I CAN'T WORK IT OUT!

MATHS ANXIETY AND DISCOUNT EFFECTIVENESS

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgement is made in the acknowledgements.

_____

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Ethical Approval

Ethics approval from the Auckland University of Technology Ethics Committee (AUTEC) was granted on September 15th, 2020, as detailed in *Appendix One*, for a period of three years commencing September 15th, 2020. The AUTEC ethics application number is 20/306.

Abstract

Mathematics Anxiety (MX) and Mathematics Ability (MA) are separate variables, that do not necessarily correlate (Suri, Monroe and Koc, 2013). Whereas MA is learned, MX is apparently innate; a person with a high mathematical ability can still suffer mathematical anxiety, and *vice versa*. Suri *et al* show that in the USA both high levels of MX and low levels of MA tend to lead consumers to prefer a discount framed simply as a price reduction rather than a percentage reduction.

The purpose of this thesis is first, to see if this concept (regarding the relationship of maths anxiety and ability) holds true cross-culturally; to explore the relationship between maths anxiety, maths ability and purchase intentions when exposed to a discounted product. There is good reason to suppose that Chinese consumers process information differently to their American counterparts, and they certainly have enjoyed a different educational experience. Second, the analysis is conducted using two different discount frames; one a simple monetary reduction and the other a more complex percentage reduction. Minor hypotheses and propositions concerning possible gender and age cohort differences in this regard will also be developed and tested.

The research is conducted using panel data drawn from the United States and China. The scales are developed and tested, then analysis by simple means difference testing and Hayes PROCESS models to address the hypotheses is conducted.

Key words: Maths Anxiety; Maths ability; price discount; purchase intention; cross-cultural; age; gender

CHAPTER 1

Introduction to the issue and the thesis structure

A stroll through any shopping centre or high street of any major city in the world will show that price promotions are widely used in marketing strategies. A large body of research on various aspects of price promotions suggests that such promotion is one of the most effective and efficient methods to increase merchandise sales, even if unit net profit is partially sacrificed (Darke and Dahl, 2003; Hardesty and Bearden, 2003; Raghubir, 2004). Meanwhile, merchants love to stimulate sales in the short run, especially in the holidays and especially where they believe (or hope!) price elasticity of their merchandise is high. Thus, much previous research, as well as the evidence of companies' strategies, show the importance of price promotions in influencing sales and enhancing firms' profitability (Taylor, 2001; Raghubir, 2004).

Research on marketing strategies around price promotions have utilised various contexts, such as restaurants, entertainment, retail, and travelling services (Peattie and Peattie, 1995). In general, no matter what the context, price promotion can be categorized as either indirect or direct price promotion. Indirect price promotion occurs when the price of merchandise is lowered in a way that does not involve a simple reduction of a single price, but rather with such indirect mechanisms as "buy one get one free," "half price on the second purchase," "ten dollars for three," as well as cash back, coupon and voucher methods. Indirect price

promotion is typically framed to stimulate customer's impulsivity and compulsivity (Sharma, Bharadhwaj & Marshall, 2010; Joowon, 2017). Firms often use these indirect strategies to clear excess stock or to generate funds for the following season.

Unlike indirect price promotion, where the discount offered is not always immediately clear to customers, direct price promotion has the advantage of being more flexible and has a stronger influence on the customer (Krishna et al. 2002); the depth of a direct price discount can directly influence customer purchase intention in both the short and long term with different strategies (Kikyoung, Gangseog and Youngjee 2017). Although adaptation in different industries and situation may be required, previous research shows that direct price discounts do work for most consumers.

Direct discounts are of themselves categorized to two types – a monetary or a percentage discount. There is no objective economic difference between a 20% and a $20 discount for merchandise with a value of $100. However, there appears to be a difference in some customers' perception of value to the same depth of discount in these different display modes. The perception of promotion value is influenced by both customer factors such as income, education, gender and age, and price promotion factors (level and framing of discount). Moreover, cultural background may also be a factor that influences customers' ways of thinking and thus their perspective toward price promotion. Knowledge of the most suitable framework for price promotions in various situations would be of significant help to marketing managers planning specific strategies toward their targeted customers.

The major aim of this research is to ascertain if the relationship between mathematical anxiety (MX), mathematical ability (MA) and purchase intentions when faced with a discount. This is important as it has a direct bearing on the optimal way to frame discounts in cultures where these variables may have a different comparative valence. A secondary aim is to ascertain any differences between two cultures, the United States of America (USA) and the Peoples' Republic of China (China). Third, I aim to test the above relationships in response to different types of discount frame offered, price-off or percentage-off and, finally, to explore differences in age group and gender in response to discounted prices.

The thesis follows a standard, logical pattern. In the next chapter (Chapter 2) I review the relevant recent literature concerning MX and MA, the framing of discounts, the cross-cultural issue and then discuss the (somewhat thin) literature around age and gender in the price discount domain. I will develop research hypotheses in parallel with the discussion of the literature.

After reviewing the literature and developing hypotheses, Chapter 3 presents the research method used to gather data and assemble a database, and to analyse the data in order to address the hypotheses. This is followed, in Chapter 4, by the analysis of the data and these results are then discussed in relationship to the hypotheses in Chapter 5. Finally, a discussion chapter briefly summarises, points the way for future research based upon both the contributions and the shortcomings of the present project.

CHAPTER 2

A synopsis of the relevant literature

Historical perspective

There has been continued interest in framing of discounts in modern marketing since the turn of the 21st Century, but initially this took the form of exploring the effect of discount depth on purchase intention (Alba et al., 1999; Grewal et al., 1998; Marshall & Seow, 2002), rather than frame, although the ideas are similar to a degree. Kahneman and Tversky (1979) and other researchers have confirmed that the presentation, or framing, of messages about products affects consumers' purchase intentions or behaviour. Perhaps the most well-known framing study is that of Levin *et al* (1995, cited in Levin and Garth 1998), who found that consumers were more likely to purchase ground (minced) beef when the meat is described (framed) in terms of its percentage lean rather than its percentage fat. In the same vein, Ganzach and Karsahi (1995) reported that a negatively-framed message (the loss incurred by using a cheque instead of a credit card) produced higher card utilisation and charges than a positively-framed message (the gains from using a credit card).

This work continues this stream of research but focusses upon individual responses, aggregated to a national level, to framing effects driven either by the purchasers' mathematical ability (and hence an inability to calculate complex discounts) and the anxiety many people (no matter what their ability) feel when confronted by a mathematical

calculation. These constructs are discussed next.

2.1 Mathematics Anxiety, Mathematics Ability and purchase intention

Mathematics anxiety (MX) was originally mentioned by Richardson and Suinn (1972); it is described by these authors as a feeling of tension or even dread affect people's when they manipulate numbers or attempt to solve mathematical problems. Interestingly, maths anxiety cannot be explained by general anxiety, as people with low anxiety in other area may still be aggravated by their MX (Hopko et al. 2003). MX is considered a congenital factor but one that can be ameliorated by education or training. MX does influence people to a greater or lesser degree regarding their use of maths skills, and can lead them to sacrifice accuracy for speed or cause a negative effect on their maths ability when performing numerical tasks. Moreover, math anxiety will have a negative influence on participants in directly proportion with the complexity level of their numerical task (Hembree 1990; Richardson and Woolfolk 1980).

It seems logical, and is commonly believed, that maths anxiety will have some relationship to maths ability, such that people with a higher mathematical ability – who can better solve and predict numerical problems in everyday situations – should not suffer too much from MX. However, researchers have discovered that the correlation of MX and MA is actually quite weak. Smith and Kirby (2009) demonstrate that participants with high math skills faced with a higher level of difficulty in a math problem also suffer math anxiety that affects their ability to solve the problem. This result indirectly shows that MX is more like a negative emotion

activated by mathematical computation, rather than a defect which only applies to those poor at maths. So, MX is not directly, inversely, proportional to MA. Thus, a difference between emotion toward mathematics and a defect in mathematical skill is that emotion is activated with a mathematical problem and the degree of MX will depend on the level of math problem and the individual's ability – however, MX cannot usually be completely eliminated. Meanwhile, a defect in maths ability can be weakened with acquired training. In other words, people's math ability can be improved by education and experience, but their fear toward complicated math problem is innate and does not change.

Thus, Hypothesis 1 follows:

H1: The effect of mathematical anxiety (MX) upon purchase intention when confronted by a price discount is moderated by an individual's mathematical ability (MA).

Within a marketing context this implies that activation of MX could be generated by a price manipulation or, perhaps, a time constraint on performing a discount value. Consumers normally spend more time on highly involving (relevant to them) service and product decisions such as property or vehicles, and less time on cheaper, low-involving merchandise. So, when a consumer is confronted with a single merchandise purchase decision, their MA may not be activated but, when the same consumer walks into a supermarket and is confronted with a range of merchandise priced at different levels and presented with different discount strategies, then activation of their math anxiety may well increase rapidly (Pauwels

and Siddarth 2002).

Time is also possibly an important factor influencing the activation of a consumer's MX. The previous research explains a theory that consumers are considered to sacrifice accuracy for time when their Math anxiety are activated. It also could be understood as when consumer realize that they do not have enough time to solve their mathematics problem they will unconsciously sacrifice the accuracy of result in order to match the time they have.

2.2 Frame as a possible mediator

There is a large and growing literature on the perceptions of price discounts, and there is even a little research directly addressing the question of whether a discount is more effectively framed as a percentage reduction or as a cash amount reduction (Del Vecchio, Krishnan, & Smith, 2007; Lehtimäki, Somervuori, & Monroe, 2018; Lin and Wang, 2017).

To start at the beginning, several authors have long ago shown very convincingly that discounts do, indeed, work, and that the depth of discount is critical to just how well a discount generates purchase intentions (Beerli and Santana, 1999; Marshall and Seow, 2002). The former authors included several dimensions (cognition, affect and conation) in their work, and this does suggest that frame will matter (Beerli and Santana believe that framing affects emotions as well as cognition). Both these sets of authors, among others, also show that there is a saturation effect, where increasing levels of discount at first increase demand

but this effect fades as the discount rises much above 30%, most typically as there is a price-quality relationship suspected (Lee and Chen-Yu (2018). This does have an implication for the research described here, in that frames should work, but the discounted level should not be set too high or low (around 20% seems optimal for an effect to show).

Having said that framing matters, Esteva, Roggeveen and Grewal (2015) demonstrate the relationship between price level of product and discount format and show that consumers preference to be higher (in terms of both purchase intention and perceived value) when price promotion is presented in monetary rather than percentage for a high price merchandise, but the reverse seems true for low price merchandise (less than $100). Lehtimäki, Monroe and Somervuori in 2019, though, investigated the framing of discount (monetary or percentage) on customer's perception of discount amount and attractiveness when a reduction is made from a regular price in both monetary and percentage level and found very similar attractiveness.

There are other frames, and a great deal of work has been undertaken on a variety of them. Although not directly relevant to my research, as I am concerned only with the most common %-off versus money-off formats, I mention some here to show just how complex and confused the whole issue is. Chen, Monroe and Lou (1998), for instance, have similar results with the discovery that coupon promotions were evaluated more favourably and were more effective in changing subjects' purchase intentions than straight cash discounts. Oliver and Elenia (2017) also discover that consumers with repetitive behaviours prefer a price

discount, but consumer with variety-seeking behaviour favour a free gift or demonstration. As mentioned in the opening of this section, some work on MA and MX has already been conducted. Suri, Monroe and Koc. (2013) explain that consumers with maths anxiety prefer a simple net price rather than in a dollars-off format. This result is based on the idea that consumer's high on MX prefer not to load their cognitive resource regardless of their MA. Weathers, Swain and Carlson (2012) also mentioned the cognition difficulty to influence consumer's evaluation according to different kinds of quantities, different evaluations, and processing modes. This suggests to me the primacy of maths anxiety, and the reason I set my basic model to use maths ability to mediate maths anxiety, and not the other way around. That is, many people (consumers) suffer mathematics anxiety to some extent, but that anxiety can me ameliorated by the acquisition of quantitative skills.

Thus, when consumers face a merchandise with price discount, their perception of value and their interest in purchase will be influenced by not only on the price-level of the product or service but also on the depth of the price promotion. The format/frame of the price promotion may, however, trigger their math anxiety and further influence the decision.

The basic relationship of MA mediating the effect of MX on purchase intention should be reflected in the marketplace – that is, MX is innate so should have an effect on the way people react to a discount no matter how the discount is framed. However, I suspect that when the frame is more mathematically complex (as in demanding a maths calculation of a percentage) then the mediating relevance of ability will be significant, whereas in a simple

price-off situation then maths ability will cease to matter. Thus, my second hypothesis:

H2: The relationship of mathematical anxiety on purchase intentions moderated by MA when customers are offered a discount, but this only pertains when a %-off reduction frame is used (as when a simple price reduction frame is used then ability ceases to matter although anxiety will still be triggered).

2.3 Country as a possible moderator

Setting aside involvement and time, there are other environment factors that may well also have an effect. Many researchers, in a general context, have shown differences between Eastern and Western thinking modes and behaviours toward the same object (Ji, Peng, & Nisbett, 2000; Masuda & Nisbett, 2001; Masuda et al., 2008; Nisbett et al., 2001; Lee 2018). Culture, as a set of inherited general values and behaviours, is inextricably interwoven with the educational practices and social systems of a particular country. I selected China and the USA as my comparison countries for two reasons. First, is that the two countries are culturally different, but they also differ strongly in other aspects, such as educational systems and market practices.

2.4 Identified cultural differences that may pertain

One widely recognized factor relevant here is the hypothesised different thinking style between different culture. Lee (2018) points out the difference between people from East and

West. Consumers with an Eastern cultural background tend to think holistically toward people and objects. They prefer to evaluate people or objects comprehensively, which means there is an inseparable relation between characteristics of people or objects, whereas consumers with Western culture mindset tend toward analytical thinking toward people and objects, judging their characteristics in isolation (Ji, Peng, & Nisbett, 2000; Masuda & Nisbett, 2001; Masuda et al., 2008; Nisbett et al., 2001). This idea is similar to Hoftede's earlier and current work on Eastern collectivism and Western individualism (online: geerthoftede.com).

Jo and Sarigollu, (2007) have pointed out differences in the way consumers in different cultures perceive price-quality relationships, and this can affect attitudes to discounts. Their research indicate that Japanese consumers show much greater corresponding perceived quality rather than Australian consumers toward unbranded tourism packages. Meanwhile, Tsai and Men (2017) reveal the similarities and difference between Chinese and American customer's engagement on social network sites. (e.g., Chinese consumers display stronger engagement, more interest in watching videos, pictures and reading companies' posts) and Hsin-Chen and Kalwani (2018) indicate the differences on cross-cultural eWOM. Zhang and Tsai (2017) demonstrate the difference between Chinese and American consumer when they purchase merchandise through online group buying; American consumers consider perceived risk as the most important predictor and Chinese consumers consider brand consciousness as the most important factor to increase their intention. Whilst these latter examples illustrate cultural (or, possibly, national) differences, they do not directly pertain the to the cash-

percentage discount frame I am exploring. They do illustrate, though, just how many influencing factors there are so, although I might not expect to find many large significant differences (without a very large sample indeed), it will be of value if I can identify any difference, but also any consistency, in the way Chinese and American consumers perceive the two frames in question.

2.5 Identified national differences that may pertain

There are obvious and clear political and social differences between China and the USA, but one of the differences that caught my attention in the present context is that the widely different education system in the two countries may cause a discrepancy in consumers' perception toward price discount and the format of the discount. The key point here is the level of mathematics taught to children and young adults. The U.S. News/Raytheon STEM (for science, technology, engineering and mathematics) Index (https://www.usnews.com/news/stem-index) shows very clearly that American schoolchildren are falling further and further behind their Chinese counterparts. Math anxiety cannot be eliminated by upbringing, but it can be reduced by the proper education, particularly in respect to mathematics (Lin and Wang, 2017). Smith and Kirby (2009) concur, indicating that even people with a higher mathematics education will be influenced by math anxiety, so the power of mathematics training to influence people's mathematics anxiety is not so much at its floor but more at its ceiling.

In this study I expect that Chinese respondents will exhibit just as much maths anxiety as their American counterparts, but that the Americans have less maths ability and therefore there is a greater likelihood that mediation will occur. That is, because Chinese respondents' maths ability generally higher than those in the USA, ability will not be not so relevant in China and will not therefore mediate.

Thus Hypothesis 3:

H3: The mediating effect of MA on the relationship of MX and purchase intention will be stronger for American respondents than for Chinese.

2.6 Generation as a possible moderator

Generation gaps abound and are commonly identified in all sorts of domains, from music preferences to civic obedience. Labelling a generation is more a Western than Asian propensity, but in the West people are often labelled as Generation X (born 1965-1980), Y (born 1981-1994) and Z (born 1995-2005), while in East generations tend to be tagged more by decade (e.g., if you born in 1984 then is the generation 80s).

Identified between-generation differences in the marketing literature abound. Bulut, Kökalan and Doğan (2017) discuss the relationship between generation and sustainable consumption, their results indicating that generation has significant influence on sustainable consumption behaviour, with the consumers tagged "Baby Boomers" (born 1946-1965) have the highest

level of unneeded consumption behaviour while Gen-Zers have the lowest. GurĂu (2012) also studied the relationship between different generation but in the context of consumer loyalty. The results, surprisingly, show little differences between Millennials and Generation X consumers in brand loyalty behaviour.

With regard to MX and MA, although I could find no evidence in the literature to support the statement, I believe that mathematics was more widely taught at Western schools in earlier generations, whereas it is often now possible for students in many Western countries to avoid most quantitative subjects if they chose to do so, unlike their Chinese counterparts who must study mathematics like it or not. This is not a value judgement, but merely a personal observation having had personal experience of both systems.

Because of the paucity of evidence to support or refute any generational difference in mathematics anxiety I choose not to form a hypothesis, but to merely investigate the between-generation difference in MX and MA and find if the basic relationship between them and purchase intentions in the face of a discount holds for both. This, then, is my (null) proposition:

P1: There is no difference in MX between older and younger respondents and the identified model (MX → PI mediated by MA) holds equally for both groups.

2.7 Gender as a possible moderator

This is another area where I hesitate to state definitive hypotheses. Although there is a welter of research about gender differences in consumer behaviour generally, and even price response behaviour more specifically, the changing role of women in most societies surely outdates much of the existing work. There is no research that I can find that categorically states that women's shopping behaviour is genetically derived and immutably fixed, rather that there is still a prevalence of assumptions around women being housepersons and the family shoppers and being bought up on the soft sciences while men are the breadwinners and are bought up on hard sciences. This assumption renders work in this domain perilous! A few (quite recent) examples of gender research in the marketing literature give a "flavour" for much of the rest.

Many marketers are working with the aim of finding specific differences regarding male and female shopping expectation and consumption behaviour. Oly Ndubisi (2006) showed that there are significant differences between male and female in decision-making process for purchasing and, furthermore, he claims that these discrepancies originate in differences in identity, cognition and perception.

Gao, Mittal, and Zhang (2020) examine how gender identity and local–global identity influence consumer price sensitivity. Their results demonstrate that identity incongruence depletes cognitive resources and induces affective processing which, in turn, activates a 'sacrifice mindset' and results in lower price sensitivity. In general, females are said to

display more planning of their shopping behaviour. In grocery shopping, for example, Thomas and Garland (2004) report that females use shopping lists and plan more frequently than males. Females apparently start shopping earlier and spend more hours shopping and less money per order during the Christmas period (Fischer and Arnold 1990). Comparing with females, males prefer to be competitive when they are shopping in fast fashion store and show less preference to hoard merchandise in-store or hide their preference (Gupta and Gentry 2015). Researcher also has suggested that men are significantly more interested in bargaining with each other at garage sales than are women (Hermann 1998).

The list goes on, but I can see little value in reviewing it because, as I suggested earlier, the times are changing so rapidly and if a man and a woman have the same occupation, education and social circumstance there seems no sensible reason their reaction to a pricing frame would differ. There may be a historical lag, however, so it is worthwhile investigating the current data to address the second (null) proposition:

P2: There is no difference in MX between genders and the identified model (MX → PI mediated by MA) holds equally for male and female respondents.

2.8 Summary and directions

Most research considers that the regular price and the depth of price promotion of products or services have the major effect on consumer purchase intentions and perceptions of value.

However, other factors are also mooted to influence customer's behaviour and their perception of value during their shopping. Grewal, Monroe, and Krishnan (1998) demonstrate the perceived acquisition value of merchandise will influence buyers positively when they use it. Martı´nez-Ruiz (2006) points out that overall consumer's reaction toward price promotion may take different behavioural forms (e.g., brand and store switching, price adjustment, product trial). These studies demonstrate ideas about pricing behaviour drawn from marketing strategy insights of the environment.

In contrast, this study aims to find out differences in the customer themselves. Three hypotheses are formed, concerning the overall importance of maths anxiety in driving people's perceptions of discounts and ultimate purchase behaviour, where the mediating role of maths ability can ameliorate this negative force. I further consider, and have hypothesised accordingly, that this relationship will be more powerful in a more complex discount situation (%-off) and that it is unlikely that maths ability will have any significance in a simple discount (price-off) format. Finally, I proposed that country, gender, age cohort may moderate the basic relationship.

The next chapter, Chapter Three, explains the research method I chose to use to address the research questions and the propositions.

Chapter Three

Research Design

3.1 General design

The main purpose of this research is to test a model with three variables (an independent, MA; a dependent, Purchase intention (PI); and a moderator, MA) in two countries, the USA and China. In each country there will one of two frames presented to respondents, who are classified as male or female, and older and younger. It seems appropriate to use panel data to access opinions, as the respondents are geographically distant from each other (and the researcher) and a fairly large, matched sample is required. In the work that follows I first discuss the sample, then the development of an instrument, then the procedure followed. Finally, a brief discussion of the proposed analysis method is held.

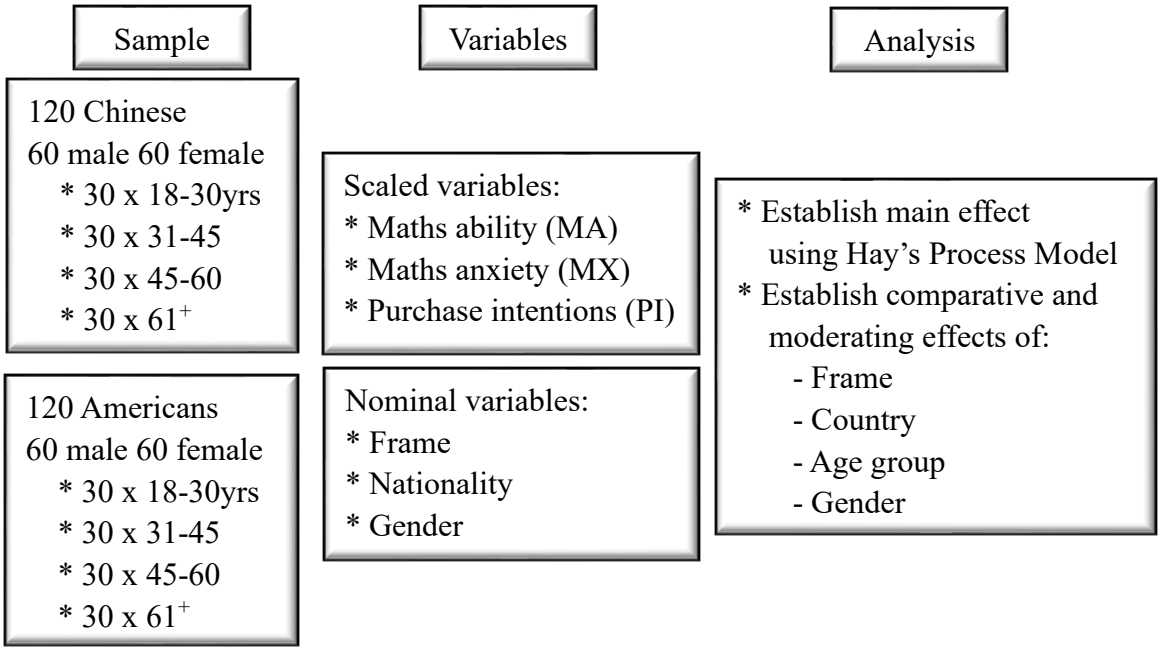


Figure 1

Schema of research method

3.2 Sample

In order to attain statistical significance a rule of thumb suggests 25-30 respondents per cell; this number will typically result in a reasonably normal distribution of variables and hence gives the statistical significance of a calculation a chance to show. The basic design calls for two matched groups of respondents, one Chinese nationals, and the other American. There is little guidance in the literature about the major nature of the matching required, apart from gender. I think that age could also have an effect, so my respondent groups should be matched by age group (two groups, 18-45, 46-60+) and gender. Social class is somewhat problematic with panel data and between cultures, so occupation will be collected and used as a proxy for social class, simply to enable a *post hoc* judgement of sample equivalence.

The main model uses maths anxiety and maths ability; these are distinct variables, but both have validated scales that yield equal-interval scale values. Unfortunately, the scales for both are very long, so I will adapt them and develop and test shorter-form scales more appropriate to apply in a panel data service context. It is intended that this should be a between-group study, with half of the respondents in each country exposed to a different frame. So, I chose to seek 120 respondents in each country, with each sample being matched for gender and roughly matched for age and occupation. Thus, each national sample group needs to be composed of 60 women 60 men, spread equally over two age groups (30 per cell).

3.3 Scales

The maths ability (MA), MX and purchase intention (PI) scales need to be developed and tested. The development and testing of scales is reported at the beginning of the results chapter (Chapter 4). A 30-item scale for Mathematical Anxiety (Suinn & Winston, 2003) forms the basis of the MX scale; a number of the items used are adopted, but the wording is changed to suit the context.

The scale used in most prior literature for MA is commercially available but also very long and not suited to collect using panel data (i.e., the "Wide Range Achievement Test" (WRAT) measures the codes needed to learn basic arithmetic skills and is widely applied in educational and psychological research and assessment work. I will use a much simpler device of asking respondents to answer seven mathematical questions in increasing order of difficulty. Although crude, this should provide a seven-item MA scale that should be accurate enough for the present purpose.

3.4 Instrument

An instrument was constructed using Qualtrics software and is included as Appendix 1. The general approach is to first give some reassurance to respondents via a participant information sheet, that is designed to inform the respondents about the research without providing any primes that might influence their answers. Then a little classification data to check the relevance of the hotel room rental scenario to each respondent is included. Then each respondent is exposed to one of four scenario/advertisements, two in English and two in

Chinese language. The English advertisements are shown here in Figure 2a and 2b. Note that the discount rate is 15% in both, but one is framed as a plain price reduction and the other as a %-off discounted price.

Figure 2a

Experiment scenario in English, %-off version

Figure 2b

Experiment scenario in English, cash reduction version

The advertisement is accompanied by text as follows:

> "Imagine you are about to book a hotel room, online, for a three-night holiday in August, and come across this advertisement for a 5-star hotel in the area you want to visit on a local website:"

Then the questions follow, randomised, to measure the various scale and classification items.

3.5 Data-gathering

The relatively recent adoption of respondent-administered Internet surveys is rapidly

becoming a well-accepted method of data collection. It has been noted that response behaviour in web-based surveys is very similar to that of pen-and-paper mail surveys (Couper & Bosnjak, 2010; Groves et al., 2013).

One of the primary cost-savers of Internet surveys is automated response encoding, and this service also offers some control of response quality in the face of criticism of paid respondents (Leiner, 2013). Of course, this issue is not confined to online panel surveys.

The Cint Access® panel service I used has additional paradata, that helps limit some of the possible biases and limitations of the panel members' responses. Survey completion time, respondent IP address, browser identification is all collected and helps to assess the quality of recorded responses (Olson & Parkhurst, 2013). This paradata has proven helpful to identify multiple submissions by the same respondent (Van Selm & Jankowski, 2006) and to supplement the screening for careless responses (Barge & Gehlbach, 2012; Meade & Craig, 2012).

A very helpful service I made use of is the respondent survey completion time, to screen for invalid data. The average time of completion is calculated and then respondents who answered very much quicker or slower were screened out. In my case, I asked the panel service to monitor individual responses to the questionnaire and remove those that have a completion time less than 10% of the average completion time. Longer response times are not of too much concern, as often panellists may leave the survey and come back to it later. The

panel service makes the data numbers up, but I still removed a few response sets that had no variation in the answers at all (i.e., all answers were in the middle of the scales).

3.6 Final sample statistics

The final number of respondents' data sets I used for analysis is 243; 121 in the USA and 122 in the PRC. Of these, 121 were exposed to a simple price reduction and 122 to a percentage-off reduction. There were more males (137) than females (106) and more younger (195) than older (48) responders. Although not ideal, these numbers should be sufficient to attain statistical significance, although performing analysis on small subgroups will be constrained.

3.7 Analysis

Scales are tested with factor analysis and reliability analysis (Cronbach's Alpha) and the variables' distribution inspected, all using SPSS (v27). The basic relationship of interest is causal, as it is hypothesised that maths anxiety can cause a reaction affecting the purchase decision, and that this can be moderated by maths ability. The scales concerned are of the 7-point Likert-type equal interval type anchored at 1 and 7, and a causal relationship is being investigated, so regression analysis is appropriate. Hay's PROCESS model 4, also run in SPSS v27, provides mediation analysis, so is used to address the main model.

I did think quite hard about whether or not MA mediates or moderates the MX → PI relationship. In the end, I decided that although maths ability can be used to classify people, it is essentially an internal, person variable rather than an environmental factor, and maths

ability does have a direct causal bearing on the dependent variable rather than simply dividing the responses to the main relationship, and thus is more properly considered as a mediator.

This same model is then also used when data in the set is selected to represent one group only – for instance, when hypothesising that the model will work under the more complex percentage discount but not in a simple price reduction frame, then each frame is selected to run the analysis. The causal analysis is accompanied by explanatory means testing using t-tests, which helps explicate the main analysis and also adds credibility to the dataset (in that the variables behave in the way they are supposed to).

The next chapter, Chapter 4, contains the analysis of the dataset.

CHAPTER 4

Data analysis

In this chapter the scales are first developed and tested, before the research hypotheses and propositions are addressed. Throughout the analysis SPSS version 27 is used.

4.1 Scale development – Maths Anxiety

As mentioned in the last section, Suinn & Winston (2003) developed a 30-item scale for Mathematical Anxiety that is well validated. However a 30-point scale is inappropriate for a professional panel service so I decided to develop my own scale more relevant to the commercial scenario presented in the research scenarios and shorter to suit the commercial panel service. The original items are shown in Table 2 below, respondents were asked to rate, on a 7-point scale, how anxious each item made them.

The six items in Table 1 were drawn partly from the MARS scale but also through logic and discussion with colleagues. Again, the questions are prefaced by asking respondents to use a 7-point Likert scale provided, anchored by “disagree strongly” and “agree strongly.”

1	I get really nervous when faced with tricky maths problems
3	Calculating percentages to a number stresses me out
4	Thinking about an upcoming maths test makes me very anxious
5	Someone watching while I add up a row of numbers makes me very nervous
6	I get really flustered when dividing the restaurant bill between seven of us

Table 1

Reduced scale to measure respondents' maths anxiety

Cronbach's Alpha for the five items is .95 (n = 243), and all items contribute to the scale Alpha. A single item, MA, was created by taking a mean of each item.

1	Taking an examination (final) in a mathematics course	16	Dividing a five digit number by a two digit number in private with pencil and paper
2	Thinking about an upcoming mathematics test one week before	17	Adding 976 + 777 on paper
3	Thinking about an upcoming mathematics test one day before	18	Reading a cash register receipt
4	Thinking about an upcoming mathematics test one hour before	19	Figuring the sales tax on a purchase that costs more than $1.00
5	Thinking about an upcoming mathematics test five minutes before	20	Figuring out your monthly budget
6	Waiting to get a mathematics test returned in which you expected to do well	21	Being given a set of numerical problems involving addition to solve on paper
7	Receiving your final mathematics grade in the mail	22	Having someone watch you as you total up a column of figures
8	Realizing that you have to take a number of mathematics classes to fulfil the requirements in your major	23	Totalling up a dinner bill that you think overcharged you
9	Being given a "pop" quiz in a	24	Being responsible for collecting dues

	mathematics class		for an organization and keeping track of the amount
10	Studying for a mathematics test	25	Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at different speeds.
11	Taking the mathematics section of a college entrance examination	26	Totalling up the dues received and the expenses of a club you belong to
12	Taking an examination (quiz) in a mathematics course	27	Watching someone work with a calculator
13	Picking up the mathematics textbook to begin working on a homework assignment	28	Being given a set of division problems to solve
14	Being given a homework assignment of many difficult problems which is due the next class meeting	29	Being given a set of subtraction problems to solve
15	Getting ready to study for a mathematics test	30	Being given a set of multiplication problems to solve

Table 2

The 30-item Maths Anxiety Rating Scale, Suinn & Winston (2003)

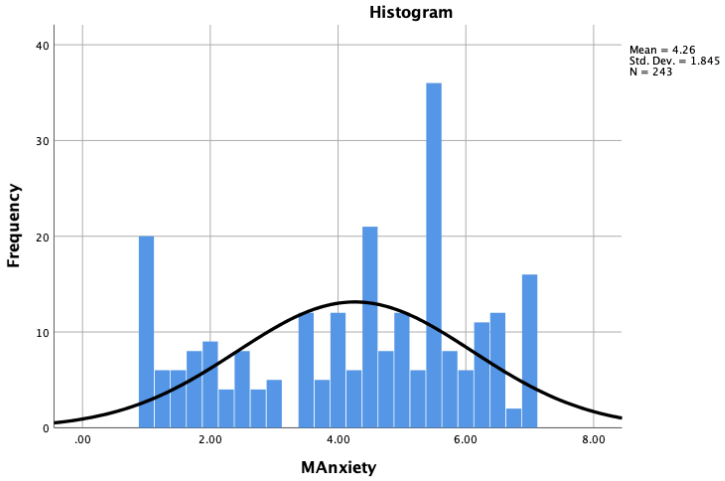


Figure 3a, Overall distribution of the MX scale

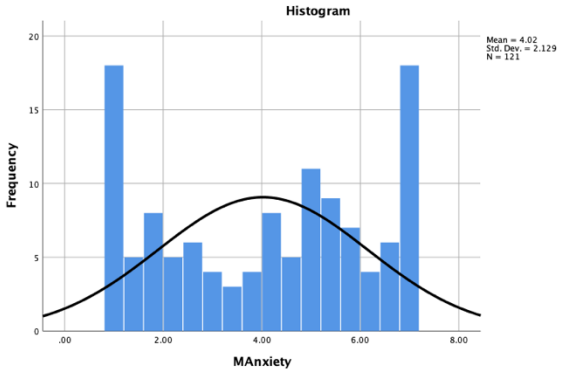


Figure 3b, distribution of MX in the USA

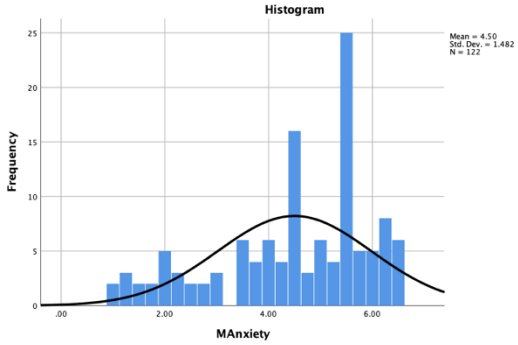


Figure 3c, distribution of MX in China

The distribution of the new scale is shown in Figure 3. There seem to be two distributions here, so I also show the distribution for just the USA and PRC separately. These are interesting charts and slightly surprising. First, the mean score is marginally higher in the PRC ((Mean$_{USA}$ = 4.02 (n = 121); Mean$_{PRC}$ = 4.49 (n = 122). t = 2.02, p = .044). A possible

explanation is that the Chinese respondents are generally rather more anxious with their maths ability (standard deviation = 1.3) whereas some Americans are deeply concerned but a significant number just don't care (SD = 1.9).

Scale development – Maths Ability

As suggested previously, I find the published mathematics ability scale far too long, two general in nature and more suited to educational assessment tasks than commercial applications – it is also expensive to purchase. The simple scale I developed and used is based on seven mathematical problems the respondents are asked to solve. This was supposed to yield a seven-point scale through simply calculating how many questions each respondent was able to answer correctly, but unfortunately some respondents could not answer even the easiest question, so the scale ends up with eight points.

The maths tasks were subjectively invented and arranged in an increasing level of difficulty, then pretested on an undergraduate group to confirm their level of difficulty. The final list is shown in Table 3. Respondents were asked to calculate the answers without recourse to using a calculator.

Other methods were considered but were not used. For instance, I did record the time it took each respondent to answer each question. However, although this method could work well in a controlled laboratory situation, but with a panel service many people apparently left the task incomplete for a while to either take a break or to think longer, I cannot tell which, so this

method was abandoned.

1	34 + 27	
2	25 ÷ 12.5	
3	5 * 18	
4	7.5 * 0.5	
5	97.68 * 6	
6	(85 * 3) – (55 * 3)	
7	(45 * 0.69)	

Table 3

Scale to measure mathematical ability

To give some credibility to the new MA scale, though, I conducted a t-test between the Chinese and American respondent, with the prior expectation that the Chinese would score higher. This expectation is confirmed ($Mean_{USA}$ = 3.86 (n = 121); $Mean_{PRC}$ = 5.44 (n = 122). t = 6.57, p < .001).

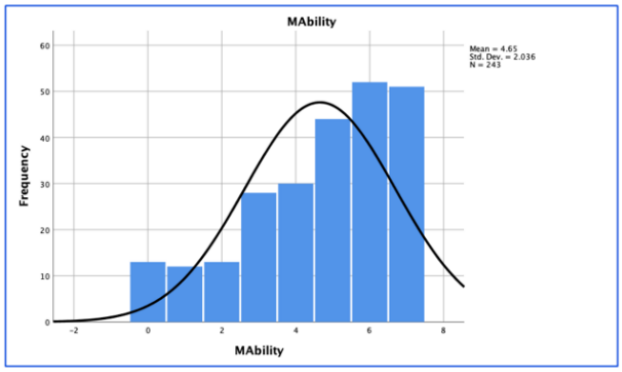


Figure 4a, overall distribution of mathematical ability

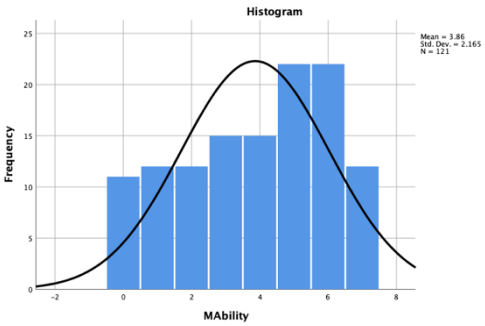


Figure 4b, distribution of MA in the USA

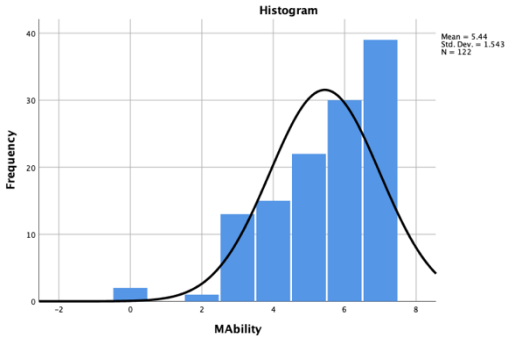


Figure 4c, distribution of MA in China

The distribution of MA is shown in Figure 4, with the distribution within each country displayed as for MX. As expected, the distribution is more normal in the USA but in the PRC the distribution is heavily negatively skewed.

4.2 Scale development – Purchase intention

1	This hotel looks good value at this price
2	I would be very interested in the hotel at the reduced price
3	This is a very good discount indeed
4	I think many people would be eager to take advantage of this price
5	Most people would grab this bargain if the timing suits

Table 4

Items measuring desirability of room hire (purchase intention)

I designed a scale indicating the attraction of the hotel room to those who had been exposed to the hotel room advertisement. Not all items are strictly about the behavioural intention of purchase, some are about the attitude toward the purchase but, overall, I believe that the scale does have face validity. To further test the integrity of the scale and to ensure that it is does actually represent a single variable and not two distinct variables, I subjected it to principal component factor analysis.

The KMO is high (.89) and Bartlett's test of sphericity is also high and highly significant (10084, $p < .001$). I used a Varimax rotation with no bootstrap. The communalities are all high > .716). Only 1 factor emerges, as hopes, with an eigenvalue of 4.048, which explains 815 of the variation in the data. The next factor has an eigenvalue of only .36. Cronbach's Alpha for the five items is .94, so a new variable named Purchase Intention (PI) is constructed. The distribution of PI does not tell me very much, except that it does confirm that, and Marshall & Seow (2002) suggest, 15% is a satisfactory level of discount to attract interest in purchase.

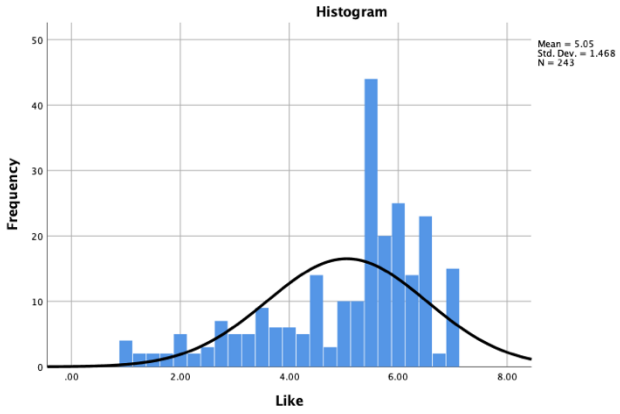


Figure 5, Distribution of Purchase intention, complete dataset

Before addressing the hypotheses, a between country comparison is of interest. Figure 6 illustrates the differences well; maths ability and purchase intention are higher in China, but Americans are not so impressed by the discounted product and have lower anxiety about doing the math (even if they cannot do it!).

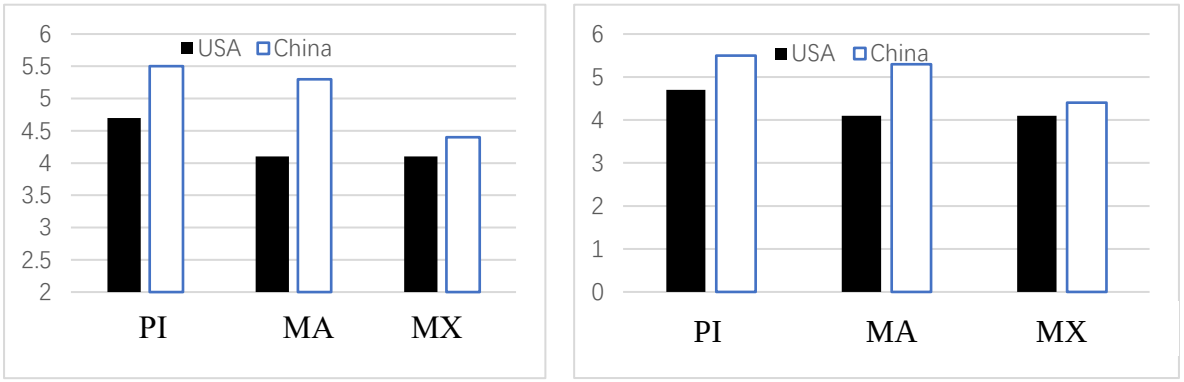


Figure 6, Comparative statistics between the PRC and the USA for model variables

4.3 Addressing the hypotheses; H1

The first hypothesis seeks the effect of mathematical anxiety (MX) upon purchase intention when confronted by a price discount, and moderation by mathematical ability (MA). Hayes' Process Model 4 is used, as illustrated in Figure 7.

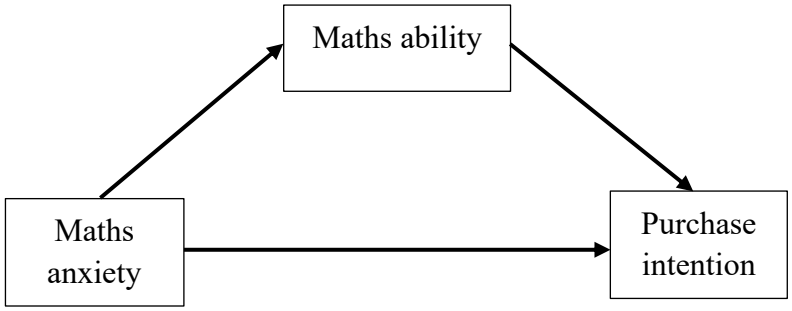


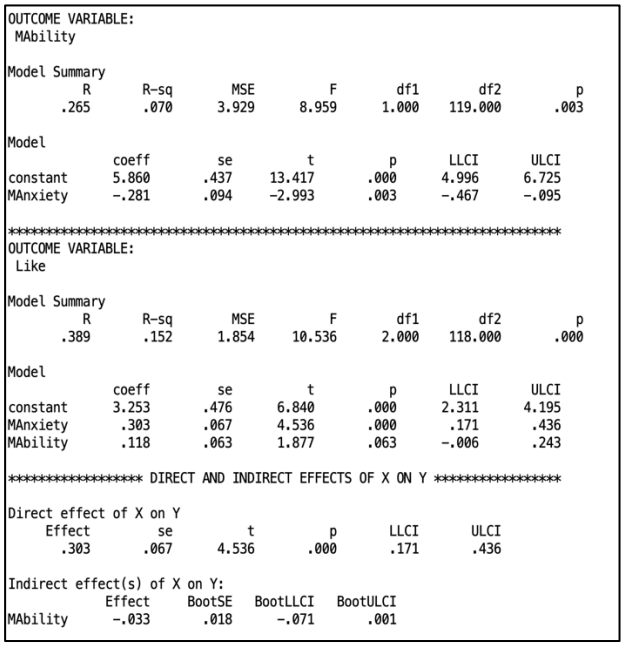
Figure 7, schematic of Hayes' Model 4

Inspection of the output in Table 5 show that partial mediation occurs, as both MX and MA have a highly significant effect on PI, and the lower and upper limits of the confidence interval do not include zero.

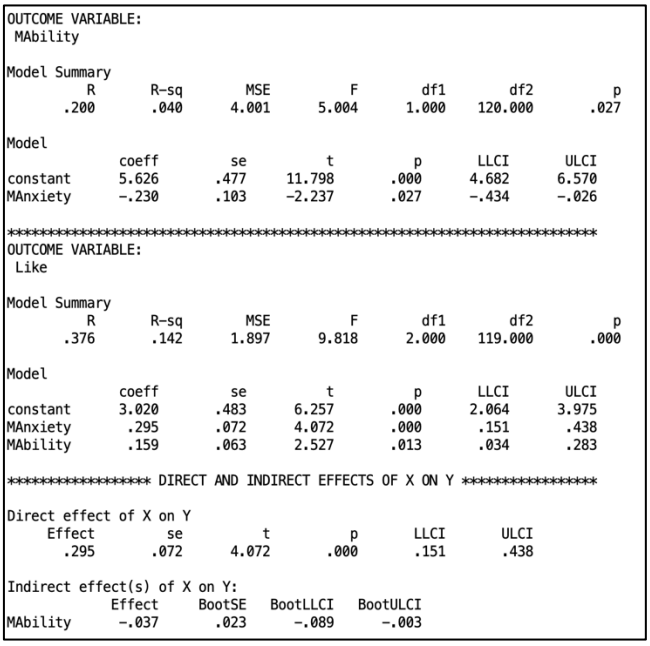
```
OUTCOME VARIABLE:
 MAbility

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .234       .055      3.935     13.911      1.000    241.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     5.753       .321     17.928       .000      5.121      6.385
MAnxiety     -.258       .069     -3.730       .000      -.394      -.122

**************************************************************************
OUTCOME VARIABLE:
 Like

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .381       .145      1.856     20.408      2.000    240.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     3.131       .337      9.298       .000      2.467      3.794
MAnxiety      .300       .049      6.145       .000       .204       .396
MAbility      .139       .044      3.135       .002       .052       .226

****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
       .300       .049      6.145       .000       .204       .396

Indirect effect(s) of X on Y:
            Effect     BootSE   BootLLCI   BootULCI
MAbility      -.036       .014      -.066      -.012
```

Table 5, Mediation of MX→PI by MA, output from Hayes' Model 4

4.4 Addressing the hypotheses; H2



```
OUTCOME VARIABLE:
 MAbility

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .265       .070      3.929      8.959      1.000    119.000       .003

Model
             coeff         se          t          p       LLCI       ULCI
constant     5.860       .437     13.417       .000      4.996      6.725
MAnxiety     -.281       .094     -2.993       .003      -.467      -.095

**************************************************************************
OUTCOME VARIABLE:
 Like

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .389       .152      1.854     10.536      2.000    118.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     3.253       .476      6.840       .000      2.311      4.195
MAnxiety      .303       .067      4.536       .000       .171       .436
MAbility      .118       .063      1.877       .063      -.006       .243

************** DIRECT AND INDIRECT EFFECTS OF X ON Y **************

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
       .303       .067      4.536       .000       .171       .436

Indirect effect(s) of X on Y:
            Effect     BootSE   BootLLCI   BootULCI
MAbility      -.033       .018      -.071       .001
```



```
OUTCOME VARIABLE:
 MAbility

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .200       .040      4.001      5.004      1.000    120.000       .027

Model
             coeff         se          t          p       LLCI       ULCI
constant     5.626       .477     11.798       .000      4.682      6.570
MAnxiety     -.230       .103     -2.237       .027      -.434      -.026

**************************************************************************
OUTCOME VARIABLE:
 Like

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .376       .142      1.897      9.818      2.000    119.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     3.020       .483      6.257       .000      2.064      3.975
MAnxiety      .295       .072      4.072       .000       .151       .438
MAbility      .159       .063      2.527       .013       .034       .283

************** DIRECT AND INDIRECT EFFECTS OF X ON Y **************

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
       .295       .072      4.072       .000       .151       .438

Indirect effect(s) of X on Y:
            Effect     BootSE   BootLLCI   BootULCI
MAbility      -.037       .023      -.089      -.003
```

Table 6a, Hayes' Model 4 for price-off data Table 6b, Hayes' Model 4 for %-off data

The second hypothesis states that the relationship of mathematical anxiety on purchase intentions moderated by MA when customers are offered a discount only pertains when a %-off reduction frame is used. To address this issue Model 4 is again run but first with the data for the price-off frame suppressed and then with the %-off data supressed. Once again, inspection shows support for the hypothesis, as although in the price-off frame anxiety still has a negative relationship to ability (i.e., high ability lowers anxiety), ability has no direct effect upon purchase intentions. This makes sense, as the computation level required is very light indeed even for those with a very low arithmetic skill. The upper and lower confidence interval for the interaction contains zero, which is to be expected given the lack of a significant relationship between MA and PI.

On the other hand, inspection of Figure 6b shows that this is not the case when there is a percentage reduction to be calculated – here the relationships are all significant and the ULCI and LLCI do not straddle (contain) zero.

4.5 Addressing the hypotheses; H3

Here I consider the cross-cultural differences. The hypothesis states that the mediating effect of MA on the relationship of MX and purchase intention will be stronger for Americans than

```
OUTCOME VARIABLE:
 MAbility

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .365       .133      4.099     18.265      1.000    119.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     5.352       .395     13.558       .000      4.570      6.134
MAnxiety     -.371       .087     -4.274       .000      -.543      -.199

**************************************************************************
OUTCOME VARIABLE:
 Like

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .370       .137      2.524      9.349      2.000    118.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     2.958       .494      5.985       .000      1.979      3.936
MAnxiety      .315       .073      4.312       .000       .171       .460
MAbility      .091       .072      1.269       .207      -.051       .234

************** DIRECT AND INDIRECT EFFECTS OF X ON Y **************

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
       .315       .073      4.312       .000       .171       .460

Indirect effect(s) of X on Y:
            Effect     BootSE   BootLLCI   BootULCI
MAbility      -.034       .025      -.085       .015
```

Table 7a, Hayes' Model 4 for USA data

```
OUTCOME VARIABLE:
 MAbility

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .203       .041      2.302      5.171      1.000    120.000       .025

Model
             coeff         se          t          p       LLCI       ULCI
constant     6.395       .441     14.512       .000      5.522      7.267
MAnxiety     -.212       .093     -2.274       .025      -.396      -.027

**************************************************************************
OUTCOME VARIABLE:
 Like

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .208       .043       .977      2.677      2.000    119.000       .073

Model
             coeff         se          t          p       LLCI       ULCI
constant     4.799       .477     10.069       .000      3.855      5.742
MAnxiety      .143       .062      2.305       .023       .020       .265
MAbility      .016       .059       .266       .790      -.102       .134

************** DIRECT AND INDIRECT EFFECTS OF X ON Y **************

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
       .143       .062      2.305       .023       .020       .265

Indirect effect(s) of X on Y:
            Effect     BootSE   BootLLCI   BootULCI
MAbility      -.003       .010      -.024       .019
```

Table 7b, Hayes' Model 4 for PRC data

Chinese, because of the higher ability of the PRC respondents. Rather than run a moderated mediation analysis I choose to separate the US and Chinese data, to give more comparative detail. Tables 7a and 7b shows some mean differences between the PRC and the USA, but does not go as far as showing that the causal relationships differ.

In fact, as can be seen from Table 7a and 7b, although maths ability and anxiety enjoy a reverse correlation, maths ability has an insignificant effect on the dependent variable, PI, in both countries. Thus, this hypothesis is not supported.

4.6 Addressing the propositions, P1, Age

This proposition concerns the difference between two age cohorts, with an expectation of some differences between them. There I propose that there is no difference in MX between older and younger respondents and the identified model (MX → PI mediated by MA) holds equally for both groups.

To test for a difference in MX (and MA) between age cohorts t-tests are run. There is no difference in ability between the two groups ($Mean_{Younger} = 4.75$; $Mean_{Older} = 4.27$, $p = .146$), but there is in anxiety ($Mean_{Younger} = 4.49$; $Mean_{Older} = 3.31$, $t = .413$, $p < .001$). Possibly the young are more often judged on their maths ability than are their seniors.

This time, rather than suppressing data and running Model 4 I will use all the data and use Hayes' Process Model 15, which runs the same mediation but moderates both the Ability → PI and the MX → PI vectors (the MX → MA relationship seems consistent regardless of circumstance, and the data numbers are insufficient to run too many analyses at once).

A consideration of the output from SPSS shown in Table 8 tells me that, as expected, there is

no interaction between MX and age (interaction 1) but there is for MA and age, where the younger people's ability does help drive purchase intentions.

```
OUTCOME VARIABLE:
 MAbility

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .234       .055      3.935     13.911      1.000    241.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     5.753       .321     17.928       .000      5.121      6.385
MAnxiety     -.258       .069     -3.730       .000      -.394      -.122

**************************************************************************
OUTCOME VARIABLE:
 Like

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .480       .230      1.693     14.154      5.000    237.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant    -1.100      1.276       -.862       .389     -3.615      1.414
MAnxiety      .587       .192      3.060       .002       .209       .965
MAbility      .486       .196      2.480       .014       .100       .872
Age          2.644       .725      3.647       .000      1.216      4.073
Int_1        -.202       .108     -1.867       .063      -.415       .011
Int_2        -.211       .106     -1.982       .049      -.421      -.001

Product terms key:
 Int_1    :        MAnxiety x        Age
 Int_2    :        MAbility x        Age

   Focal predict: MAbility (M)
         Mod var: Age      (W)

Conditional effects of the focal predictor at values of the moderator(s):

       Age     Effect         se          t          p       LLCI       ULCI
     1.000       .275       .095      2.895       .004       .088       .462
     2.000       .064       .048      1.334       .183      -.031       .159

****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Conditional direct effect(s) of X on Y:
       Age     Effect         se          t          p       LLCI       ULCI
     1.000       .385       .091      4.210       .000       .205       .565
     2.000       .183       .058      3.179       .002       .070       .297
```

Table 8, Moderated (by age) mediation by MA of MX → PI, Hayes' Model 15

This is a proposition, as I was uncertain what to expect. What I found was that there is no between-age cohort maths ability, but younger people are more maths-anxious and that does

have an effect on their purchase intentions when faced with a discount purchase situation.

4.7 Addressing the propositions, P2, Gender

As for age, I first seek a difference in maths ability and maths anxiety between genders – history says there should be some but contemporary (or at least emerging) educational and social norms may determine otherwise. T-tests show that males have more ability and less anxiety, but both differences only approach significance (MA_{Men} = 4.88, MA_{Women} = 4.37, t = 1.9, p = .054; MX_{Men} = 4.06, MX_{Women} = 4.51, t = 1.9, p = .057). Once again, Hayes' Process Model 15 is used, and the results (Figure 9) show that, as I suspected, there are no between-gender differences to the basic moderation model.

```
OUTCOME VARIABLE:
 MAbility

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .234       .055      3.935     13.911      1.000    241.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     5.753       .321     17.928       .000      5.121      6.385
MAnxiety     -.258       .069     -3.730       .000      -.394      -.122

**************************************************************************
OUTCOME VARIABLE:
 Like

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       .391       .153      1.863      8.542      5.000    237.000       .000

Model
             coeff         se          t          p       LLCI       ULCI
constant     1.907      1.047      1.822       .070      -.155      3.970
MAnxiety      .383       .150      2.556       .011       .088       .677
MAbility      .329       .144      2.281       .023       .045       .612
Gender        .826       .687      1.202       .231      -.528      2.180
Int_1        -.060       .100      -.602       .547      -.257       .137
Int_2        -.125       .090     -1.399       .163      -.302       .051

Product terms key:
 Int_1    :       MAnxiety x        Gender
 Int_2    :       MAbility x        Gender
```

Table 9, Moderated (by gender) mediation by MA of MX → PI, Hayes' Model 15

CHAPTER 5

Brief summary, discussions and conclusions

5.1 Brief summary of findings

The major contribution of this thesis is to confirm the tentative findings of recent work in the domain that suggests that maths anxiety is fairly ubiquitous, but maths ability does vary not only geographically and socially, but also demographically and temporally. However, this is not so important in this context as it is maths anxiety that is the more important aspect when considering the effect of a discount frame on purchase behaviour.

The major hypothesis, then, is supported very neatly by using a mediation model (Model 4) from Andrew Hayes (2018),) where it is clearly demonstrated that maths anxiety has a strong, negative effect on purchase intention when a consumer is faced with a discounted product or service, but that this effect is countered to an extent by the mathematical ability of the individual. It is of interest, and evident here, that there is only a weak relationship between MA and MX.

Results for frame – either a 5-off or a simpler price-off format, shows that expectations are again confirmed. When a simple frame is used then maths ability ceases to have any significance and there is no mediation of the main effect of anxiety on purchase intentions; it

is only when a more complex calculation is called for that ability has an effect.

The analysis of the country data is disappointing in a sense. It is evident that Chinese respondents, and probably Chinese people generally, have a higher mathematical ability than Americans, but it is also evident that anxiety about maths is higher in China too. These relationships will, of course, tend to cancel each other out. The Hayes' model shows no difference between the USA and China in that both models show no mediation for ability.

Age as a moderator of the basic model is interesting and soes follow a logical pattern. Younger people are more concerned with maths, probably most use it more as many young people are still at school or university. The models, when run within each age group, show that MX (as expected) does have an influence on purchase behaviour for both groups, but that it is only the younger folk whose maths ability ameliorates the anxiety. This is consistent with the current relationship of these variables.

Finally, the gender analysis also yielded results congruent to proposed expectations. Although men are marginally more proficient and marginally less anxious about maths, there are no differences in the interaction between the gender groups.

5.2 Implications for practice

Pricing, as so many business decisions, is complex and interactive. I mean by that, that in

narrowing the scope of this research by placing boundaries around the variables of interest, relationships can be identified. Whether or not these relationships would hold in the marketplace is, though, questionable. As always, there is a trade-off between control and external validity. It seems from the research conducted here that it is almost certainly to keep discounts simple, and not make only minimal demands on mental resources. After all, most people making a purchase decision are under some sort of pressure; whether it is being observed by someone, requiring money to be spent, making a choice from a large choice set, or simply being in a hurry. Under this circumstance it seems probable that consumers take a holistic approach to price and simply look at the advertised price and only give the "normal" price minimal scrutiny. This approach is consistent with a body of emerging research where we begin to understand that many consumer decisions are not nearly as considered as had been thought previously.

I really want to say that there are differences cross-culturally, but unfortunately there is not a great deal to say in this regard based on the results I obtained. It is true that both maths ability and maths anxiety differ country to country, but they will also differ regionally as well. Again, this suggests an argument to "keep it simple," rather than use, for instance, a percentage to be subtracted from an odd price. Maths ability will be stretched even more if a currency is unfamiliar, so the simplicity argument is made yet stronger.

The evidence here does allow me to suggest that there are no gender differences of any importance in this price discount topic, and that there may be a small difference in that young

people are perhaps more involved (and anxious) about mathematics, but the difference is probably not large enough to matter when compared to the raw price difference or the host of other factors in the environment that impinge on a purchase decision.

Overall, then, the best advice I can give to retailers is to keep the discounts offered simple, and do not place to much strain of the cognitive resources of customers or cause their anxiety levels to rise too high.

5.3 Implications for theory

There is a long history of pricing research, and a reasonable amount of it concerning discounts. The variables investigated here, maths anxiety and ability, have only recently been explored, however, and this research builds on it. In particular, existing research is mainly in educational psychology and not in business and marketing. This is one reason I had to develop my own scales for both MA and MX. Indeed, these scales have proved to be quite effective, showing both internal reliability and working well in the analysis and providing a small contribution to marketing scholarship.

The research also does provide solid statistical significance to support the mediation of the negative MX → PI relationship by the positive influence of MA – that is, that anxiety about making arithmetic calculations is ameliorated by having superior maths skills, yet the partial nature of the mediation shows that some anxiety is almost always present no matter what

level of mathematical competence the decisionmaker has. This relationship has been investigated before, but never in a commercial context such as that utilised here.

The findings here concerning age are not strong, but the gender investigation is of significant interest to gender researchers. The evidence here is quite clear; there is a small lag in gender mathematical skill and anxiety, but the difference is very small, and the basic relationships of MX, MA and PI is the same for both genders. Signs of a changing gender environment.

5.4 Agenda items for future research

Almost all research suffers some limitations, and it is always fairly easy to pick holes in most work. The "jugular vein" of research is the sample. The sample in the work reported here is of doubtful quality, as all the respondents are paid respondents. Panel services do offer a useful way to collect data, particularly in the present Covid-19 environment, where people are stressed, often in a lockdown situation and face-to-face interactions are well-nigh impossible.

Nevertheless, the maths ability scale I developed and used is crude. A timing mechanism would be superior and could be used in a laboratory situation. As this is a key variable, a replication using the length of time taken to answer a set of maths questions would offer an opportunity to obtain a more accurate result.

One of the most interesting findings here is the confirmation of the ubiquitous nature of maths anxiety. Thus far, though, this phenomenon has only been observed in the USA and the PRC. Replication to other, different, cultures such as Russia, the United Kingdom and Japan would offer much stronger support.

I manipulated frame using two types of frame, a simple and a slightly more computationally complex frame. With the multitude of frames available and in common use, it would be of theoretical interest and commercial value to measure the effect of anxiety and ability in more extreme frames. Possibly a package deal with a reduction for a multiple price, a hire-purchase deal with no interest charged or some similar deal which uses more cognitive resource and requires more sophisticated maths skills than simply a percentage reduction. In these situations, the effects noted here would be exacerbated and given a better chance to show.

5.5 Endnote

This research has been a trial because Covid-19 interfered so much, taking me away from University and supervisor, adding worry and making data collection harder than it could have been. Having said that, the situation has provided a great learning experience and the results very interesting and quite useful. I do believe that establishing the commercial relevance of the relationship between maths ability, anxiety and purchase intentions in the face of a discounted product or service is of importance and value, and I look forward to others picking up the gauntlet and building on the platform provided.

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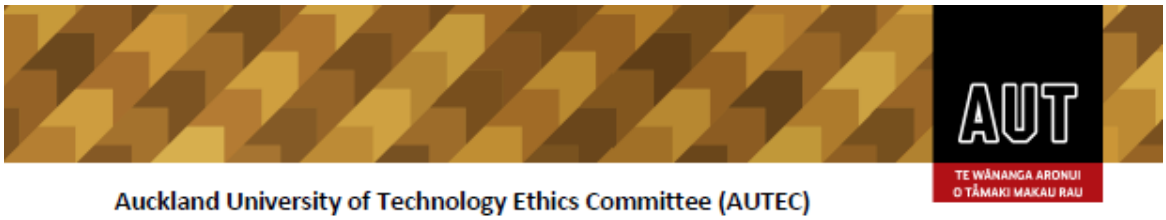
Appendices

Appendix One – Ethics Approval Letter



Auckland University of Technology Ethics Committee (AUTEC)

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E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

10 December 2020

Roger Marshall
Faculty of Business Economics and Law

Dear Roger

Re Ethics Application: **20/306 I can't work it out! Math Anxiety and Discount Effectiveness**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 10 December 2023.

Non-Standard Conditions of Approval

1. Please move the last sentence in the introduction to the survey, beginning 'your consent to participate…' to the end of the Information Sheet.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC in this application.
2. A progress report is due annually on the anniversary of the approval date, using the EA2 form.
3. A final report is due at the expiration of the approval period, or, upon completion of project, using the EA3 form.
4. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form.
5. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
6. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.
7. It is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard and that all the dates on the documents are updated.

AUTEC grants ethical approval only. You are responsible for obtaining management approval for access for your research from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

Please quote the application number and title on all future correspondence related to this project.

For any enquiries please contact ethics@aut.ac.nz. The forms mentioned above are available online through http://www.aut.ac.nz/research/researchethics

(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

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Appendix Two – Research Questionnaire

Chinese Version

您所表达的观点都是保密的您可以在您想的任何时间撤回。问卷是完全保密的；您的身份无法被识别。参加者资料表可在此游览。

填写问卷表明了您的参加意愿。

请想象一下您准备在 8 月份订购 3 晚的度假酒店，在当地网站上看到了你想访问的地区的一家五星级酒店的广告:

Please imagine you are about to purchase a holiday hotel for three nights in August, and come across this advertisement for a 5-star hotel in the area you want to visit on a local website:

请表达你对这家酒店的观点通过以下的衡量表:

非常不同意　1　2　3　4　5　6　7　非常同意

1	这家酒店看起来非常对得起它的价格.....	
2	我会对这家酒店折扣后的价格非常感兴趣.....	
3	这确实是非常棒的折扣.....	
4	我认为很多人都会急于利用这个价格.....	
5	大多数人都会抓住这笔交易如果时机合适的话.....	

6. 在不使用计算机的情况下请计算并回答下列问题。如果你不能回答就把它放一边

1	34 + 27	
2	25 ÷ 12.5	
3	5 * 18	
4	7.5 * 0.5	
5	97.68 * 6	
6	(85 * 3) – (55 * 3)	
7	(45 * 0.69)	

请回答下列问题通过使用您之前使用过相同的衡量表:

非常不同意　　1　2　3　4　5　6　7　非常同意

1　我真的会很紧张当面对棘手的数学问题时.....

3　计算百分比转换成数字时使我非常紧张.....

4　一想到即将到来的数学考试时我就很焦虑.....

5　有人看着我把一串数字相加时会让我非常紧张

6　我真的会慌乱当在餐厅里平分我们七个的账单时...

以下数据仅供分类时使用。

7. 您的性别?　　男性

女性

8. 您何时出生?　　先于 1962 年

后于 1962 年

9. 你的最高教育学历是什么? 高中或以下

高于高中

4. 您的家庭年收入大概多少?

低于 $70,000 每年

高于 $70,000 每年

English Version

The opinions you express are confidential and you may withdraw at any time you wish. The questionnaire is totally confidential; you cannot be personally identified. A participant information sheet is available here.

Filling out the questionnaire indicates your willingness to participate.

Please imagine you are about to purchase a holiday hotel for three nights in August, and come across this advertisement for a 5-star hotel in the area you want to visit on a local website:

Please indicate your opinion of this hotel, using the following scale:

Disagree strongly 1 2 3 4 5 6 7 Agree strongly

1 This hotel looks good value at this price..... ☐

2 I would be very interested in the hotel at the reduced price..... ☐

3 This is a very good discount indeed..... ☐

4 I think many people would be eager to take advantage of this price..... ☐

5 Most people would grab this bargain if the timing suits..... ☐

6. Without using a calculator, please calculate answers to the following questions. If you can't do a question then just leave it out.

1	34 + 27	
2	25 ÷ 12.5	
3	5 * 18	
4	7.5 * 0.5	
5	97.68 * 6	
6	(85 * 3) – (55 * 3)	
7	(45 * 0.69)	

Please answer the following questions using the same scale you used previously:

Disagree strongly 1 2 3 4 5 6 7 Agree strongly

1 I get really nervous when faced with tricky maths problems..... ☐

3 Calculating percentages to a number stresses me out..... ☐

4 Thinking about an upcoming maths test makes me very anxious..... ☐

5 Someone watching while I add up a row of numbers makes me very nervous ☐

6 I get really flustered when dividing the restaurant bill between seven of us.... ☐

The following data is merely for classification purposes.

7. What is your gender? Male
   Female

8. When were you born? Prior to 1962
   After 1962

9. What is your highest level of formal education? High School or less
   Higher than high school

4. What is your approximate annual household income?
   Less than $70,000 per year
   Greater than $70,000 per year

Appendix Three – Participant Information Sheet

Participant Information Sheet

Date Information Sheet Produced:

25/08/2020

Project Title

"I can't work it out! Maths Anxiety and Discount Effectiveness"

What is the purpose of this research?

To ascertain if mathematical anxiety and/or mathematical ability moderate a preference for a discount expressed as a percentage reduction or a price reduction. Data is collected in several countries so that comparisons/generalisations can be made. This information is useful for both marketing practitioners and is also helpful in advancing pricing theory.

What will happen in this research?

Panel service participants are exposed to an advertisement and asked to express their interest in a discounted hotel room rental. Respondents are selected if they fit the criteria that they have had any experience renting a hotel room, and even numbers of women and men respondents are sought, over several age groups. The data collected is anonymous and is amalgamated for statistical analysis. The work will be published as a thesis toward a Masters' degree.

What do you do if you have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Roger Marshall, *roger.marshall@aut.ac.nz*, +64 9 921 9999 ext. 5478

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Dr Carina Meares, *ethics@aut.ac.nz*, +64 9 921 9999 ext 6038.

Whom do you contact for further information about this research?

Please keep this Information Sheet. You are also able to contact the research team as follows:

Researcher Contact Details:

Primary Researcher: Xu Xiaoqi, wind2275@gmail.com

Project Supervisor Contact Details:

Project Supervisor: Roger Marshall, *roger.marshall@aut.ac.nz*, +64 9 921 9999 ext. 5478

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.