-out, we don't find a clear relationship with purchase quantity in both the mismatched and matched design.

Table 3.3 The frequency of choosing expensive and opt-out options

	# of Expensive			# of Opt-out		
purchase quantity	**Mismatched**	**Matched**	**Δp-value**	**Mismatched**	**Matched**	**Δp-value**
100-400	30%	38%	<0.01	7%	1%	<0.01
500	40%	36%	<0.01	9%	1%	<0.01
600-1000	40%	34%	<0.01	3%	0%	<0.01
1100-1500	46%	34%	<0.01	4%	1%	0.26
1600-2000	50%	31%	<0.01	7%	1%	0.07
p-value	0.15	0.12		0.12	0.12	

Note: P-value is used to test the difference between the two designs.

3.6 Results

We remind the reader that α^q in equation (6), and γ^q in equation (8) are used to test H1 and H3 separately. And H4 can be confirmed by estimating equation (10). Both equation (6) and (8) are estimated separately for the control and treatment group. Table 3.4 reports the estimation results from the mixed logit model in preference space. We specify a triangular distribution for α_i, and normal distributions for $\beta_1,\ldots,\beta_5$ while fixing ASC. In both groups, the signs of all estimated coefficients are as expected. In general, consumers dislike higher prices, favor tender, Blockchain traceable beef, and have a strong preference for Australian beef products. Tastes are found to be heterogeneous with regard to price and country of origins as indicated by the significant standard deviations. More importantly, the results indicate that the interaction term of interest in equation (6), α^q, is positive and significant in the mismatched design. This implies that consumers who usually purchase larger quantities than those presented in the experiment are less price sensitive, while individuals are more sensitive to costs when their actual purchase quantities are smaller. As

predicted, α^q is insignificant in the matched design. These findings confirm the effects of mental accounting on price sensitivity, supporting our first hypothesis (**H1**). Based on **H1**, we can further confirm that in the mismatched design, people with larger purchase quantities are more likely to select the expensive alternative within a choice set, confirming the second hypothesis (**H2**). A negative and significant interaction between ASC and the quantity indicator, γ^q, implies that people with larger purchase quantities are less likely to opt-out from making a choice confirming hypothesis (**H3**). As predicted, γ^q is insignificant in the matched design, indicating the framing effect of the experimental quantity. Since mixed logit models are based on distributional assumption of the random parameters, we ensure robustness of our results by testing different distributional assumptions of the price and opt-out coefficients[10]. From the analysis we can conclude that hypotheses **H1**, **H2** and **H3** are supported and our results are generally robust.

To determine if the differences in choice behavior affect the estimated WTP values, we estimate mixed logit models with correlated parameters in WTP-space for both the treatment and control group (Table 3.5). On average, we find that consumers are willing to pay a premium for Blockchain traceability, tenderness and beef from Australia and Canada. In both groups, the highest premium is found in Australian beef, and the lowest in the U.S. beef, which are consistent with the results in preference space. To test our last hypothesis (**H4**), we compare WTPs across groups. Since 59% of our respondents buy more than the researcher-predetermined quantity (500 grams) in their usual beef purchases, we would expect that individuals in the mismatched group

10. Lognormally, Johnson Sb distributed and fixed price coefficients have been specified in equation (6) while holding ASC fixed; normally distributed ASC has been used while holding price coefficient triangularly distributed when estimating equation (8).

Table 3.4 Estimates from the mixed logit model in preference space, mismatched and matched design

	Model 1		Model 2	
	Mismatched	**Matched**	**Mismatched**	**Matched**
Mean				
ASC	***-4.55***	***-5.08***	***-4.35***	***-5.04***
	(0.20)	(0.22)	(0.20)	(0.23)
λ^q			***-0.34***	-0.08
			(0.12)	(0.12)
Price	***-0.04***	***-0.05***	***-0.04***	***-0.05***
	(0.004)	(0.004)	(0.003)	(-0.003)
α^q	***0.01***	-0.002		
	(0.002)	(0.003)		
Tender	***0.11***	***0.12***	*0.11*	***0.13***
	(0.05)	(0.05)	(0.05)	(0.05)
Blockchain	***0.18***	***0.14***	***0.18***	***0.13***
	(0.05)	(0.05)	(0.05)	(0.05)
USA	-0.03	0.05	-0.05	0.05
	(0.08)	(0.08)	(0.08)	(0.08)
Canada	0.11	0.11	0.11	0.10
	(0.08)	(0.08)	(0.08)	(0.08)
Australia	***0.29***	*0.20*	***0.28***	*0.20*
	(0.08)	(0.08)	(0.08)	(0.08)
SD				
Price	***0.07***	***0.07***	***0.07***	***0.07***
	(0.004)	(0.004)	(0.004)	(0.004)
Tender	***0.32***	0.21	***0.32***	0.20
	(0.11)	(0.15)	(0.11)	(0.15)
Blockchain	*0.29*	0.08	0.24	0.18
	(0.12)	(0.17)	(0.16)	(0.17)
USA	***0.50***	***0.54***	***0.50***	***0.54***
	(0.14)	(0.13)	(0.14)	(0.13)
Canada	***0.65***	***0.50***	***0.66***	***0.52***
	(0.13)	(0.14)	(0.13)	(0.14)
Australia	***0.43***	***0.53***	***0.43***	***0.54***
	(0.16)	(0.15)	(0.16)	(0.15)
N	3064	3008	3064	3008
LLK	-2359.9	-2295.7	-2362.3	-2295.6
AIC/N	1.55	1.54	1.55	1.54

Note: Model 1 is estimated using equation (6) while Model 2 is estimated using equation (8).Italic and bold number means significant at 1%, italic number means 5% and bold number means 10% of significance. Standard errors are in parentheses.

are willing to pay more for product attributes than consumers in the matched group. With regard to country of origins, WTP for the Australian beef is 4.87 RMB/500 grams in the matched design, which is nearly half of the value in the mismatched design. Using estimates from the mismatched

design would suggest that consumers value domestic beef at 3.20 RMB/500 grams relative to the same product originating from the US; results from the matched design suggests that there is virtually no difference. We also find the price premium for Canadian beef to be 1 RMB/500 grams higher in the mismatched design. The average premium consumers in the mismatched group are willing to pay for Blockchain traceable beef is 4.83 RMB/500 grams which is about 2.8 times that of the matched group (1.70 RMB). No significant differences in the WTP for tender beef were found between the two groups, which valued this attribute at approximately 2.40 RMB/500 grams. Overall, these results indicate that the mean WTPs for the majority of attributes were significantly higher in the mismatched group. This is specially the case for novel product characteristics such as Blockchain traceability and suggests that these effects may be attribute specific.

Table 3.5 Estimates from the mixed logit model in WTP space, mismatched and matched design

	Mismatched	**Matched**	**Δp-value**
Mean			
Blockchain	*4.83*	1.70	<0.01
	(2.42)	(1.74)	
Tender	2.46	2.34	0.28
	(2.12)	(1.46)	
US	-3.20	0.42	<0.01
	(4.64)	(3.36)	
Australia	*8.51*	**4.87**	<0.01
	(3.75)	(2.77)	
Canada	3.40	2.34	0.05
	(3.90)	(2.57)	
ASC	***-3.78***	***-4.49***	
SD			
Blockchain	***10.09***	**6.16**	<0.01
	(3.76)	(3.61)	
Tender	9.44	**5.56**	<0.01
	(7.39)	(3.25)	
US	***50.30***	*36.18*	<0.01
	(6.23)	(15.27)	
Australia	***35.87***	*28.75*	<0.01
	(9.13)	(11.81)	
Canada	*37.17*	***24.14***	<0.01
	(16.05)	(7.95)	
LLK	-2492	-2392	
AIC/N	1.64	1.61	

Note: Italic and bold number means significant at 1%, italic number means 5% and bold number means 10% of significance. P-value is used to test the difference in WTP values between the two designs. Standard errors are in parentheses.

3.7 Conclusion

Given the increased use of stated preference methods in policy and marketing analysis, the reliability of experimental results becomes a critical issue. This study leverages mental accounting, one of the most commonly invoked ideas in behavioral economics, to understand consumer decision-making process in stated preference experiments with a researcher-predetermined quantity. Meanwhile, we propose a novel experimental design eliciting consumer choices that are more reflective of their real-world behaviors. Our findings indicate that consumers who buy larger amounts than the experimental quantity (and have larger default budgets) are less price sensitive, more likely to select the expensive product and have a lower probability to opt-out from making a purchase. Similarly, individuals with smaller purchase quantities (which have smaller default budgets) are more sensitive to price, and are more likely to make a no-purchase decision. These discrepancies in choice behavior are mitigated when the experimental unit is matched with consumers' usual beef purchase quantities. Further, we examine whether and how much these discrepancies in choice behavior result in the differences in derived welfare estimates. The WTPs for most product attributes such as country of origin and Blockchain traceability are significantly smaller in the matched design, while no difference in the premium for tender beef is found between the two designs. Our finding shows that the effect of experimental quantity on willingness to pay values are attribute-specific.

Our findings contribute to the better understanding of consumer choice behavior in stated preference methods. Our results demonstrate how a researcher-predetermined experimental quantity affects individual choice behavior and derived welfare estimates because of behavioral

mental accounting. In traditional mismatched designs, when most respondents usually have a purchase quantity greater than the researcher predetermined unit, average WTPs are biased upward. Similarly, if the majority of the respondents actually purchase a smaller quantity than what they encounter in the experiment, the average WTP values will be downward biased. Thus, we caution the use of WTP values derived from designs that fail to account for heterogeneity in respondents' actual purchase quantities to inform marketing strategies and food polices.

Given the significant difference found in consumer choice behavior between the two designs, we caution the use of researcher-predetermined experimental quantities and encourage designs that account for heterogeneity in purchase quantities. Our findings contribute to the literature by providing and validating a novel design where experimental quantities are heterogenous and matched with respondents' real purchase quantities. Due to the limited research in this area, we call for more applications of this novel design. As the effect of a researcher-predetermined experimental quantity on WTP values are attribute specific, implying that the effectiveness of the novel design may be context dependent, future stated preference studies in various contexts are needed, both in hypothetical and real settings.

APPENDIX

APPENDIX

Table 3A.1 Experimental quantities used in food DCEs

Product	Quantity	Author
	12-oz	Lusk and Schroeder (2004); Gao and Schroeder (2009); Lusk, Schroeder and Tonsor (2014); Caputo, Scarpa and Nayga (2016)
	1 pound	Lusk, Roosen and Fox (2003); Arunachalam et al. (2009); Chang, Lusk and Norwood (2009); Loureiro and Umberger (2007); Gao, House and Bi (2016); Chung, Boyer and Han (2009); Gao and Schroeder (2009); Caputo, Scarpa, and Nayga (2016)
Beef	500 grams	Ortega et al. (2016); Grebitus, Jensen and Roosen (2013); Olsen and Meyerhoff (2016)
	375 grams	Lewis et al. (2017)
	A package (1.58 or 0.69 pounds)	Maples, Lusk and Peel (2018)
	1 kilogram	Alfnes (2005); Carlsson, Frykblom and Lagerkvist (2007); Wezemael et al. (2014); Scarpa et al. (2012); Burton and Rigby (2012)
	1 gallon	Brooks and Lusk (2010); Wolf, Tonsor and Olynk (2011); Caputo, Lusk and Nayga (2018); Crespi et al. (2016)
Milk	half-gallon	Wolf, Tonsor and Olynk (2011)
	250 grams	Bai, Zhang and Jiang (2013); Ortega et al. (2012)
	120 grams	Yu, Yan and Gao (2014)
	1 kilogram	Ubilava and Foster (2009); Goddard et al. (2013); Balogh et al. (2016); Yu, Yan and Gao (2014)
	1 pound	Nilsson, Foster and Lusk (2006); Pozo, Tonsor and Schroeder (2012); Gao, House and Bi (2016); Lusk et al. (2018); Pozo, Tonsor and Schroeder (2012)
Pork	0.5 pound	Lusk, Norwood and Pruitt (2006)
	500 grams	Ortega et al. (2011); Wu et al. (2016)
	450 grams	Balcombe et al. (2016)
	400 grams	Dahlhausen, Rungie and Roosen (2018)
	100 grams	Gracia, Loureiro and Nayga (2011)
	A Package	Barreiro-Hurle, Gracia and de-Magistris (2010); Teisl and Roe (2010)
	1 pound	Gao, House and Bi (2016); Kemper et al. (2018); Kemper, Popp and Nayga (2019)
	1 kilogram	Carlsson, Frykblom and Lagerkvist (2007); Scarpa et al. (2012); Van Loo et al. (2014); Caputo et al. (2018)
Chicken	A whole chicken	Erdem (2015); Ifft, Roland-Holst and Zilberman (2012)
	500 grams	Carlsson, Morkbak and Olsen (2012); Balcombe et al. (2016)
	A tray of two pieces	Sandorf and Campbell (2018)
Salmon	400 grams	Alfnes et al. (2006)

Table 3A.1 (cont'd)

	A fillet	Uchida et al. (2012)
	1 pound	Gao, House and Bi (2016)
	1 pound	Onozaka and Mcfadden (2011)
Tomato	1 kilogram	Bello and Abdulai (2016); Yu, Yan and Gao (2014)
	3 kilograms	Probst et al. (2012)
	2.2 pounds	Caputo, Nayga and Scarpa (2013)
	1 pound	Tonsor and Shupp (2011); Onozaka and Mcfadden (2011); Costanigro and Lusk (2014)
Apple	1 kilogram	Rousseau and Vranken (2013); Moser, Raffaelli and Notaro (2014); Morkbak and Olsen (2015); Kaye-Blake, Bicknell and Saunders (2005)
	A package	Hu, Adamowicz and Veeman (2006); Alemu and Olsen (2018)
	800 grams	Bitzios, Fraser and Haddock-Fraser (2011); Balcombe et al. (2014)
Bread	600 grams	Hu et al. (2004)
	250 grams	Aerni, Scholderer and Ermen (2011)
	50 grams	Aerni, Scholderer and Ermen (2011)
	1 liter	Volinskiy, Adamowicz and Veeman (2011); Menapace et al. (2011); Ding, Veeman and Adamowicz (2015)
Vegetable oil	0.75 liter	Menapace et al. (2011)
	0.5 liter	Hartl and Herrmann (2009); Menapace et al. (2011)
	600 grams	Hu (2008)
	500 grams	Corrigan et al. (2009)
Rice	1 pound	Lusk (2003)
	1 kilogram	Zhou et al. (2017)
Potato	1 kilogram	Grebitus, Steiner and Veeman (2015)
	3 kilograms	Carlsson, Frykblom and Lagerkvist (2007)
Egg	1 dozen	Asselin (2005); Goddard et al. (2013)
	10	Dahlhausen, Rungie and Roosen (2018)
Yogurt	A package of 4 counts	Marchi et al. (2016); Barreiro-Hurle, Gracia and de-Magistris (2010)
	500 grams	Bechtold and Abdulai (2014)
Oyster	1 dozen	Gao, House and Bi (2016)
	Half dozen	Petrolia (2016)
Pasta	A dish	Hoefkens et al. (2012)
	500 grams	Dahlhausen, Rungie and Roosen (2018)
Coffee	12 oz	Van Loo et al. (2018)
	1 kilogram	Gelaw, Speelman and Huylenbroeck (2016)
Cheese	200 grams	Bechtold and Abdulai (2014)
	500 grams	Ovrum et al. (2012)
	A bundle	Ochieng, Veettil and Qaim (2017)
Vegetable	1 kilogram	Wongprawmas and Canavari (2017)
	1 pound	Xie et al. (2016)

Note: Including all food products that have been investigated by DCE studies published in AJAE, Food Policy, ERAE, AE, JAE and AJARE since 2000 and use different experimental quantities.

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