An Investigation into the Demand for Service Contracts

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Dissertation submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Economics

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August 13, 2002
Blacksburg, Virginia

Keywords: Risk Aversion, Ambiguity, Experimental Economics

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(ABSTRACT)

This dissertation is an investigation into the determinants of demand for service contracts on new vehicles. In the first chapter, I characterize the consumer decision to buy a service contract with a discrete choice model. Hypotheses and conjectures are tested empirically using survey data from new vehicle buyers. The second chapter consists of the development and testing of an instrument for measuring attitudes toward uncertainty. This tool is useful in gauging aversion toward weak ambiguity. Finally, in the third chapter, I use additional survey and experimental data from new vehicle buyers to further differentiate between the factors that significantly affect the service contract purchase decision. A variety of uncertainty measures and their predictive powers are discussed.

I would like to thank the John D. and Catherine T. MacArthur Foundation, Network on Preferences and Norms, for their generous financial support, which was indispensable to the completion of this research.

Acknowledgements

I want to thank Nancy Lutz and Catherine Eckel for their guidance and patience throughout my graduate career. The comments of Nancy Lutz on Chapters One and Three, and the work of Catherine Eckel on Chapter Two, were particularly helpful.

I thank the members of my committee, Anya McGuirk, Russell Murphy, and Aris Spanos, for their remarks and suggestions.

My thanks also go to Robert Gregory, who first introduced me to economic theory.

For their love and support, I dedicate this dissertation to my parents.

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Preface

Service contracts are expensive forms of insurance available to new vehicle buyers. The profit margins on these contracts can reach upwards of 100%. Although there is considerable mark-up on these offerings, roughly one third of all new vehicle buyers purchase a service contract. This leads to an interesting question: *Why do consumers purchase these service contracts when the expected benefits are so small relative to the costs?* This thesis makes use of new survey and experimental data collected from new vehicle purchasers from automotive dealerships in Virginia in order to address this question.

The first chapter characterizes the consumer decision to buy a service contract for a new vehicle with a discrete choice theoretical model and investigated with empirical modeling. Several factors affecting the likelihood of a service contract purchase are explored. The theoretical model's hypotheses and other conjectures are tested with a binary dependent variable empirical model using survey data from new vehicle buyers. Empirical evidence suggests that risk aversion, length of ownership, having children over the age of 16 in the household, financing the purchase with a loan, and previous service contract purchases increase the likelihood of a service contract purchase. Import buyers and consumers with more knowledge about vehicles are less likely to buy a service contract. Finally, the statistical adequacy of the empirical model and misspecification testing are discussed.

The second chapter consists of the development and testing of an instrument for measuring attitudes toward uncertainty. This is a new instrument for measuring ambiguity aversion in gambles for substantial stakes. We focus on weak ambiguity, where the subjects are informed of the probability distribution of the ambiguous aspects of the gamble. Several features of our instrument are notable. First, subjects make choices for different levels of ambiguity over probabilities, over payoffs, and decisions involving double ambiguity over both probabilities and payoffs. Second, we measure preferences at different base probability levels allowing us to explore systematic variations in aversion for different levels of underlying uncertainty. Third, we measure ambiguity aversion over both possible gains and possible losses. Fourth, we use two different frames, describing the gambles as a "lotteries" or as "investments". Finally, our design avoids asymmetry of information between the subject and the experimenter, as the level of knowledge of the experimenter and subjects is the same. Our findings indicate that our undergraduate subjects are ambiguity averse. They are averse when the ambiguity is over probabilities in the gain domain and, conversely, are averse to ambiguity in the outcome in the loss domain.

The third chapter addresses the question of why people buy service contracts by looking not only at demographic data but also at the beliefs and preferences of the new vehicle buyers. A portion of these consumers participated in a follow-up study involving an experiment for considerable financial stakes and an additional survey. This survey contains question that I was not able to ask on the original and allows for a more accurate portrayal of the characteristics and beliefs of new vehicle buyers. The evidence suggests that the number of vehicles and drivers in the household affects the service contract purchase decision. The experiment involves testing these customers' attitudes toward uncertainty using the measure developed in Chapter Two. The new vehicle buyers are ambiguity averse. In both the gain and loss domains, these subjects are averse to ambiguity in the probability of an event. The experimental measures were not significant in predicting the likelihood of a service contract purchase, however.

Chapter 1. Investigating the Demand for Service Contracts

1. Introduction

Interest in extended warranties has increased considerably over the last two decades. A reason for this is the growth of such offerings, which is due to their tremendous profit potential. Retail profit margins on extended warranties range from 30 percent to 75 percent and typically generate more profit than the products covered (The New York Times, 1999). Because of these large margins, a variety of retailers offer these warranties on numerous goods. Sears provides extended warranties on home appliances while firms like Circuit City, Radio Shack, and CompUSA offer them on electronic equipment. WarrantyNow and RevBox have recently begun to provide extended warranty services to online retailers. The large profit margins have led to considerable commissions being offered on the sale of extended warranties. With commissions as high as 75 percent, retailers can often earn more from these commissions than from the sale of the product (The New York Times, 1995). Extended warranties in the automotive industry, known as service contracts, are also quite profitable. The markup on service contracts for new vehicles can reach upwards of 100 percent. Some contracts with an average retail price of $1,100 to $1,200 can provide dealers with an average profit of $560 (Automotive News, 1998). In a court case involving Nissan Motor Corporation, dealers were shown to profit $555 on a contract priced at $795 (Automotive News, 1988). There are considerable profits from the sale of service contracts on used vehicles. The profits were nearly $1.9 billion for franchised dealers

in 1997. The average gross profit on each of these contracts was $455 (Automotive News, 1998).

The profitability of service contracts alone is a sufficient reason for firms to provide these offerings. Other reasons firms provide these offerings include enhancing brand image, providing the customer with more coverage, and increasing revenues. There is an interesting economic question here: *Why do consumers purchase these service contracts when the expected benefits are so small relative to the costs?* Roughly 30 percent of new and used car buyers and 40 percent of electronic and appliance goods consumers purchase an extended warranty (The Houston Chronicle, 1996). It is intriguing that there is so much activity in the extended warranty market given that the vast majority of consumer experts state that these items are not a worthwhile purchase. Consumer Reports has advised against the purchase of an extended warranty for years.

Customers' reasons for purchasing these offerings include protection against breakdowns and a belief that the cost of an extended warranty would be cheaper than the cost of potential repairs. According to Ursula Moran, analyst for Sanford C. Bernstein & Company, two types of consumers purchase extended warranties. "One are the people who live paycheck to paycheck who don't want to deal with any extra expenses. The second kind are those who buy it for convenience." (St. Louis Post Dispatch, 1998) Low income and convenience are not the only answers as to who or why these offerings are purchased. My work looks at factors affecting the decision to purchase a service contract for a new vehicle. Trying to understand the factors that affect demand for these contracts is a useful study. This research allows for the investigation of a number of these factors including heterogeneities in risk and uncertainty aversion, usage, product experience, income, and length of ownership. Another hypothesis is that a service contract may be purchased in an attempt to minimize the chances of unnecessary repairs and the accompanying expenses from trips to the mechanic. These are only a few of the hypotheses and conjectures examined in this study.

I present a theoretical model and a thorough empirical analysis of factors affecting the service contract purchase decision. The empirical section contains a discussion on specification testing in an attempt to evaluate the statistical adequacy of the model. This is done to ensure the validity of inferences made from the empirical results.

2. Literature review

There is an extensive body of literature on the provision and role of warranties. Various authors (Lutz 1989, Cooper and Ross 1985, Dybvig and Lutz 1993) have shown that manufacturers can maximize profit by providing a warranty in both single and double moral hazard theoretical frameworks. Soberman (1992) provides a model that has warranties simultaneously acting as both a screen and a signal.

The relationships between warranty, reliability, and quality have also been explored. Price and Dawar (1995) examine how the effects of brands and warranties affect consumer evaluations of quality. They find that, under certain conditions, the two signals may interact to convey quality. Warranty and quality issues, along with costs of warranty repair, in the automobile industry have been investigated. Douglas et al (1993) find an inverse relationship between quality and warranty in the US market. Gill and Roberts (1989) find empirical support for their model that predicts that there is a higher cost of warranty repairs, i.e. more trips to the mechanic, for people more willing to visit the shop.

Agrawal et al (1996) look at the relationship between warranty levels and reliability and find that product age, increased market penetration, and greater variation in the reliability of brands lead to 'improvements' in this relationship.

My work relates more directly with the extended warranty literature. Lutz and Padmanabhan (1998) look at the effect of third party insurers offering extended warranties on manufacturer's price, quality, and warranty offerings. Lutz and Padmanabhan (1995) derive a model to explain why some manufacturers offer a minimal warranty or no warranty coverage. They show that extended warranty purchases from independent providers erode the manufacturer's profits from warranty insurance. Chen and Ross (1994) develop a model that demonstrates how extended warranties can be expensive in a perfectly competitive industry.

An oft-quoted work in the field of extended warranties is that of Day and Fox (1985). These authors discuss some of the practices and issues involving extended warranties and provide marketing suggestions for these products. They pointed out the 'relative paucity' of work in this area and that insight was limited due to this. Day and Fox state that considerably more information on the when, why, and incidence of service contract purchases along with sociodemographic characteristics of 'purchasers/nonpurchasers' is needed. Information of this

sort is being collected and analyzed in my research. This information can then be used in identifying target markets.

There has been an increase in the amount of research on extended warranties and service contracts since the paper by Day and Fox. Kelly and Conant's (1991) study on consumer and manufacturer perceptions of extended warranty sales is an interesting qualitative analysis. A comparison of why these offerings are bought and sold is conducted and evaluated. They find that the results may be of particular importance to marketing managers and public policy makers, "…if corroborated by future research." Their focus is on major household appliance manufacturers. One of their suggestions is to focus on another market and look at the retailing sector. I am doing this by focusing on the new car and truck industry.

Padmanabhan and Rao (1993) investigate manufacturer warranty policy in a market with heterogeneous consumers who have different preferences. Padmanabhan (1995) continues this research agenda by investigating manufacturer warranty policy in a market characterized by consumers with usage heterogeneities and consumer moral hazard. These authors test their theories empirically using data collected from a mail questionnaire of new car buyers in the Dallas-Fort Worth Metroplex area. These papers have some interesting findings. Padmanabhan and Rao find support for consumer risk as a factor leading to the offering of service contracts as screening devices. Interestingly, they find no support for usage or length of ownership as factors affecting service contracts as screening devices. Padmanabhan and Rao also determine that a base warranty of three years on new automobiles will 'erase the role of risk-aversion' in the demand for service contracts. Padmanabhan (1995) complements this work. Using a subset consisting of those autos with 3 years/36,000 mile base warranties of the larger data set, he finds no support for risk as a factor in the use of service contracts as a screening device. Padmanabhan finds support for usage heterogeneity as a screening device and evidence that lends credence to length of ownership as a screen (the coefficient is significant at the 10 percent confidence level).

The works of Padmanabhan and Rao can be criticized for a few reasons. Their efforts are rather narrow in scope as the emphasis is on only two factors: risk attitudes and vehicle usage. Their claim that a 3 year base warranty will erase the role of risk aversion is suspect. The market penetration of service contracts is substantial. It's unlikely that risk aversion does not play a role in the decision to purchase this type of insurance. Furthermore, a number of their measures may

suffer from possible inaccuracies.[1] These include using time rather than distance intervals for oil changes, marital status as a proxy for experience with vehicles, and the vehicle being for personal or business purposes as the measure of use.

I do not consider my research as an extension of their works but as an attempt to address the nature of service contract demand in a more complete fashion. I investigate a wider array of factors and use more precise instruments to measure the characteristics and attitudes of these consumers. I also attempt to capture a more accurate reflection of the types of vehicles being purchased in the new vehicle market.

None of the previous empirical studies involving the vehicle market have included light trucks and sport utility vehicles in the analysis. This segment of the new vehicle market is important as almost half of all new vehicle sales in the last decade were light trucks and recently sales of SUVs have outpaced the rise in overall auto sales. In the U.S., sales of SUVs rose 17% in February of 2000 versus the same month in 1999. Overall auto sales rose just 12%. (USA Today, 2000) General Motors believes that, in the United States, light trucks will, "…account for 60% of the passenger vehicle market within a few years." (The Economist, 2000) There are a number of reasons to suspect that drivers of light trucks may have different attitudes toward purchasing a service contract. One reason may be the portrayal of these vehicles as incredibly rugged and durable. If the consumer believes in the advertisement then one may conjecture that these consumers are less likely to purchase a service contract. The role of the type of vehicle is discussed further in Section 4. An interesting aspect of my research is the inclusion of light trucks and sport utility vehicles along with automobiles.

3. A Discrete Choice Model

Here I model the consumer decision to a purchase a service contract. Let $U(x,\theta; d)$ be the individual's utility as a function of dollars, x, observable personal characteristics, θ, and a risk aversion parameter, d. I assume that U(.) is an increasing and concave function of x.

The consumer has just purchased a new vehicle and is considering buying a service contract. π is the probability that the vehicle works, y is income, w is the dollar valuation of a broken vehicle covered by the base warranty, and v is the dollar valuation of a properly

[1] These authors have noted the inaccuracies of their measures of consumer effort, i.e. oil and fluid changes.

functioning vehicle. I assume that $v > w$. The price of a service contract is t and it provides additional coverage with a dollar valuation of s. Total coverage with a service contract is thus $w + s$.

I also make the following assumptions: $y > 0$, $v > 0$, $w > 0$, $t > 0$, $v > w+s$, and $s-t \geq 0$. This leads to the ranking of dollar valuations $y+v > y+v-t > y+w+s-t \geq y+w$. This ordering makes intuitive sense. It shows that the value of a working vehicle is greater than the value of a non-working vehicle regardless of the purchase of a service contract.

The consumer's expected utility without a service contract:

$EU_0(y,w,v,\pi,\theta;d) = \pi U(y+v,\theta;d) + (1-\pi)U(y+w,\theta;d) + \phi_0$, where ϕ_0 is an unobservable component of utility.

The consumer's expected utility with a service contract:

$EU_1(y,w,v,t,s,\pi,\theta;d) = \pi U(y+v-t,\theta;d) + (1-\pi)U(y+w+s-t,\theta;d) + \phi_1$, where ϕ_1 is an unobservable component of utility that is independent of ϕ_0 but with the same distribution.

The consumer will purchase a service contract if and only if

$EU_1(y,w,v,t,s,\pi,\theta;d) > EU_0(y,w,v,\pi,\theta;d)$.

Therefore, the probability of a service contract purchase is

$\text{Prob}\{\phi_1 - \phi_0 > \pi U(y+v,\theta;d) + (1-\pi)U(y+w,\theta;d) - \pi U(y+v-t,\theta;d) - (1-\pi)U(y+w+s-t,\theta;d)\}$. (1)

If $\phi_1 - \phi_0$ is logistically distributed then I can use a logit model to empirically test this theory.

It is easy to show that the right hand side of equation (1) is an increasing function of π, the probability that the vehicle works. I need to make additional assumptions on the utility function before we can examine the effects of changes in the other parameters. Three functional forms will be investigated. The first is a constant absolute risk aversion (CARA) utility function of the form $U(x;d)= -e^{(-dx)}$ where $d>0$. The second is an expo-power (EP) utility function of the form $U(x;d)= -e^{(-bx^d)}$ where $0<d<1$ and $db>0$. It should be noted that the CARA functional form is a special case of the EP form. The third is a hyperbolic absolute risk aversion (HARA) utility function of the form $U(x;d)= a(x-d)^L$ where $0<L<1$, $a>0$, and $y+w > d$.

Table 1. Arrow-Pratt measures for the functional forms

Functional Form	Arrow-Pratt Measure of Absolute Risk Aversion	Arrow-Pratt Measure of Relative Risk Aversion
CARA	d	dx
EP	$\frac{1 - d + bdx^d}{x}$	$1 - d + bdx^d$
HARA	$\frac{-(L - 1)}{x - d}$	$\frac{-(L - 1)x}{x - d}$

Table 1 presents the Arrow-Pratt (AP) measures of absolute and relative risk aversion for each of the functional forms. The absolute measure for the CARA function is, of course, a constant. Use of this functional form has been criticized for its lack of realism as a description of actual behavior. Rabin (2000) points out that "… for any concave utility function, even very little risk aversion over modest stakes implies an absurd degree of risk aversion over large stakes." Holt and Laury (2000) note that scaling up payoffs by some factor, r, is the same as having r times as much risk aversion for the original payoffs with a CARA utility function.

As noted in Varian (1992), "It is quite plausible to assume that absolute risk aversion decreases with wealth." The HARA function exhibits decreasing absolute risk aversion (DARA). I have assumed that $0<d<1$ in the case of the EP utility function so that it exhibits DARA. In experiments involving risk aversion and incentive effects, Holt and Laury (2000) find that the use of positive parameters taking values between 0 and 1 (for b and d) fit their aggregate data closely.[2]

The EP and CARA functional forms exhibit increasing relative risk aversion (IRRA). The HARA form displays decreasing relative risk aversion (DRRA). Varian describes the behavior of relative risk aversion as "problematic" as it is not clear whether one would be more or less averse to losing a fraction of wealth as it increases. Abdellaoui et al point out that concavity, DARA, and IRRA are viewed as desirable properties in the literature and are possible with the use of the EP functional form.

[2] Abdellaoui et al (2000) assume that $b = 1/d$ and that $0<d<1$. These authors discuss the merits of restrictions on the range of d.

I am now able to discuss the effects of changes in the parameters on the likelihood of a service contract purchase. To do this I investigate the first derivatives of the formulation as described in (1) above. The focus is on the right-hand side (RHS) of this equation. I define this as

$$RHS = \pi U(y+v,\theta;d) + (1-\pi)U(y+w,\theta;d) - \pi U(y+v-t,\theta;d) - (1-\pi)U(y+w+s-t,\theta;d).$$

The probability of $\phi_1 - \phi_0$ exceeding the RHS falls as the RHS increases.

It is a simple exercise to show that the right hand side of equation (1) is an increasing function of w for all three functional forms. The same is the case with the first derivative with respect to t. This indicates that increases in base warranty coverage and increases in the price of a service contract each decrease the likelihood of a service contract purchase. It is also an easy exercise to show the RHS of equation (1) is a decreasing function of v and also s. This reveals that increases in the value of a working vehicle increase the likelihood of a service contract purchase. Many service contracts provide for the use of a 'loaner' vehicle while the owner's vehicle is being repaired. Practically speaking, someone who has a high need for a working vehicle, in a traveling occupation for example, might well be more likely to purchase a service contract. Increases in the additional coverage, s, from a service contract are more likely to lead to a purchase, ceteris paribus.

However, the signs of the first derivatives with respect to the risk aversion parameter, d, and income, y, are not as evident for any of the functional forms. It is possible to derive sufficient conditions such that the right hand side of equation (1) is a decreasing function of d, the risk aversion parameter. In the full insurance case, $w+s=v$, this follows from Pratt's theorem. Things are not as clear-cut in the partial insurance case, $w+s<v$. For any given y, v, d, t, w, and s, the right hand side of equation (1) is a decreasing function of d if π is sufficiently large in the CARA case. With the HARA and EP functions, for any given y, v, d, t, w, and s, the right hand side of equation (1) is a decreasing function of d if π is sufficiently small. The derivations and further explanations of these claims for the partial insurance cases are shown in Appendix A.

It is also possible to show that the right hand side of equation (1) is a decreasing function of income, y. For any given y, d, v, t, w, and s, this is the result if π is sufficiently large in the CARA and EP cases. The right hand side of equation (1) is a decreasing function of y in the HARA case if π is sufficiently small for any given y, d, v, t, w, and s. These results reveal that

increases in income increase the probability of a service contract purchase. Derivations and additional explanations for these claims are also shown in Appendix A.

4. Hypotheses and conjectures

Several factors play a role in determining whether or not a service contract is purchased. These factors range from risk aversion to marital status. The implications of the theoretical model are presented first. The remaining factors are presented as conjectures and are grouped under four headings. Table 2 lists the variables used to test each implication or conjecture under these groupings. Some of these have been investigated, with differing conclusions, in earlier research while others are being investigated empirically for the first time. It is expected that each of these factors will have some effect on the purchase decision. Each factor is discussed below and the accompanying variables are listed in italics.

Table 2. Grouping of factors affecting service contract (SC) demand

Group	General hypothesis or conjecture
Probability the vehicle works	As the probability of the vehicle working increases the likelihood of an SC purchase decreases. *Variables: import, maintenance*
Value of a working vehicle	As the value of a working vehicle increases the likelihood of an SC purchase increases. *Variables: use, family size, over 16, user*
Risk aversion	As risk aversion increases the likelihood of an SC purchase increases. *Variable: risk*
Income	As income increases the likelihood of an SC purchase increases. *Variable: income*
Experience	As experience with vehicles and service contracts increase the likelihood of an SC purchase decreases. *Variables: experience, knowledge, education, previous, married, female, age*
Time	As loan duration and expected length of ownership of the vehicle increase the likelihood of an SC purchase increases. *Variables: loan, length*
Vehicle characteristics	*Variables: price, suvpick*
Dealership effects	*Variables: dealer, manager*

The following discussion of each factor concludes with a prediction of its effect on the likelihood of a service contract purchase.

4.1. Implications from the theoretical model

4.1.1. Probability the vehicle works

It was shown in section 3 that as the probability of the vehicle working increases the likelihood of a service contract purchase falls. I use import status, i.e. the vehicle having a foreign nameplate, as a proxy for perceived reliability. Another factor affecting the probability of the vehicle working is routine maintenance.

Imports *(import)*

Throughout the 1980s, domestic automobiles had more registered complaints than imported vehicles. The reason for most of the complaints is due to some type of product failure (Douglas, Glennon, and Lane 1993). Padmanabhan and Rao (1993) include an import variable in their empirical analysis as, "… people typically associate imports with lower product failure and therefore insurance might be less important for them." It should be noted that the coefficient on the import variable in their analysis was insignificant with a P-value of 0.97.

If the vehicle is an import then there is a lower likelihood of a service contract purchase.

Maintenance *(maintenance)*

Consumers who provide regular maintenance and follow the maintenance schedule in the owner's manual are less likely to purchase service contracts. Using frequency of oil change as an indicator of maintenance, Eckel et al (1998) find that increases in the frequency of oil change have a significantly negative effect on the likelihood of a service contract purchase.

The greater the level of consumer maintenance the lower the likelihood of a service contract purchase.

4.1.2. Value of a working vehicle

The results from the theoretical model indicate that as the value of a working vehicle increases the likelihood of a service contract increases. Four variables are presented to measure this value.

Product Usage (*use*)

It is reasonable to expect the level of product use to have an effect on the service contract purchase decision. Regarding an automobile or light truck, if the consumer expects to use the vehicle heavily then the consumer may purchase a service contract. There are two reasons for this: (1) A consumer who uses a vehicle more than average may expect a higher likelihood of product failure (breakdown or other problem) and (2) heavy use consumers are likely to be more

dependent on their vehicle and suffer higher inconveniences from product failure. These inconveniences include not only the time the vehicle is in the shop but also search costs for locating a 'trustworthy' mechanic. Any dealership that sells that vehicle make will often repair a vehicle covered by a service contract.

Consumers with higher usage levels are more likely to purchase service contracts.

Family Size *(family size, over 16)*

Day and Fox (1985) assert that family size affects the demand for service contracts. These authors state that larger families with small children are more likely than small families to purchase service contracts. An apparent reason for this is that there will be a higher level of product use in a large family. In the case of a new vehicle purchase, one might expect that a larger family will have more trips made for children's events. It is also interesting to see if there is a child of driving age, at least 16 years old, when the vehicle purchase is made. Parents may expect a younger driver to be harder on the vehicle.

The larger the size of the family the greater the likelihood of a service contract purchase.

If the consumer has children of driving age living with them, the greater the likelihood of a service contract purchase.

Vehicle Purchased for Another Person *(user)*

Vehicle purchases are sometimes made for family members or friends. An adult purchasing a new vehicle for his child may be more likely to purchase a service contract. An instance where this is likely is a purchase for a college student who will use the vehicle to travel to a distant university. The contract may be purchased so the student will not have to deal with any covered repairs that could arise while at school. Similarly, buying a vehicle for a parent may also lead an individual to purchase a service contract in an attempt to minimize any inconvenience or financial concerns caused by problems with the vehicle.

If the consumer is purchasing the vehicle for another person, the greater the likelihood of purchasing a service contract.

4.1.3. Risk aversion

The theoretical model does not provide a clear prediction of the effect of risk aversion on a service contract purchase. However, conditions were presented in which increases in risk aversion would increase the likelihood of a service contract purchase.

Risk aversion (*risk*)

The role of risk aversion on insurance purchase decisions has been discussed in many articles and texts. Three papers (Eckel et al 1998, Padmanabhan 1995, Padmanabhan and Rao 1993) investigate the impact of risk aversion on service contract purchases with econometric analysis. Eckel et al and Padmanabhan find risk to be insignificant in logit analyses with the service contract purchase decision for new automobiles as the dependent variable. Eckel et al do find the interaction of risk and single woman is significant for service contract purchases on new computers. Padmanabhan and Rao find that risk and the interaction of risk and base warranty coverage are significant at the 5% and 10% levels on service contract purchases for new automobiles.

Day and Fox note, "In general, the primary demand will continue to exist among those persons who… are risk-averse." Padmanabhan (1995) and Padmanabhan and Rao (1993) determine that risk will no longer be a factor in the purchase decision once the base warranty on autos is 3 years/36,000 miles. As this has been the minimum new vehicle standard base warranty for the majority of producers for some time, I can test their prediction.

Consumers who are more risk averse are more likely to purchase service contracts.

4.1.4. Income

The theoretical model does not provide a clear prediction of the effect of income on a service contract purchase. However, conditions were presented in which increases in income would increase the likelihood of a service contract purchase.

Income (*income*)

Gerner and Bryant (1980), Bryant and Gerner (1982), Padmanabhan and Rao (1993), and Padmanabhan (1995) indicate that family income and service contract ownership are related. Day and Fox suggest that low-income and relatively high-income persons are less likely to purchase service contracts. Their reasoning is that affluent people will choose to self-insure. Low-income consumers are felt to be unable to afford this type of insurance. They suggest that middle-income families will be the greatest purchasers of these contracts.

Applied studies (Eckel et al, Padmanabhan, Padmanabhan and Rao) have included an income regressor in qualitative dependent variable analysis. In each instance the coefficient has had a positive value, though not always significant. I am able to look at both personal and household incomes.

Higher income persons and families are more likely to purchase service contracts.

4.1.5. Base warranty coverage

A clear implication of the theoretical model is that increasing base warranty coverage decreases the likelihood of a service contract purchase. Consumers may view longer base warranties as indicative of higher quality vehicles.[3] In the current vehicle market, longer bumper-to-bumper base warranties are usually offered by upscale manufacturers like BMW, Infiniti, Lexus, Jaguar, Lincoln, Mercedes, and Porsche. Padmanabhan and Rao (1993), among others, point out that a longer base warranty reduces the perceived risk for the consumer. There are no consistent empirical findings regarding base warranty coverage and extended warranty decisions. I am not able to test the effect of base warranty coverage on service contract purchase decisions as the vehicles in this study all have a standard 3 year/36,000 mile base warranty.

The longer the length of the base warranty, the lower the likelihood of a service contract purchase.

4.2. Additional Conjectures

4.2.1. Experience

Experience with vehicles and service contracts is expected to decrease the likelihood of a service contract purchase. Seven variables are presented that serve as measures of experience.

<u>Product Experience</u> *(experience, age)*

According to Day and Fox (1985), "… the appeal of appliance service contracts tends to vary inversely with product experience." They discuss how the aging of the US population should lead to a decreased demand for service contracts as this should tie with consumers becoming more experienced with the product. Both marital status and age of the individual have been used in applied research to capture product experience. The *experience* variable is a binary variable indicating whether this is the consumer's first new vehicle or not.

[3] Numerous authors have discussed the signaling role of a warranty as it relates to quality (Spence 1977, Douglas, Glennon, and Lane 1993, Lutz 1989, Agrawal, Richardson, and Grimm 1996).

The greater the consumer's product experience the less likely a service contract purchase is made.

Knowledge (*knowledge*)

Consumers who consider themselves more knowledgeable than the average buyer about vehicles are likely to have done considerable research regarding their new vehicle purchase. These consumers probably consulted buying guides while investigating the market and found sections in these guides recommending against a service contract purchase. Furthermore, these individuals may have better information about the likelihood of breakdown or the cost of repairs. Day and Fox (1985) state that, "…as consumers become more knowledgeable…it is likely that they will more carefully weigh the costs versus benefits of…service contracts."

The higher the level of consumer knowledge about the vehicle the lower the likelihood of a service contract purchase.

Education (*education*)

Gerner and Bryant (1980) find a positive but statistically insignificant relationship between the head of household's education level and the demand for warranty comprehensiveness. Eckel et al (1998) report positive but insignificant relationships between the level of education and the likelihood for service contract purchases for automobiles and computers. A possible explanation for these positive coefficients is that individuals with higher levels of education have a higher opportunity cost of their time. Therefore, these individuals do not want to spend time searching for mechanics or dealing with delays from vehicles in need of repair.

Consumers with a higher level of education are more likely to purchase a service contract.

Service Contract Experience *(previous)*

Experience with service contracts is related to product experience. Unlike most of the conjectures in this section, it is difficult to pre-determine the effect of prior service contract purchases on the current purchase decision. The consumer's previous experience, if positive, could lead to further purchases. Of course the opposite is also true. Also, there are some individuals who may purchase a contract regardless of prior events.

Consumers who have purchased a service contract(s) on a previous vehicle(s) are less likely to purchase a service contract.

Marriage *(married)*

Padmanabhan (1995) and Padmanabhan and Rao (1993) used marital status as a proxy for product experience in econometric models. The general explanation given by these authors is that a new vehicle is the first major purchase for a single individual along with singles having lower income, lower age, and less product experience. After controlling for these other factors, it is an interesting exercise to see what effect, if any, marital status may have on the purchase decision for a service contract. They found that singles derived greater utility from a service contract purchase.

Married persons are less likely to purchase a service contract.

Gender (*female*)

A considerable amount of research has been conducted investigating the differences between men and women regarding risk aversion and, to a lesser extent, risk assessment. The interested reader should consult Eckel et al for a thorough literature review. The general conclusion is that women are more risk averse than men. Women appear to engage in risky behavior less frequently and their perception of risk is greater than that of men. Eckel et al point out how these differences may affect a woman's behavior in many areas of life.

A widely held belief is that women, on average, are less knowledgeable about motor vehicles than men. If this true, one might expect a woman to be more likely to purchase a service contract to avoid being 'taken advantage of' by a mechanic, i.e. charged for unnecessary repairs or charged more for a given repair.

For these reasons one may speculate that women, particularly single women, are more likely to purchase service contracts.

Women are more likely to purchase service contracts.

4.2.2. Time

This group consists of two timing factors: length of ownership and duration of financing of the new vehicle. As either of these factors increase the likelihood of a service contract purchase increases.

Length of ownership *(length)*

Length of ownership will play a role in the purchase of a service contract. There is no need for a consumer to purchase a contract if they do not expect to own the vehicle for much longer than the length of the base warranty. If the consumer intends on keeping the vehicle for a

considerable amount of time beyond the base warranty she may want to purchase a service contract to keep the vehicle under some type of warranty for a longer period.

The longer the consumer expects to own the product, the greater the likelihood of a service contract purchase.

Financing the Vehicle Purchase with a Loan (*loan*)

Financing a new vehicle purchase through a loan is likely to increase the likelihood of a service contract purchase. This is because the marginal increase in the monthly payment of the loan due to the service contract is a fairly small percentage of the payment. As the loan duration increases, the decrease in the absolute size of the monthly payment due to the service contract appears relatively small and thus the service contract may appear to be a more attractive purchase. It may also be the case that individuals that need longer loans cannot afford the larger monthly payments associated with shorter loans. These consumers may not have the resources available to pay for costly vehicle repairs and therefore will likely find it cheaper to pay small monthly payments for a service contract.

Increases in loan duration increase the likelihood of a service contract purchase.

4.2.3. Vehicle characteristics

Three factors relating to the effect of the vehicle on the service contract purchase decision are considered: the price, model, and if the vehicle is an import. Since import was discussed earlier as a proxy for probability of the vehicle working, it will not be listed here.

Product Price *(price)*

The works of Padmanabhan, Padmanabhan and Rao, and Eckel et al include a regressor for product price and each cite Day and Fox as a reason for its inclusion. "The increasing costs of automobiles and their repair make service contracts more and more attractive to new car purchasers." (Day and Fox, 1985) This would imply that the value of the service contract increases with the price of the vehicle. I am able to discern the actual vehicle price from the total purchase price, which would include the vehicle and contract prices. It is not clear that this was done in earlier works.

As the price of the car increases the likelihood of a service contract purchase increases.

Light truck buyers (*suvpick*)

There are reasons to believe that consumers in this portion of the new vehicle market may regard service contracts in a different manner than those in the automobile section. First, many

consumers of light trucks feel these vehicles are safer (for the occupants in the truck) in an accident. If one believes that these consumers are more risk averse then they might be more likely to purchase a service contract. Second, suppose some of the light truck consumers are actually risk loving and intend on using the vehicle for more rigorous purposes such as off road driving. Current theory suggests that heavy users are more likely to purchase service contracts. Third, for comparably priced autos and light trucks, light trucks use relatively basic technology. It is the case that light trucks are more reliable in comparison. In 1988, truck buyers purchased 30 percent of the service contracts sold by Nissan yet accounted for only 14 percent of the claims made. (Automotive News, 1988) If trucks were more reliable, one would expect to see fewer service contracts sold.

SUV and pickup truck buyers are less likely to purchase a service contract.

4.2.4. Dealership effects *(dealer, manager)*

It is not clear, a priori, what effect if any the dealership or business managers will have on the service contract purchase decision. The import variable is controlling for the manufacturing origin of the vehicles so there is unlikely to be any significant effect from the dealership or salespeople. There is a dummy variable for each dealership. At each dealership, there was a primary business manager who handled the majority of the surveys (*managers 1-4)*. There were a few additional managers who dealt with a small portion of the surveys. These additional managers were pooled to make the dummy variable *manager 5*.

5. Empirical Modeling*:*

5.1. Data

I collected survey data on new vehicle buyers at the point of purchase after all purchase decisions have been finalized. The survey is presented in Appendix B. Information about a number of consumer attributes has been collected including length of financing, usage characteristics, product experience, maintenance effort, risk preferences, and demographic factors. Four dealerships in Richmond and Christiansburg, Virginia distributed the surveys. These dealerships sell the nameplates Chrysler, Ford, Honda, Jeep, Mazda, Mercury, Plymouth, and Saturn. All of these manufacturers provide a standard 3 year/36,000 mile base warranty so testing the hypothesis about levels of base warranty coverage is not possible. The data set has 172 usable observations. Table 3 presents descriptive statistics for the variables used in this analysis.

Table 3. Summary of variables

Variable	Description	Mean	Std. Dev.
Purchase	= 1 if service contract purchased for vehicle = 0 otherwise	0.420	(0.495)
Risk	= 1 if willing to purchase trip insurance at price exceeding expected loss = 0 otherwise	0.195	(0.398)
Use	= 1 if vehicle purchased for business use = 0 otherwise	0.115	(0.320)
Female	= 1 if female = 0 otherwise	0.477	(0.501)
Income	Income (1 is $20,000-50,000; 2 is $50,000-80,000)	1.753	(1.291)
Experience	= 1 if first-time vehicle buyer = 0 otherwise	0.034	(0.183)
Length	Expected length of ownership (2 is 5-7 years)	2.057	(1.136)
Price	vehicle price in dollars	24843.7	(5614.7)
Over16	number of children over the age of 16 in the household	0.201	(0.569)
User	= 1 if vehicle purchased for someone else = 0 otherwise	0.167	(0.374)
Married	= 1 if married = 0 otherwise	0.679	(0.468)
Knowledge	level of knowledge versus average consumer (range of 1-6; 3.5 is the value of the average consumer)	3.753	(1.232)
Loan	= 1 if vehicle purchased with a loan = 0 otherwise	0.845	(0.363)
Education	highest level of education (2 is some college, 3 is bachelor's degree)	2.713	(1.147)
Previous	frequency of previous SC purchases on other vehicles	1.575	(0.731)
Maintenance	miles between oil changes	3203.7	(681.6)
Suvpick	= 1 if vehicle and SUV or pickup = 0 otherwise	0.489	(0.501)
Family size	number of people in the household	2.385	(1.404)
Age	in years	45.132	(13.239)
Import	= 1 if the vehicle is an import = 0 otherwise	0.333	(0.473)

This survey work is innovative for a number of reasons. First, this survey is administered at the point-of-purchase, whereas existing work has used mailings. These mailings were done months after the vehicles were purchased and with limited follow-up. Second, to some extent I was able to choose the dealerships that I would like to participate in this study, allowing me to

have greater control over the vehicle models selected. Third, I used incentives for both the new vehicle purchaser and the dealership for participating. These incentives included a cash payment or gift certificate for the consumer and a cash reward for the dealerships. Fourth, I not only look at data on new automobile purchases but also on new light truck purchases such as SUVs, pickup trucks, and vans. Previous research has completely ignored the light truck market. Because of these efforts, I am able to analyze the new vehicle market more completely. I have higher response rates for my survey and fewer issues with sample bias. The data also have the potential to be 'cleaner' than the data used in previous studies as an employee of the dealership verified the purchase information.

5.2. Estimation and Results

I use binary logit modeling to test the hypotheses and conjectures. Table 4 presents the results from these logit estimations. Model 1 contains the variables discussed in section 4 except those relating to the dealership.

Notice that the majority of the independent variables in the large model are not statistically significant at any reasonable level. Model 2 presents the results of logit analysis after removing variables with little predictive power. I use an ad hoc approach suggested by Zikmund and Parker (1999) to eliminate these variables. This consists of removing variables singly and continuing this process until any additional removal would have decreased the pseudo-R^2 by more than 0.005. I verified that none of the removed variables should re-enter the analysis. Likelihood ratio testing confirms that the coefficients of the removed variables were insignificantly different from zero. The value of the test statistic is 5.03 with a p-value of 0.7541.[4]

[4] The coefficients of the remaining variables in Model 2 were quite stable across the reduction suggesting that the explanatory power of these variables is considerable.

I will focus on the results of model 2. These results are discussed in relation to the groupings presented in Table 2. The "probability of the vehicle working" hypothesis receives support from the data. The coefficients on *maintenance* and *import* are negative. The significantly negative *import* coefficient indicates that buyers of these vehicles are less likely to purchase service contracts. This suggests that import buyers perceive their vehicles as more reliable, which is reasonable as Japanese makes suffer from fewer problems than their U.S. counterparts (Consumer Reports, 2001).

The data also support the conjecture that having children over the age of 16 in the household increases the likelihood of a service contract purchase. This is indicated by the positive and significant coefficient of *over16*. This is the only variable from the "value of a working vehicle" group in the second model. While the other variables in this group were not statistically significant, the signs of the *family size* and *user* coefficients from model 1 were negative which was not expected.

The positive and significant coefficient of *risk* indicates that more risk-averse consumers are likely to purchase service contracts. This result is similar to those of Padmanabhan (1995) and Eckel et al (1998). It is interesting to note that the choice of the risk measure was not essential. I am using question 13 from the survey in Appendix B as my measure of risk in the models. Using question 14 from the survey in the above models provides a coefficient of Risk that is also positive and significant.

Table 4. Logit results: Factors affecting the decision to purchase a service contract

The dependent variable is PURCHASE, which equals 1 if a contract was purchased.

	Model 1	Model 2
Risk	1.608 ***	1.731 ***
	(0.520)	(0.513)
Use	0.570	-
	(0.656)	
Female	0.225	-
	(0.437)	
Income	-0.140	-0.249 ^
	(0.201)	(0.170)
Experience	1.430	-
	(1.259)	
Length	0.380 **	0.305 *
	(0.194)	(0.184)
Price	-0.032	-0.038
	(0.042)	(0.038)
Over16	0.749 *	0.777 **
	(0.425)	(0.386)
User	-0.291	-
	(0.574)	
Married	0.260	-
	(0.384)	
Knowledge	-0.385 **	-0.362 **
	(0.171)	(0.160)
Loan	3.293 ***	3.335 ***
	(0.904)	(0.882)
Education	-0.208	-
	(0.189)	
Previous	0.880 ***	0.796 ***
	(0.298)	(0.275)
Maintenance	-0.258	-0.234
	(0.270)	(0.261)
Suvpick	-0.449	-
	(0.469)	
Family size	-0.030	-
	(0.155)	
Age	0.003	0.005
	(0.018)	(0.017)
Import	-1.183 **	-1.023 **
	(0.544)	(0.452)
Constant	-1.975	-2.138
	(1.839)	(1.705)
# observations	172	172
Model Chi-square	65.14 ***	60.11 ***
Log likelihood	-84.678	-87.194

*** indicates significance at 1 percent.
** indicates significance at 5 percent.
* indicates significance at 10 percent.
^ indicates significance at 15 percent.
Standard errors in parentheses.

The results from the "experience" group are mixed. The *knowledge* coefficient is significant and is negative as expected. This coefficient indicates the impact of the consumer's personal assessment of knowledge about the vehicles on the decision to purchase a service contract. It lends support to the conjecture that people who are more knowledgeable about automobiles are less likely to buy a service contract. The second variable in this group is *previous*. The positive and significant coefficient of *previous* service contract purchases is contradictory to my conjecture that individuals with prior experience with these contracts would be less likely to purchase a contract with the new vehicle. However, this result is not completely surprising. A business manager at one of the dealerships informed me that some individuals ask to buy service contracts before the manager has had the opportunity to make the sales pitch. There appear to be consumers that have had positive experiences with previous contracts.

There is strong support for the "time" conjectures. The coefficient of *length*, which measures the impact of length of ownership on the likelihood of a service contract purchase, is positive and significant. Padmanabhan (1995) and Eckel et al (1998) both find a similar result. The significantly positive coefficient of *loan* supports the conjecture that longer loan duration increases the likelihood of a service contract purchase. One could interpret this as indicative of myopic time preferences on the part of consumers who finance their vehicle over longer periods of time. Rather than think about the total cost of the vehicle and service contract, these customers may focus on the size of the monthly payment.

The negative *income* and positive *loan* coefficients suggest that low-income consumers and those new vehicle buyers who finance their purchase over longer time frames are more likely to purchase a service contract. A reason for this is that low-income buyers may not be able to afford a relatively expensive repair should one occur. To avoid this possibility, these consumers may choose to pay a slightly greater monthly payment to purchase a contract, particularly as the duration of the loan increases.

The coefficients for the "income" and "vehicle characteristics" groups were not statistically significant. Nevertheless, the coefficients for *income* and *price* are negative. The negative *income* coefficient suggests that individuals choose to self-insure as their income increases. The *price* coefficient reveals that consumers who purchase more expensive vehicles are less likely to purchase service contracts.

6. Misspecification testing and the notion of statistical adequacy

At this point, one may wonder about the statistical adequacy of the postulated model, the notion that the assumptions underlying the model are satisfied, and therefore the legitimacy of the inferences presented in the previous section. The importance of a statistically adequate model cannot be overstated. Regarding the underlying assumptions of a model, Spanos (2000) states, "When some of these assumptions are invalid the statistical inference results are, in general, invalid."

Misspecification testing for binary dependent variable modeling is not an entirely novel idea. According to Davidson and MacKinnon (1993), "… there is absolutely no excuse for the specifications of binary response models to be tested any less thoroughly than those of regression models." I will not claim that the tests presented here are the best possible for all situations, but that they are useful for testing the specification of my empirical model.

Misspecification testing is a bit more manageable if one has a notion of the assumptions underlying the model. Spanos (2000) has given a detailed specification for the logit model. This specification lists the five underlying assumptions, which allow for clearer testing. These assumptions are replicated below and appropriate misspecification tests are discussed. In each of the following assumptions y_k represents the dependent variable, x_k the dependent variables, and γ_k are the unknown parameters to be estimated with β representing the coefficients.

I test the specification, i.e. the underlying assumptions, of the reduced empirical model (Model 2).

Assumption 1. Bernoulli: $f(y_k \mid x_k; \gamma_k)$ is Bernoulli distributed

This assumption states that the conditional density of y_k on x_k is Bernoulli. There is no specific test necessary for this assumption. This assumption is satisfied as long as the dependent variable is binary, typically taking values of zero and one. This is true for my data set as the variable takes a value of one if a service contract is purchased, zero otherwise.

Assumption 2. Logit: $$E(Y_k \mid X_k = x_k) := F(\beta^T x_k) = \frac{\exp(\beta^T x_k)}{1+\exp(\beta^T x_k)}$$

This assumption states that the conditional mean follows the functional form on the right hand side of the equation. For the logit model this form is the logistic function. I am interested in testing this functional form against other alternatives. According to Davidson and MacKinnon

(1993), the best way to compare the performance of two or more binary dependent variable models estimated on the same data set, with the same index function, is to compare the loglikelihood functions. If the difference exceeds 1.92, half of the 5% critical value of the test statistic distributed as $\chi^2(1)$, reject the model with the lower loglikelihood function.

Table 5. Binary models with different CDFs

The dependent variable is PURCHASE, which equals 1 if a contract was purchased.

	Normal	Logistic	Cauchy
Risk	0.966 ***	1.731 ***	2.501 ***
	(0.286)	(0.513)	(0.903)
Income	-0.160 ^	-0.249 ^	-0.224
	(0.102)	(0.170)	(0.184)
Length	0.166 ^	0.305 *	0.437 *
	(0.108)	(0.184)	(0.229)
Price	-0.022	-0.038	-0.047
	(0.023)	(0.038)	(0.042)
Over16	0.452 **	0.777 **	0.873 **
	(0.226)	(0.386)	(0.434)
Knowledge	-0.212 **	-0.362 **	-0.363 *
	(0.094)	(0.160)	(0.221)
Loan	1.793 ***	3.335 ***	4.868 *
	(0.446)	(0.882)	(2.581)
Previous	0.447 ***	0.796 ***	0.916 ***
	(0.161)	(0.275)	(0.330)
Maintenance	-0.113	-0.234	-0.448 ^
	(0.151)	(0.261)	(0.304)
Age	0.001	0.005	0.004
	(0.010)	(0.017)	(0.022)
Import	-0.623 **	-1.023 **	-1.239 **
	(0.265)	(0.452)	(0.580)
Constant	-0.990	-2.138	-3.277
	(0.971)	(1.705)	(2.886)
# observations	172	172	172
Log likelihood	-87.788	-87.194	-85.771

*** indicates significance at 1 percent.
** indicates significance at 5 percent.
* indicates significance at 10 percent.
^ indicates significance at 15 percent.
Standard errors in parentheses.

I use three functional forms in this test: the normal cumulative distribution function (probit), the logistic function (logit), and the Cauchy cumulative distribution function. The functions are arranged in the order of increasing probability mass in the tails. Table 5 presents

the results of estimating the model with each of these functions. These estimations yield the following loglikelihood functions:

Normal CDF	-87.788
Logistic CDF	-87.194
Cauchy CDF	-85.771

Notice that the logit model does not appear to be rejected in favor of the probit or Cauchy cdf models. However, one can reject the probit as the difference in loglikelihood functions between the normal and Cauchy cdfs is 2.017. This suggests that a cdf with fatter tails has a better 'fit'. Since the Cauchy cdf does not present a statistically significant better fit versus the logistic, I use the logit model as the interpretation of results from this model is well known.

Assumption 3. Heteroskedasticity: $Var(Y_k \mid X_k = x_k) = F(\beta^T x_k)\,[1 - F(\beta^T x_k)]$

This assumption states that the conditional variance takes the functional form shown. This is equivalent to the 'traditional' assumption that the disturbance (error) term is heteroskedastic. In the description of the test below note that x_t represents independent variables, y_t represents the dependent variable, and u the error term from the postulated model. A variable in bold italics indicates the estimated value. All Greek letters are coefficients.

The test consists of the following:

1. Conduct logit analysis of the postulated model and obtain *u* and *y*. Square the residuals (*u*) and set up the following $u^2 - [(y)(1\text{-}y)] = w^2$ where w^2 is now the whitened residual squared. The heteroskedastic portion is being subtracted from the squared residual.
2. Run a normal linear regression of the following form $w^2 = \lambda_0 + \lambda_1 x_2 + \ldots + e_i$, where e_i is an error term. One can include other forms of the independent variables if desired.

The null hypothesis is that the coefficients λ_i (i≠zero) are equal to zero $H_0 : \lambda_i = 0$. If the coefficients are significant then there is a problem of additional heteroskedasticity (the heteroskedasticity should have been captured by the [(*y*)(1-*y*)]) indicating a violation of the assumption. This tests the functional form of the conditional variance.

The following linear regression is used for this test:

$$\begin{aligned}\text{Whitened Residual squared} = {} & \delta_0 + \delta_1\text{RISK} + \delta_2\text{INCOME} + \delta_3\text{LENGTH} + \delta_4\text{PRICE} + \\ & \delta_5\text{OVER16} + \delta_6\text{KNOWLEDGE} + \delta_7\text{LOAN} + \delta_8\text{PREVIOUS} + \\ & \delta_9\text{MAINTENANCE} + \delta_{10}\text{AGE} + \delta_{11}\text{IMPORT}\end{aligned}$$

The results of this test are presented in Table 6. The overall F-test suggests that the coefficients are jointly insignificant. The Price coefficient is significant at the 10 percent level but this does not appear to be indicative of any serious violation of this assumption.

Table 6. Linear regression results: Misspecification test for heteroskedasticity

The dependent variable is the whitened residual squared.

Coefficient	Value
Risk	0.014
	(0.036)
Income	-0.015
	(0.012)
Length	-0.018
	(0.013)
Price	-0.005 *
	(0.003)
Over16	-0.033
	(0.025)
Knowledge	0.008
	(0.011)
Loan	-0.013
	(0.041)
Previous	-0.004
	(0.020)
Maintenance	0.033 ^
	(0.021)
Age	0.000
	(0.001)
Import	-0.040
	(0.032)
Constant	0.084
	(0.125)
# observations	172
Overall F-test	0.99
R^2	0.064

*** indicates significance at 1 percent.
** indicates significance at 5 percent.
* indicates significance at 10 percent.
^ indicates significance at 15 percent.
Standard errors in parentheses.

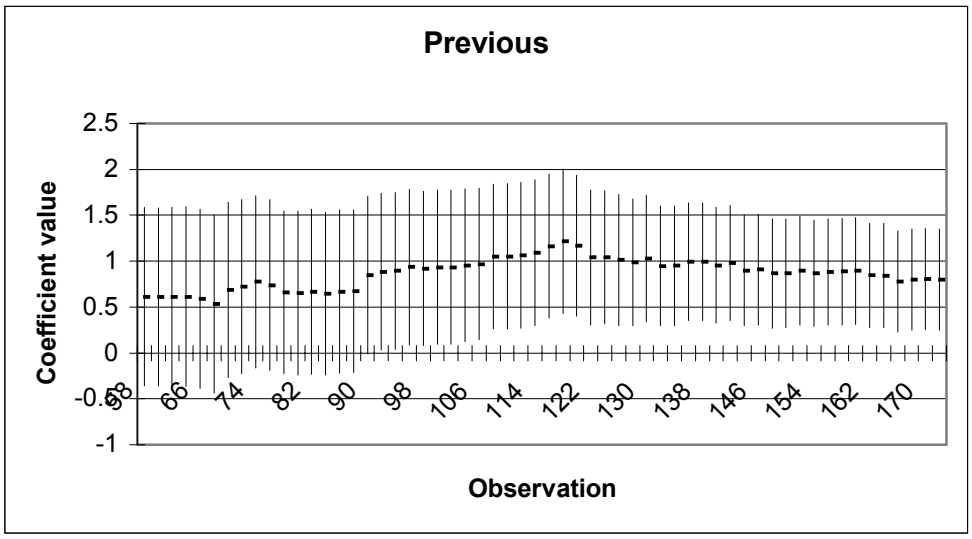
Assumption 4. index-homogeneity: the parameters β are not functions of $k \in \mathrm{N}$

Index-homogeneity is commonly known as parameter stability (or parameter constancy). This test is conducted through graphical analysis of the parameter values from recursive estimation. Recursive estimation involves estimating the empirical model with some portion of the data and then re-estimating the model with additional observations and examining the

behavior of the coefficients. The data are ordered by income and then date of purchase. I use a base of the first 60 observations and then add 2 observations in each of the following estimations. I plot the coefficients with ± two standard errors. An example, the chart for the *previous* coefficient, is shown below. If the coefficient is stable, it will converge and exhibit little variance. Considerable variation of the coefficient indicates the parameter is unstable and that little of the heterogeneity of the data is explained.

An examination of the chart reveals that the coefficient for *previous* service contract purchases appears to exhibit parameter stability. Charts for the other coefficients are similar indicating that they are invariant to additional observations.

Chart 1. Parameter stability of *previous* coefficient



Assumption 5. Independence: $\{(Y_k \mid X_k = x_k), k \in N\}$ is an independent process

On the surface this assumption appears straightforward and indicates that each observation should have no effect on the others. The data set in this analysis is a cross section of new vehicle buyers. Therefore, it seems like dependence should not be an issue – my decision to purchase a service contract should not affect some other consumer's decision. Nevertheless, thinking about this more closely reveals some possibilities for dependence across observations.

Table 7. Logit results: Models including dealership and manager dummies

The dependent variable is PURCHASE, which equals 1 if a contract was purchased.

	Model 3	Model 4
Risk	1.862 ***	1.667 ***
	(0.530)	(0.524)
Income	-0.283 ^	-0.226
	(0.175)	(0.173)
Length	0.310 ^	0.264
	(0.190)	(0.190)
Price	-0.043	-0.038
	(0.040)	(0.040)
Over16	0.742 *	0.798 **
	(0.390)	(0.385)
Knowledge	-0.335 **	-0.411 **
	(0.166)	(0.171)
Loan	3.406 ***	3.447 ***
	(0.901)	(0.924)
Previous	0.855 ***	0.717 **
	(0.283)	(0.293)
Maintenance	-0.195	-0.248
	(0.262)	(0.268)
Age	0.009	0.001
	(0.017)	(0.017)
Import	-0.372	-2.393 *
	(1.768)	(1.412)
Dealer 2	-0.293	-
	(0.703)	
Dealer 3	-0.718	-
	(1.810)	
Dealer 4	-1.389	-
	(1.165)	
Manager 2	-	-0.743
		(1.421)
Manager 3	-	0.794
		(1.387)
Manager 4	-	-0.940
		(0.693)
Manager 5	-	0.162
		(0.851)
Constant	-2.411	-1.012
	(1.831)	(1.885)
# observations	172	172
Pseudo R^2	0.264	0.274
Log likelihood	-86.281	-85.133

*** indicates significance at 1 percent.
** indicates significance at 5 percent.
* indicates significance at 10 percent.
^ indicates significance at 15 percent.
Standard errors in parentheses.

The most obvious links between the customers involve the dealerships and their employees. It is easy to investigate the role of the dealerships and business managers involved in selling the service contracts through nested testing. The restricted model is the reduced Model 2. The unrestricted models include dummy variables for the dealerships and business managers. The unrestricted models are presented in Table 7.

Notice that none of the coefficients for the dealerships or business managers are significant. Furthermore, likelihood ratio testing of Models 3 and 4 against Model 2 suggests that these factors did not significantly affect the decisions of the consumers in this sample.[5]

7. Conclusion

This paper presents an expected utility model representation of the consumer's decision to purchase a service contract. The implications of this model are derived allowing for testable hypotheses. I present a number of conjectures, many of which have not been investigated in prior research, including the effects of loan financing, number of driving age children in the household, experience with owning a vehicle, knowledge about breakdown and repair, and the type of vehicle purchased, regarding the consumer's decision to buy a service contract. The theoretical implications of the model and these conjectures addressing factors that may affect the purchase decision are empirically tested.

The empirical analysis presented suggests that risk aversion, length of ownership, children living with the consumer over the age of 16, financing the purchase with a loan, and previous service contract purchases increase the likelihood of a service contract purchase. Import buyers and consumers with higher levels of knowledge about vehicles are less likely to buy a service contract.

[5] The LR test statistic (coefficients equal to zero) for the dealership dummies is 1.82 with a p-value of 0.610. The LR test statistic for the manager dummies is 4.12 with a p-value of 0.390.

Chapter 2. Measuring ambiguity aversion

This chapter has been written jointly with professor Catherine Eckel, Department of Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061.

1. Introduction

One of the fundamental problems in the study of decision making is the analysis of choices under uncertainty, especially when the probabilities or payoffs to an event are unknown. Choices involving uncertain events can generally be classified in two categories: risky events and ambiguous events.[6] A risky event is an event that is typically thought of as having a clear probability for a given outcome: for instance a 10% chance at winning a prize of $50 in a raffle. Ambiguous events encompass a greater degree of uncertainty. This would include not only being unsure of the outcome of an event, but also not being sure of the probability of an event or the payoff associated with an event. Consider the question, "What is the chance that the transmission in your car will break in the next year, and how much will it cost to fix it?" In this case, neither the probability of breakdown nor the exact cost of the repair are known, though a

[6] Knight (1921) introduced a distinction between measurable uncertainty or risk, which can be represented by precise probabilities, and unmeasurable uncertainty, where the probabilities are unknown. Our paper addresses a somewhat different distinction. In our experiments the uncertainty is not unmeasurable, but rather the probability distribution over the unknown probability is known. Under this form of "weak" ambiguity probabilities are still measureable, but less transparent to the decision maker.

decision-maker may have some idea of the range of probabilities or payoffs. Many day-to-day decisions have these properties. As Heath and Tversky (1991) note, "The potential significance of ambiguity…stems from its relevance to the evaluation of evidence in the real world."

In this paper we investigate attitudes toward a particular type of ambiguity, where the probability distributions over the unknown parameter of the decision are known. This 'weak' ambiguity is the simplest form of ambiguity. The primary purpose of our research is to test a new instrument designed to measure attitudes toward weak ambiguity in gamble choices. Subjects complete a series of choice tasks in risky and ambiguous settings involving gambles for substantial financial stakes.

In all cases the distribution of the unknown parameter is given in a way that is transparent for the subjects. We include gambles at three different underlying probabilities (10, 50 and 90 percent), over gains and losses, and in two different decision frames (abstract and investment/insurance). These aspects of the experimental design are explained in detail below.

A secondary purpose of our experiment is to examine differences between women and men in their attitudes toward ambiguity. The typical stereotypes are that women are both more risk-averse and also more ambiguity-averse than men; that is women are more averse to variance in payoffs, and more averse to imprecision in the information about possible payoffs. If there is any validity to these stereotypes – and a considerable amount of experimental research supports differences, on average, between men and women – then attempting to understand the nature of such differences is a useful research program. (See Eckel and Grossman, 2001, for a discussion of differences in risk attitudes between women and men.) Furthermore, regardless of their validity, such stereotypes could have serious economic consequences. These may include limits on the professions or the range of positions available to women, product-marketing schemes targeted at either sex, and also may affect the evaluations of certain government policies.

2. An instrument for measuring attitudes toward risk and ambiguity

We have developed a new instrument for measuring attitudes toward risk and ambiguity in gambles for monetary stakes. The type of ambiguity that we are measuring is known as 'weak' ambiguity, where subjects are not only informed of the range of the ambiguity but also the second order, or underlying, distribution of the ambiguous aspect of the gamble. The use of weak ambiguity effectively creates a range of possible expected values for the gamble. In our experiments, the distribution of the unknown parameter is uniform. The payment procedure is

described in detail to subjects prior to filling out the decision sheets, and makes clear to subjects the distribution over possible probabilities or payoffs.

Our instrument is notably different from other instruments used to measure preferences toward risk and ambiguity. (The results of previous studies are discussed in more detail in section 6 below.) Other studies differ in the range of possible outcomes and in the number of decisions that subjects make. Powell and Ansic (1997) have three possible outcomes for the insurance gambles: no loss, the asset loses half of its value, and complete loss. They implement ambiguity through the use of five different charts with possible distributions of outcomes. We have two outcomes (no loss or complete loss) and a simpler implementation of ambiguity. Schubert et al (2000) use gambles that do not include a gain of zero or a loss of 100 percent. For example, in a risky gamble a subject might receive a large sum with a certain probability, p, and a smaller sum with probability 1-p. An ambiguous gamble is represented by two risky gambles with an equal likelihood of occurrence. This type of weak ambiguity does not appear to be as transparent as that used in our experiment.

A number of studies, especially those that consider ambiguity where the distribution is not known, involve the use of hypothetical stakes. For example, Hogarth and Kunreuther (1989) vary four factors in their experiment, which concerns a possible large loss. These factors are: the role of the subject as either firm or consumer, whether the situation involves ambiguity, the probability of loss, and the type of respondent. After stating the probability of loss, a comment regarding the certainty of this probability is given. In the nonambiguous or risky situation, the statement involves "feeling confident" about the probability. In the ambiguous situation the subject should "experience considerable uncertainty." The four probabilities are .01, .35, .65, and .90. These authors do not "play" the gambles. They do note the possible objection to their research for lacking incentives. Di Mauro and Maffioletti (1996) also use 4 possible probabilities in their experiments involving self-insurance and self-protection against losses. These are .03, .20, .50, and .80. They also choose to keep the subjects in the 'dark' about how the ambiguity will be resolved. As noted above, we explain every aspect of the ambiguity to the subjects in our experiment. Our work also differs from this and Hogarth and Kunreuther's as we use .10, .50, and .90 probabilities and also include a gain domain.

Other studies differ from ours in the asymmetry of information between the experimenter and the subject. Eisenberger and Weber (1995) implement ambiguity through three different

means: an Ellsberg urn, a past stock price for a bank, and a prior stock price for the same bank with additional information about other banks. In all of these cases the experimenter has full information about the ambiguity: she knows the balls in the urn and the previous stock price. This asymmetry of information between the subjects and the experimenter is not present in our experiment. It is possible that such an asymmetry may cause subjects to lower their valuations of an ambiguous gamble, not because of the ambiguity, but rather because they think they are playing against a stacked deck. Regarding the Ellsberg scenario, Dawes, Grankvist, and Leland (2000) note that, "…the problem might not be a concern about ambiguity so much as a concern about a 'stacked deck.'" Our procedure avoids this problem.

Our measure involves a series of choices between a risky or ambiguous gamble and a certain amount. Each choice involves a tradeoff between two types of choices in a decision sheet, modeled after the choice sheets developed in Holt and Laury (2000). In Table 1 we show one such decision sheet with ambiguity in probabilities. For each Decision, the subjects must choose between Option A and Option B. Note that Option A is constant for all decisions, and has an expected value of $25.00, while option B is a certain amount ranging from $16 for Decision 1 to $35 for Decision 20. Only an extremely risk- or ambiguity-averse person would prefer Option B at the top of the sheet, and only an extremely risk- or ambiguity-seeking person would prefer option A at Decision 20. While each sheet appears to involve numerous decisions, this is not really the case. The point where subjects cross over from preferring Option A to preferring Option B provides a measure of the subject's valuation of the ambiguous gamble. By comparing similar sheets with the same underlying probability of winning and payoff with varying degrees and types of ambiguity, i.e. expected values, we can measure subjects' aversion to weak ambiguity.

Table 1. A sample decision sheet with ambiguity in the probability

	Option A	Option B	Your Choice A or B
Decision 1	45-55% chance at winning $50	$16.00	
Decision 2	45-55% chance at winning $50	$17.00	
Decision 3	45-55% chance at winning $50	$18.00	
Decision 4	45-55% chance at winning $50	$19.00	
Decision 5	45-55% chance at winning $50	$20.00	
Decision 6	45-55% chance at winning $50	$21.00	
Decision 7	45-55% chance at winning $50	$22.00	
Decision 8	45-55% chance at winning $50	$23.00	
Decision 9	45-55% chance at winning $50	$24.00	
Decision 10	45-55% chance at winning $50	$25.00	
Decision 11	45-55% chance at winning $50	$26.00	
Decision 12	45-55% chance at winning $50	$27.00	
Decision 13	45-55% chance at winning $50	$28.00	
Decision 14	45-55% chance at winning $50	$29.00	
Decision 15	45-55% chance at winning $50	$30.00	
Decision 16	45-55% chance at winning $50	$31.00	
Decision 17	45-55% chance at winning $50	$32.00	
Decision 18	45-55% chance at winning $50	$33.00	
Decision 19	45-55% chance at winning $50	$34.00	
Decision 20	45-55% chance at winning $50	$35.00	

Decision used:_____ Die Throw:_____ Your Earnings:_____

Subjects complete a series of sheets, where the underlying probability, the range over probabilities, and the range over payoffs are varied. The full set of decision sheets is summarized in Table 2. For example, the sample decision sheet shown in Table 1 appears as sheet 10 in the gain domain of the table. The Option A choice consists of a 45-55% chance of winning a prize of $50. The Option B choice, the certain alternative, ranges from $16 for Decision 1 to $35 for Decision 20. The structure of the instrument prevents the subjects from stating certainty equivalents outside of a reasonable standard. For instance, there is no opportunity for a subject to state a certainty equivalent of greater than $50 for a gamble with a prize of $50. Our instrument measures preferences at three different base probability levels, 10%, 50%, and 90%. This allows us to explore systematic variations in aversion for different levels of underlying uncertainty.

We use two different ranges for ambiguity in the probability of an event: ranges of 10 and 20 percentage points (e.g., 85-95% or 80-100%). We also use several different ranges for ambiguity in payoffs, as shown in Table 2. We chose the levels of ambiguity over both probabilities and payoffs in part allows us to compare a subset of the choices that involve the same range of possible expected values. We also include gambles where there is *double ambiguity* in the sense that there is ambiguity in both the probability and the payoff. Subjects complete a subset of the sheets, making choices for different levels of ambiguity over both probabilities and payoffs, as described in the experimental design section below.

Table 2. Experimental design: Decision sheets

	Gain Domain (abstract and investment):			
	Option A choice		Option B choice:	
Decision sheet	Probability (%)	Prize ($)	Choice range: Minimum ($)	Maximum ($)
1	10	50	1	20
2	5-15	50	1	20
3	0-20	50	1	20
4	10	45-55	1	20
5	10	40-60	1	20
6	5-15	45-55	1	20
7	10	0-100	1	20
8	10	25-75	1	20
9	50	50	16	35
10	45-55	50	16	35
11	50	45-55	16	35
12	45-55	45-55	16	35
13	90	50	31	50
14	85-95	50	31	50
15	80-100	50	31	50
16	90	45-55	31	50
17	90	40-60	31	50
18	85-95	45-55	31	50
19	90	47-53	31	50
20	90	44-56	31	50

Table 2. Continued

	Loss Domain (abstract and insurance):			
	Option A choice		Option B choice:	
Decision sheet	Probability (%)	Prize ($)	Choice range: Minimum ($)	Maximum ($)
1	10	50	1	20
2	5-15	50	1	20
3	0-20	50	1	20
4	10	45-55	1	20
5	10	40-60	1	20
6	5-15	45-55	1	20
7	10	47-53	1	20
8	10	44-56	1	20
9	50	50	16	35
10	45-55	50	16	35
11	50	45-55	16	35
12	45-55	45-55	16	35
13	90	50	31	50
14	85-95	50	31	50
15	80-100	50	31	50
16	90	45-55	31	50
17	90	40-60	31	50
18	85-95	45-55	31	50
19	90	0-100	31	50
20	90	25-75	31	50

An important characteristic of our instrument is that there is no asymmetry of information between the experimenter and the subject. Chow and Sarin (2000) show that the asymmetry alone can significantly affect valuations. We use discrete uniform distributions as the second order distributions in the gambles involving weak ambiguity. To operationalize the ranges, the subject draws a chip from a box that contains 1 chip for each number in the range. For instance, in the example in Table 1 the box contains 11 chips. The subjects are informed in the instructions that there is only one chip for each number in a range and that this means that each chip has an equal likelihood of being drawn. The subjects also roll two ten sided dice to determine the outcome of a gamble. We conduct examples of winning and losing gambles, along with allowing the subjects to ask questions, to ensure that the subjects understand the nature of the ambiguity. Once all decisions are made, one decision is randomly selected for payment. Because neither the subject nor the experimenter knows the actual values of the

ambiguous variables, our design avoids asymmetry of information between the subject and the experimenter.

3. Experimental design

Our design elicits subjects' certainty equivalents using the instrument described above. The treatment combinations used in our experimental design vary the decision frame, and are shown in Table 3. Subjects complete either Set A or Set B of the decision sheets. Each subject completes a full set of decision sheets, giving valuations of risky and ambiguous gambles over both possible gains and possible losses, which allows us to explore asymmetries in preferences relative to a reference point. In addition, we use two different frames, describing the gambles as abstract "lotteries" or as "investments" or "insurance" decisions. We refer to the case of lotteries as the *abstract treatment* and the investment and insurance decisions as the *context treatment*.

Table 3. Experimental design: Treatment combinations

Treatment	Risk	Ambiguity in Probabilities	Ambiguity in Payment	Ambiguity in Probabilities and Payment
Abstract: Gain	Set A	Set A	Set A	Set A
Abstract: Loss	Set A	Set A	Set A	Set A
Investment	Set B	Set B	Set B	Set B
Insurance	Set B	Set B	Set B	Set B

Furthermore, the subjects face four different types of information in both decision frames and treatments. The 'risk' information frame has exact probabilities stated for the outcomes and the payments. Each of the ambiguity frames involves 'weak' ambiguity. Weak ambiguity, as described by Schubert et al (2000), implies that the distributions, for probabilities and for payments, are known and the second order distributions for these distributions are also known. In this experiment all second order distributions are uniform. In the 'ambiguity in probability' frames, the probability is stated as a range and the payment is fixed. Conversely, in the 'ambiguity in payment' frames, the probability is fixed and the payment is stated as a range. Finally, in the 'ambiguity in probability and payment' frames, ranges are stated for both the probabilities and payments.

4. Procedure and subject recruitment

Two pre-test sessions were conducted in Principles of Economics classes at Virginia Tech; 65 students participated in the two pre-test sessions (22 females and 43 males). Six laboratory sessions were conducted with 84 volunteer subjects (41 females and 44 males) recruited from other Principles of Economics classes. Table 4 shows the sex, number of participants, and average payment for the pre-tests and for each laboratory session.

Table 4. Sex, number of participants, and average payment for each session

Session	Abstract	Context	Average* Payment
	Lotteries	Invest/Insure	
Pre-test 1	18 males 11 females		$26.90
Pre-test 2		25 males 11 females	$34.70
Lab 1	8 males 7 females		$26.27
Lab 2		6 males 6 females	$32.58
Lab 3		6 males 7 females	$19.85
Lab 4	7 males 7 females		$31.79
Lab 5		9 males 6 females	$31.40
Lab 6	7 males 8 females		$34.00
Totals	40 males 33 females	46 males 30 females	$29.67

*Calculations for the average payments for the pre-test sessions are based on the payments received by the 10 students selected to be paid from each of these sessions.

Two instructors agreed to let us conduct the pre-test sessions in their classes. Students did not receive any form of class credit for participating and their course instructor was not present. Students were asked if they would like to stay for an economics experiment and informed that they would not be penalized if they did not wish to participate. The participants were informed at the start of the class that ten (roughly 1/3) of the subjects who participated, chosen randomly, would be paid for one of their own decisions.

In the pre-test sessions, after consent forms were distributed and completed, instructions and forms were distributed, illustrated on an overhead projector, and read aloud by the experimenters. The experimenters also simulated the procedure and payment method by

completing an experiment in the front of the room. In the simulation one of the experimenters acted as if she were participating in the experiment by completing an example decision sheet on a transparency and then drawing the appropriate chips to clarify the ambiguity, i.e., she drew a chip to determine the exact percentage out of the range of possible percentages. She then rolled the dice to determine the outcome. This was done in plain view of the subjects. The decision sheets were distributed in a randomized order that was the same for all participants. At the end of the experiment, the experimenter drew 10 subject numbers for payment and the rest were allowed to leave. These 10 subjects rolled a die to select a decision, then played that decision. They were then paid their earnings in private.

In the six laboratory sessions, which took place at the Laboratory for the Study of Human Thought and Action (LSHTA), all of the participants received a $5 payment for showing up and were paid for one of their own decisions chosen at random. We visited each section of the Principles courses at the start of class to announce that the students will be receiving an email to participate in an economics experiment. Subjects received emails that were sent to class listserves. Interested students responded to the email indicating the session that they would like to attend. Students who participated in other economics experiments involving risk were not allowed to participate. Efforts were made to ensure that there were roughly equal numbers of male and female participants.

The experimental procedure used in the laboratory sessions was almost identical to that used in the pretest sessions, except that all subjects were paid for one decision chosen at random. Subjects played their decisions and were paid in private.

The expected average payment to each subject for his or her decision is $25, in addition to a show up payment for those subjects attending the LSHTA sessions of $5. Actual average payment for the pretest sessions, for the 20 students who were chosen to be paid, was $30.80. The actual average payment for the laboratory sessions was $29.40, which includes the $5 show up payment. Each session lasted about 1 hour and 20 minutes.

5. Results

5.1. Descriptive Results

We first present the aggregate data by the level of ambiguity, for gains and losses, pooled over the abstract/context decision frames. (Appendix C contains the average valuation for each decision sheet.) Table 5 contains the average valuations. For the winning gambles, the

valuations represent the average minimum selling prices for each of the gambles. In the winning gambles, the subjects' valuations for low-probability gambles fall with increasing ambiguity in probabilities, from 10.19 to 9.42 to 8.42 as the range of probabilities goes from certain to a ten-point range to a 20-point range. However, ambiguity in payoffs has an inconsistent effect; increasing the range of payoffs from $50 to $45-55 decreases the valuation, but a further increase in the range to $40-60 actually increases the average valuation. Double ambiguity further decreases the valuation; the combination of 5-15% and $45-$55 gives a valuation that is lower than either ambiguity alone.

Table 5. Average valuations of gambles by ambiguity levels for gains and losses (pooled over decision frames)

Minimum Selling Price for WINNING GAMBLES			
	Payoff		
Probability	$50	$45-55	$40-60
10%	10.19	9.79	10.12
5-15%	9.42	9.21	.
0-20%	8.42	.	.
50%	24.11	24.14	.
45-55%	23.94	23.01	.
90%	41.56	40.98	40.53
85-95%	39.54	40.16	.
80-100%	40.75	.	.
Willingness to Pay to Avoid LOSING GAMBLES			
	Payoff (losses)		
Probability	$50	$45-55	$40-60
10%	9.55	9.51	9.74
5-15%	9.99	10.17	.
0-20%	10.69	.	.
50%	26.52	25.94	.
45-55%	25.95	25.46	.
90%	41.26	41.05	40.60
85-95%	41.14	40.85	.
80-100%	40.47	.	.

For mid-range probability gambles, the same pattern is evident, though the differences are small. For the high-probability gambles, ambiguity in probabilities has an inconsistent effect,

first falling for a 85-95% range, then increasing again for 80-100% (possibly because of some perceptual effect of including 100% in the range). Ambiguity in payoffs has a consistent negative effect on its own, with valuations falling form 41.56 to 40.98 to 40.53. Double ambiguity results in a valuation that is above the valuation for ambiguity in probabilities alone, but below the valuation for ambiguity in payoffs alone.

In the loss domain, for low probabilities of losing the endowment, willingness to pay to avoid the gamble increases in the ambiguity in probability, but shows inconsistent effects for ambiguity in the value of the loss. However, the opposite is the case for both middle and high probabilities of loss. In these cases the subjects are willing to pay less for insurance against ambiguous losses. Moreover, double ambiguity further reduces willingness to pay. Notice that willingness to pay to avoid the gambles decreases in both increases in ambiguity in probabilities and in the amount of the loss.

Table 6. Average valuations by decision frame

CONTEXT			
WINNING GAMBLES			
		Payoff	
Probability	$50	$45-55	$40-60
10%	10.78	9.74	10.43
5-15%	9.53	9.53	.
0-20%	7.92	.	.
50%	24.58	24.82	.
45-55%	25.11	23.28	.
90%	42.22	42.03	41.88
85-95%	40.55	41.07	.
80-100%	41.62	.	.
LOSING GAMBLES			
		Payoff	
Probability	$50	$45-55	$40-60
10%	8.75	8.96	8.90
5-15%	9.30	9.71	.
0-20%	9.93	.	.
50%	26.00	25.33	.
45-55%	25.69	25.29	.
90%	41.39	41.23	39.99
85-95%	41.13	40.21	.
80-100%	40.68	.	.

ABSTRACT			
WINNING GAMBLES			
		Payoff	
Probability	$50	$45-55	$40-60
10%	9.60	9.84	9.81
5-15%	9.32	8.89	.
0-20%	8.90	.	.
50%	23.64	23.45	.
45-55%	22.76	22.73	.
90%	40.90	39.92	39.17
85-95%	38.48	39.22	.
80-100%	39.88	.	.
LOSING GAMBLES			
		Payoff	
Probability	$50	$45-55	$40-60
10%	10.35	10.05	10.58
5-15%	10.68	10.63	.
0-20%	11.44	.	.
50%	27.01	26.56	.
45-55%	26.22	25.62	.
90%	41.11	40.88	41.21
85-95%	41.15	41.45	.
80-100%	40.25	.	.

Table 6 presents the average WTA and WTP for the each of the context and abstract treatments separately. This table shows that the subjects viewed the gambles in each treatment differently. The patterns in the gain domains of each treatment are similar except for the mid-range gambles. For the mid-range gambles, subjects in the context treatment prefer ambiguity in payoffs or probabilities to the risky gamble. However, these subjects prefer the risky gamble to the gamble with double ambiguity. The subjects in the abstract treatment are strictly ambiguity-averse for the mid-range gambles. In the loss domain the subjects in both treatments appear to prefer ambiguity in the probability as compared to the risky gamble for the gambles involving mid- and high-range probabilities of loss. However, the subjects prefer the risky gamble to the ambiguity in probability gambles for the low probability of loss.

The preferences for ambiguity in the payoffs are not as evident. The only clear case of ambiguity-aversion occurs for the high-range probability of winning in the gain domains of both treatments. As for the loss domain, both groups appear to prefer ambiguity in the payoff for the mid-range probability of loss. Subjects in the context treatment exhibit a preference for this type of ambiguity at the high probability of loss.

It is also possible to compare gambles that have not only similar expected values, but also similar expected value ranges. For example, a gamble of a 5-15% chance at winning $50 has a range of expected values from $2.50-7.50. A gamble of a 10% at winning $25-75 has the same range. A simple measure of the size of this range is its absolute value, which is labeled *Range* in the tables below. Of course, both gambles have an expected value of $5. Table 7 compares gambles with similar ranges for the pooled data and for the context and abstract treatments. These gambles are over possible gains. There are distinct trends in each treatment. In the context treatment, the subjects exhibit ambiguity-seeking behavior when the ambiguity is located in the probability in 4 of the 5 comparisons. This is indicated by their higher average certainty equivalents. The opposite is the case in the abstract treatment. In all 5 cases the subjects exhibit a preference for ambiguity in the amount of the prize. Means testing for each pair of gambles indicates that only 3 of pairings are significantly different. In each of these 3 cases, the preference is for ambiguity in the payoff.

5.2. Regression analysis

Perusing Appendix Table C, it is not clear if the differences in the average valuations are statistically significant. We are interested in determining what factors affect these valuations. Furthermore, we are interested in investigating whether the location of weak ambiguity, i.e. in the probability, payoff, or both, has any significant effect on the valuations. This section contains the results of regression analyses from Random Effects models, which allow us to control for individual effects.

Variables used in the regression analysis are defined in Table 8; Table 9 reports results from 5 econometric models, estimated separately for gains and losses.[7] The dependent variable in each model is the subjects' valuations.

Model 1

We see that the coefficients in both domains have the expected signs. In the gain domain, the positive coefficient for EV indicates that subjects are more willing to accept risk and ambiguity as the EV of the gamble increases. The negative coefficient on SD indicates that subjects are less willing to accept risk and ambiguity as the variance of the gamble increases. In the loss domain, the positive coefficient on EV indicates that subjects are more willing to pay to avoid risk and ambiguity as the expected loss increases. The negative coefficient on SD indicates that subjects are more willing to pay to avoid risk and ambiguity as the variance of the gamble increases.

To check for overall sex differences, a dummy variable for female was also included in this model (not shown). The coefficient was insignificant in both domains as indicated by likelihood-ratio tests for each domain. In the gain domain, the p-value was 0.17. The p-value for the loss domain was 0.19. Therefore we cannot reject the hypothesis that the coefficient on the dummy variable for female is equal to zero in either domain.

[7] A Wald test was conducted to see if the coefficients from the EV in the gain and loss domains are equal. The p-value of this test is 0.57. We cannot reject the null hypothesis that these coefficients are equal at any reasonable level of significance.

Table 7. Comparisons of gambles with similar expected value ranges

ALL OBSERVATIONS				CONTEXT				ABSTRACT			
Prob.	Payment	Range	WTA	Prob.	Payment	Range	WTA	Prob.	Payment	Range	WTA
5-15	50	5	9.42	5-15	50	5	9.53	5-15	50	5	9.32
10	25-75	5	9.19	10	25-75	5	8.79	10	25-75	5	9.55
0-20	50	10	8.42 **	0-20	50	10	7.92 **	0-20	50	10	8.90
10	0-100	10	10.16	10	0-100	10	10.85	10	0-100	10	9.53
45-55	50	5	23.94	45-55	50	5	25.11	45-55	50	5	22.76 †
50	45-55	5	24.14	50	45-55	5	24.82	50	45-55	5	23.45
85-95	50	5	39.54 *	85-95	50	5	40.55	85-95	50	5	38.48 **
90	47-53	5.4	40.56	90	47-53	5.4	40.13	90	47-53	5.4	40.95
80-100	50	10	40.75	80-100	50	10	41.62	80-100	50	10	39.88
90	44-56	10.8	40.31	90	44-56	10.8	40.45	90	44-56	10.8	40.18

† Statistically significant at the 10 percent level (one-sided test).
** Statistically significant at the 5 percent level (two-sided test).
*Statistically significant at the 1 percent level (two-sided test).

Table 8. Description of variables in regression models

EV	Expected value of gamble
SD	Standard deviation of gamble
Context	= 1 if context (investment/insurance) treatment = 0 if abstract (lotteries) treatment
Range	measure of ambiguity in the gamble (ex. A gamble of a 0-20% chance at $50 has a range of EVs of $0-10. The value of Range is therefore 10.)
Pay	= 1 if ambiguity in the payoff *only* of the gamble = 0 otherwise
Prob	= 1 if ambiguity in the probability *only* of the gamble = 0 otherwise
Both	= 1 if ambiguity in the probability and the payoff of the gamble = 0 otherwise
Female	= 1 if female = 0 if male
Checking	amount of money in checking account
Work	= 1 if employed = 0 otherwise
Econclasses	number of economics courses taken
GPA	grade point average
Birthorder	order in siblings (i.e eldest, 2nd child, etc.)
Sci/Eng	= 1 if Science or Engineering major = 0 otherwise
Eco/Bus	= 1 if Economics or Business major = 0 otherwise
d1	= 1 if gamble is 0-20% chance at winning $50 = 0 otherwise
d2	= 1 if gamble is 80-100% chance at winning $50 = 0 otherwise
d3	= 1 if gamble is 0-20% chance at losing $50 = 0 otherwise
d4	= 1 if gamble is 80-100% chance at losing $50 = 0 otherwise
d5	= 1 if gamble is 90% chance at losing $0-100 = 0 otherwise

* indicates an interaction between two variables.

Table 9. General econometric models. The dependent variable is the VALUATION of each gamble.

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Gain	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**
Intercept	7.65 **	-5.18 **	7.47 **	-5.46 **	8.13 **	-5.81 **	7.48 **	-5.38 **	7.50 **	-5.36**
	(0.46)	(0.46)	(0.55)	(0.54)	(0.66)	(0.66)	(0.55)	(0.54)	(0.56)	(0.55)
EV	0.78 **	0.78 *	0.78 **	0.77 **	0.77 **	0.76 **	0.78 **	0.77 **	0.78 **	0.78**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
SD	-0.13 **	-0.05 **	-0.14 **	-0.06 **	-0.15 **	-0.06 *	-0.13 **	-0.06 **	-0.13 **	-0.06**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Context			1.20 *	0.82	-0.10	1.53	1.21 *	0.82	1.21 *	0.82
			(0.57)	(0.53)	(0.94)	(0.93)	(0.56)	(0.53)	(0.57)	(0.54)
Range			-0.06 **	-0.01 *	-0.08 **	-0.01				
			(0.02)	(0.01)	(0.03)	(0.01)				
EV * Context					0.03 **	0.03 **				
					(0.01)	(0.01)				
SD * context					0.02	0.00				
					(0.04)	(0.04)				
Range * Context					0.03	-0.01				
					(0.04)	(0.01)				
Range * Pay							-0.03	-0.01 *	-0.03	0.00
							(0.02)	(0.01)	(0.02)	(0.01)
Range * Prob							-0.11 **	-0.03	-0.17 **	-0.02
							(0.03)	(0.03)	(0.05)	(0.05)
Range * Both							-0.09 **	0.00	-0.09 **	0.02
							(0.02)	(0.02)	(0.02)	(0.02)
d1									0.14	
									(0.57)	
d2									1.42 **	
									(0.55)	
d3										-0.73
										(0.61)
d4										0.82
										(0.59)
d5										-1.54
										(1.08)
R^2	0.871	0.869	0.872	0.870	0.872	0.870	0.872	0.870	0.873	0.870
Log likelihood	-7728	-7758	-7720	-7754	-7713	-7749	-7713	-7753	-7709	-7749
Number of Observations	2655	2618	2655	2618	2655	2618	2655	2618	2655	2618
Haus. Stat.	0.11	1.25	0.24	1.02	96.47	1.09	0.62	0.68	0.81	0.73
p-value	0.946	0.535	0.971	0.797	0.000	0.982	0.987	0.984	0.997	0.999

** indicates significance at 1 percent. Standard errors in parentheses.
* indicates significance at 5 percent.

Model 2

The addition of the context variable provides some interesting results. The coefficient is significantly positive in the gain domain. This suggests that subjects exhibit a greater WTA risk and ambiguity when the gambles are portrayed as investment opportunities. The differences due to framing in the loss domain are not significant.

The Range coefficient, which indicates if the gamble is ambiguous by the 'size' of the range of expected values, has the expected sign and is significant in both domains. This suggests that subjects exhibit aversion to ambiguity in the gambles.

Model 3

Including interaction terms between EV, SD, and Range with Context provides some interesting results. In the gain domain, notice that the coefficient on Context is no longer significant and the sign has reversed. The signs are positive on the coefficients of all three interaction terms. The coefficient for the interaction of EV and context is significant. This suggests that, as the EV increases, subjects in the context frame are more risk and ambiguity seeking than their counterparts in the abstract frame. However, the results of this estimation are suspect. The significance of the Hausman specification test suggests this model is misspecified.[8]

Things are a little different in the loss domain. The Range coefficient is no longer significant. However, the coefficient for the interaction of EV and context is significantly positive as it is in the gain domain. Here it suggests that, as the expected loss increases, subjects in the context frame are more risk and ambiguity averse than their counterparts in the abstract frame.

Model 4

The focus of this model is the effect of the 'location' of the ambiguity and its interaction with the Range. In the gain domain, notice that the coefficients on the interaction terms are negative and significant in two cases: with probability and with the case of 'both'. This suggests that subjects in this domain are ambiguity averse when the ambiguity is in the probability and when it is jointly in the probability and the payoff. Conversely, the subjects do not appear to view gambles with ambiguity solely in the payoffs significantly different from risky gambles in this domain.

[8] The Hausman specification test is discussed in more detail in chapter 3, section 5.4.

The negative signs for the interaction terms in the loss domain are as expected. Interestingly, the only significant coefficient is for the interaction of Range and ambiguity in the amount of the loss. This suggests that subjects are more averse to ambiguity in the size of the loss than in ambiguity in the probability of the occurrence of such a loss.

Model 5

This model is an extension of Model 4 that includes dummy variables for gambles that include endpoints. Endpoints are possible focal points such as 0%, 100%, $0, and $100. In the gain domain, the coefficient on the gamble with a range of 80-100% chance of winning is positive and significant. This suggests that subjects are ambiguity seeking with high probabilities of winning. None of the coefficients for the dummy gambles are significant in the loss domain. Nevertheless, it is interesting to note that the coefficient on the dummy for the 0-20% loss is negative. This suggests that subjects are ambiguity averse for small probabilities of loss. Likelihood-ratio testing was performed to investigate the joint significance of the gamble dummies in these models. We can reject the hypothesis that the dummy coefficients are jointly equal to zero. The p-value is 0.01 in the gain domain. The p-value is 0.04 in the loss domain.

Analysis of demographics

Table 10 presents the results from extending Model 1 from Table 9 to include individual demographic variables. The coefficients for the intercept, EV, SD, Range, and Context are significant and have the expected signs. None of the coefficients for the demographic variables are significant in the gain domain. Two of the demographic coefficients are significant in the loss domain. Notice the positive coefficient on the female variable, which indicates that these subjects are more risk and ambiguity seeking in the loss domain than their male counterparts. The coefficient on GPA is significantly negative indicating that the willingness to pay to avoid the possible loss increases as GPA increases. In other words, students with higher GPAs appear to be more risk and ambiguity averse over losses. We discuss the differences between decisions of women and men in more detail in section 7 below.

Table 10. Random effects model with demographic variables
The dependent variable is the VALUATION of each gamble.

	Gain	Loss
Intercept	9.59 **	-4.43 **
	(1.17)	(1.09)
EV	0.78 **	0.77 **
	(0.01)	(0.01)
SD	-0.14 **	-0.06 **
	(0.02)	(0.02)
Context	1.17 ^	1.18 *
	(0.60)	(0.55)
Range	-0.06 **	-0.01 *
	(0.02)	(0.01)
Female	-0.76	1.08 ^
	(0.62)	(0.57)
Checking	0.13	0.16
	(0.13)	(0.12)
Work	0.03	-0.95
	(0.63)	(0.58)
Econclasses	-0.29	0.61
	(0.45)	(0.41)
GPA	-0.33	-0.66 **
	(0.26)	(0.24)
Birthorder	-0.39	-0.37
	(0.31)	(0.29)
Sci/Eng	-1.39	-0.24
	(0.86)	(0.79)
Eco/Bus	-0.62	-0.60
	(0.68)	(0.62)
R^2	0.876	0.875
Number of Observations	2655	2618
Haus. stat.	0.29	0.61
p-value	0.963	0.895

** indicates significance at 1 percent.
* indicates significance at 5 percent.
^ indicates significance at 10 percent.
Standard errors in parentheses.

5.3. Comparison of our Results with other Research

Hogarth and Kunreuther (1989) conduct experiments involving ambiguity in insurance decisions where subjects responded as either firms or consumers. For comparative purposes we will focus on the findings regarding subjects making consumer decisions for insurance. These authors find that subjects are averse to ambiguity for low probabilities of loss but prefer ambiguity for high probabilities of loss. We find similar results in both our abstract and context

treatments. Fox and Tversky (1991) propose that ambiguity aversion, "… is produced by a comparison with less ambiguous events or with more knowledgeable individuals." This is referred to as the comparative ignorance hypothesis. They find support for this hypothesis through a series of experiments involving bets in the gain domain. Our results support this hypothesis in the gain domain. Subjects exhibit a preference for the risky rather than ambiguous gambles as indicated by the greater certainty equivalents. However, we do not find an overall support for this claim in the loss domain. We do find that subjects prefer the risky gamble at low probabilities of loss but we do not find that such a preference occurs at medium and high probabilities.

Di Mauro and Maffioletti (1996) examine the effects of ambiguity in the probability of loss on the values of self-insurance (reducing the size of a loss) and self-protection (reducing the probability of a loss). They present hypotheses related to the models of Einhorn and Hogarth (1985) and Gardenfors and Sahlin (1982). The hypothesis suggested by Einhorn and Hogarth's anchoring adjustment model is that individuals will switch from ambiguity aversion to preferring ambiguity as the probability of loss increases. The accompanying hypothesis for the Gardenfors and Sahlin maximin model is that subjects will be ambiguity averse regardless of the level of probability. Contrary to Di Mauro and Maffioletti, we find some support for Einhorn and Hogarth's model. Our subjects are ambiguity averse at the low probability of loss and slightly prefer ambiguity at the middle and high probabilities of loss. It is then clear that we did not find support for Gardenfors and Sahlin's maximin model. It is evident from tables 5 and 6 that our subjects did not, on average, behave according to expected utility theory.

Camerer and Kunreuther (1989) conduct experiments for insurance protection using double-oral auction markets. In these experiments the probabilities of loss are no greater than 50 percent, with the majority being 20 or 30 percent. They introduce ambiguity in the probability of loss through the use of discrete uniform distribution. The expected values of the probabilities of loss when the consumers are facing ambiguity are 10 and 30 percent. In their example, for a 20 percent loss the range of possible loss probabilities is from 0 to 40%. These authors find an insignificant price effect with consumer-only ambiguity. We have two instances of ambiguity in the probability for with an expected value of 10%. We do not find a significant price difference between the WTP to avoid the risky and ambiguous gambles with a range of 5-15% chance of

loss. However, we do find a significant difference between the risky (10%) and ambiguous (0-20%) chance of loss (p-value<.01).

6. Sex Differences

6.1. Descriptive results

Tables 11 and 12 mirror Tables 5 and 6, and contain the average difference between the valuations of women and men for the various levels of ambiguity. Table 11 contains overall results, pooling over the abstract and context treatments. In general, in the gain domain, men's valuations of the gambles exceed those of women, indicating that women are more risk averse. However, in the loss domain, the pattern is reversed; the negative signs indicate that men have lower valuations for the losses and are willing to pay more for insurance to avoid them. Men are more risk averse in the loss domain. For low-probability of winning gambles, the difference increases with increases in ambiguity, indicating that women are also more ambiguity averse than men in the gain domain. However the pattern for mid- and high-probability gambles is not consistent. It is also not consistent in the loss domain.

We will now investigate mean differences according to treatments. Table 12 lists the average differences between women and men for the context and abstract treatments separately. In the context treatment, men consistently give higher valuations than women in the gain domain, but results in the loss domain are mixed, with the signs of the differences varying. In the abstract treatment, the results in the gain domain are inconsistent, but in the loss domain, men are consistently willing to pay more to avoid the loss than women. In both cases the patterns are similar: men have a greater preference for risk in the gain domain than in the loss domain, and the valuations of men relative to women are higher in the context treatment.

There are other points of interest in the above tables. Both sexes are risk and ambiguity seeking for low probabilities of winning a gamble and risk and ambiguity averse for high probabilities in either context. Both sexes are slightly risk and ambiguity averse for middle probabilities in the abstract treatment while men appear risk and ambiguity neutral in the context treatment.

Table 11. Average differences in valuations between males and females by ambiguity levels for gains and losses (pooled over decision frames)

Average Difference in Valuation (Male minus Female) WINNING GAMBLES			
	Payoff		
Probability	$50	$45-55	$40-60
10%	0.53	1.04	1.09
5-15%	0.24	1.70	.
0-20%	1.23	.	.
50%	0.64	0.61	.
45-55%	0.42	0.48	.
90%	0.86	1.79	0.20
85-95%	0.48	1.17	.
80-100%	0.61	.	.

Average Difference in Willingness to Pay (Male minus Female) LOSING GAMBLES			
	Payoff (losses)		
Probability	$50	$45-55	$40-60
10%	-0.48	-0.05	-0.27
5-15%	-0.80	-0.91	.
0-20%	-1.45	.	.
50%	-0.29	-0.54	.
45-55%	-1.62	-0.50	.
90%	-0.69	-0.23	-0.91
85-95%	-0.33	-0.08	.
80-100%	-0.50	.	.

Table 12. Average differences in certainty equivalents between males and females by ambiguity levels for gains and losses by decision frame

CONTEXT			
Average Difference in Valuation (Male minus Female)			
WINNING INVESTMENTS			
	Payoff		
Probability	$50	$45-55	$40-60
10%	0.48	1.23	1.10
5-15%	1.54	1.61	.
0-20%	1.96	.	.
50%	1.86	2.60	.
45-55%	0.77	0.81	.
90%	2.79	2.92	0.51
85-95%	2.10	3.14	.
80-100%	2.51	.	.
LOSING INVESTMENTS			
	Payoff		
Probability	$50	$45-55	$40-60
10%	1.64	1.37	1.52
5-15%	0.84	-0.46	.
0-20%	0.58	.	.
50%	0.06	0.24	.
45-55%	-1.32	-0.34	.
90%	-0.29	1.38	-0.15
85-95%	0.09	0.03	.
80-100%	-0.66	.	.

ABSTRACT			
Average Difference in Valuation (Male minus Female)			
WINNING GAMBLES			
	Payoff		
Probability	$50	$45-55	$40-60
10%	0.40	0.88	1.00
5-15%	-1.06	1.71	.
0-20%	0.71	.	.
50%	-0.67	-1.50	.
45-55%	-0.27	0.08	.
90%	-1.17	0.40	-0.59
85-95%	-1.47	-1.04	.
80-100%	-1.46	.	.
LOSING GAMBLES			
	Payoff		
Probability	$50	$45-55	$40-60
10%	-2.81	-1.54	-2.25
5-15%	-2.58	-1.49	.
0-20%	-3.56	.	.
50%	-0.81	-1.48	.
45-55%	-2.01	-0.70	.
90%	-1.06	-1.69	-1.76
85-95%	-0.73	-0.38	.
80-100%	-0.29	.	.

Conversely, in the loss domain, both sexes are risk and ambiguity averse for low probabilities of loss and risk and ambiguity seeking for high probabilities in both contexts. In the abstract treatment, men exhibit risk and ambiguity aversion while the women are closer to risk and ambiguity neutrality for middle probabilities. Both sexes are closer to risk and ambiguity neutrality for the middle probabilities of loss in the context treatment.

6.2. Regression Analysis

Table 13 presents the various gambles as they are used as dependent dummy variables in the regression analysis that follows. In each model, the dummy variable L9, which has an expected value of ± 25, is the base category.

Table 13. Description of dummy variables

	RISK		Ambiguity in Probability		GAIN Ambiguity in Payment		LOSS Ambiguity in Payment		Ambiguity in Both	
	Probability	Payment	Probability	Payment	Probability	Payment	Probability	Payment	Probability	Payment
L1	10	50	5-15	50	10	45-55	10	45-55	5-15	45-55
L2	90	50	0-20	50	10	40-60	10	40-60	85-95	45-55
L3			85-95	50	10	0-100	10	47-53		
L4			80-100	50	10	25-75	10	44-56		
L5					90	45-55	90	45-55		
L6					90	40-60	90	40-60		
L7					90	47-53	90	0-100		
L8					90	44-56	90	25-75		
L9	50	50	45-55	50	50	45-55	50	45-55	45-55	45-55

Schubert et al. (1999) state that, "…gender differences in risk attitudes are possibly confounded with wealth effects due to gender-specific income differences outside of the laboratory." It is reasonable to assume that such differences in attitudes towards ambiguity are also possible. We used Random Effects regression models to investigate sex differences in behavior toward risk and ambiguity controlling for wealth effects. However, unlike this prior work, we do not use income as the variable to measure wealth. We use two measures: the current dollar amount in each subject's checking account and whether or not that subject has a job.

We include a dummy variable indicating if the subject is a female to capture sex differences. The coefficient on this variable measures the difference in the valuations between male and female subjects.

The regression results for the abstract treatment are presented in Table 14. The regression results for the context treatment are presented in Table 15.

Table 14. Sex differences in the abstract treatment, controlling for wealth effects
The dependent variable is the VALUATION of each gamble.

ABSTRACT								
	RISK		Ambiguity In Probability		Ambiguity In Payoff		Ambiguity In Both	
Frame	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**
Intercept	24.36**	-27.55**	23.48**	-27.62**	24.77**	-27.16**	24.34**	-26.65**
	(1.28)	(1.08)	(1.14)	(1.06)	(1.12)	(1.16)	(1.17)	(1.21)
Female	**0.19**	**1.50***	**0.26**	**1.99****	**-0.36**	**1.93***	**-0.81**	**1.08**
	(1.07)	(0.87)	(0.93)	(0.85)	(0.91)	(0.92)	(0.98)	(1.00)
Checking	-0.21	-0.04	-0.20	0.13	-0.29	-0.07	-0.33^	0.13
	(0.21)	(0.17)	(0.18)	(0.17)	(0.18)	(0.18)	(0.20)	(0.20)
L1	-13.95**	16.67**	-13.52**	15.50**	-13.59**	16.51**	-13.79**	15.04**
	(0.68)	(0.79)	(0.70)	(0.70)	(0.66)	(0.79)	(0.64)	(0.74)
L2	17.28**	-14.09**	-13.91**	14.77**	-13.66**	15.99**	16.53**	-15.80**
	(0.68)	(0.79)	(0.70)	(0.70)	(0.65)	(0.80)	(0.64)	(0.74)
L3			15.67**	-14.92**	-14.09**	16.14**		
			(0.71)	(0.70)	(0.77)	(0.93)		
L4			17.13**	-13.98**	-14.09**	16.16**		
			(0.70)	(0.70)	(0.77)	(0.93)		
L5					16.47**	-14.31**		
					(0.65)	(0.80)		
L6					15.72**	-14.64**		
					(0.65)	(0.79)		
L7					17.32**	-15.31**		
					(0.77)	(0.95)		
L8					16.55**	-15.28**		
					(0.77)	(0.94)		
R^2	0.852	0.859	0.871	0.878	0.890	0.871	0.864	0.851
Number of Observations	217	214	357	357	535	533	215	216
Haus. stat.	0.00	1.47	0.00	0.00	0.09	1.13	0.00	0.46
p-value	1.000	0.480	1.000	1.000	1.000	0.997	1.000	0.795

** indicates significance at 1 percent.
* indicates significance at 5 percent.
^ indicates significance at 10 percent.
Standard errors in parentheses.

Abstract Treatment

There is no significant difference between the male and female subjects in behavior in the risky or ambiguous gambles in the gain domain. However, sex differences appear in the loss domain. The positive coefficients for the Female variable indicate that women subjects are more

risk and more ambiguity seeking than their male counterparts. The coefficient is significant for the risky, ambiguous in probability, and ambiguous in payment information frames.

Table 15. Sex differences in the Context treatment, controlling for wealth effects
The dependent variable is the VALUATION of each gamble.

CONTEXT								
	RISK		Ambiguity In Probability		Ambiguity In Payoff		Ambiguity In Both	
Frame	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**
Intercept	23.37**	-26.84**	24.31**	-26.26**	23.78**	-25.71**	22.56**	-25.90**
	(0.93)	(1.01)	(1.02)	(0.92)	(0.92)	(0.97)	(0.99)	(1.01)
Female	**-1.44^**	**-0.21**	**-1.50^**	**0.18**	**-1.35^**	**-0.61**	**-1.66^**	**0.33**
	(0.77)	(0.87)	(0.89)	(0.75)	(0.75)	(0.79)	(0.88)	(0.87)
Checking	0.44**	0.24	0.34*	0.13	0.40**	0.15	0.35**	0.13
	(0.15)	(0.17)	(0.17)	(0.15)	(0.15)	(0.15)	(0.17)	(0.17)
L1	-13.84**	17.20**	-15.50**	16.41**	-15.15**	16.34**	-13.83**	15.53**
	(0.82)	(0.79)	(0.71)	(0.74)	(0.76)	(0.79)	(0.68)	(0.79)
L2	17.64**	-15.43**	-17.08**	15.79**	-14.43**	16.47**	17.74**	-14.99**
	(0.81)	(0.78)	(0.72)	(0.74)	(0.76)	(0.79)	(0.68)	(0.79)
L3			15.40**	-15.51**	-13.49**	17.32**		
			(0.71)	(0.74)	(0.93)	(0.98)		
L4			16.54**	-15.03**	-15.54**	15.97**		
			(0.71)	(0.74)	(0.93)	(0.96)		
L5					17.12**	-15.86**		
					(0.76)	(0.80)		
L6					17.00**	-14.76**		
					(0.76)	(0.80)		
L7					15.73**	-17.44**		
					(0.92)	(0.97)		
L8					16.06**	-15.26**		
					(0.92)	(0.96)		
R^2	0.867	0.872	0.886	0.887	0.887	0.883	0.875	0.855
Number of Observations	220	215	363	361	526	511	222	211
Haus. Stat.	1.36	1.56	0.00	0.41	3.57	159.86	0.43	2.57
p-value	0.508	0.457	1.000	0.982	0.894	0.000	0.806	0.276

** indicates significance at 1 percent.
* indicates significance at 5 percent.
^ indicates significance at 10 percent.
Standard errors in parentheses.

Context Treatment

The results in this treatment differ from those above. There is a significantly negative effect in the gain domain for all information frames. This suggests that female subjects are more risk averse and more ambiguity averse than the male subjects. This is not surprising given that

the average WTP for females was lower than that of the males for all of the gambles in the gain domain of this treatment (see Table 12).

The sex differences disappear in the loss domain. The estimated coefficient for the Female variable is not significant in any of the information frames.

The variable for the subjects' work status was not included in the above tables as it was found insignificant in all of the regressions. None of the subjects worked in a full-time job. This indicates that having a part-time job had no effect on the decisions in this experiment.

The estimated coefficient on Checking is insignificant in the gain domain of the abstract treatment. It is insignificant in all but one of the information frames of the loss domain. Overall, this suggests that the subjects' current holdings of cash in checking accounts does not have any effect on decisions in the abstract treatment. This is not the case in the context treatment. The estimated coefficient is significantly positive in the gain domain for each information frame. It appears that subjects' willingness to accept risk and ambiguity increases as the cash in checking accounts increase. The estimated coefficient is insignificant in the loss domain of the context treatment.

Of course all of the gamble dummies are significant and have the expected signs. In the gain domain the coefficients of gambles with an expected gain of $5 are negative (indicating a valuation which is lower than that of gambles with an expected gain of $25) and the coefficients of those gambles with an expected gain of $45 are positive. Similarly, in the loss domain the coefficients are positive for those gamble with an expected loss of $5 (indicating a lower WTP to avoid a gamble as opposed to gambles with an expected loss of $25) and those of gambles with expected losses of $45 are negative. However, inference from one of the estimations, the ambiguity in payoff model for the loss domain, is possibly invalid. The significant Hausman test statistic suggests this model is mispecified.

6.3. Comparison to other studies

Schubert et al (1999) and (2000) find no significant differences in the preferences of men and women regarding risk in the investment contexts of their experiments. We find that the female subjects are more risk averse in our investment setting. In their abstract treatment, Schubert et al (1999) report that the female subjects are more risk averse over gains. We found no significant difference between the behavior of the male and female subjects. Powell and

Ansic (1997) conduct two studies for sex differences regarding risk preference. The comparable study with our research is the insurance study. They find that females are more risk averse than males. We did not find a significant difference in behavior in our insurance treatment.

Some of our results directly support the findings in these papers. Schubert et al (2000) find that female subjects are more ambiguity averse than their male counterparts in the investment context and no significantly different behavior in the insurance setting. We find similar results. Furthermore, Schubert et al (1999) find that females are more risk prone over losses in the abstract context. This is also the case in the present analysis.

7. Summary and discussion

We have attempted to investigate possible differences in behavior with regard to unambiguous (or risky) and ambiguous decision-making. We conducted an experiment using gambles designed to elicit responses in these types of situations which are comparable. Furthermore, we included ambiguity in each aspect of the gamble: the probability, the outcome, and in both the probability and the outcome simultaneously. This experiment was designed so that the level of information of the subject is equal to that of the experimenters. This was done to eliminate any "Comparative Ignorance Effects" as discussed by Fox and Tversky (1995) and Chow and Sarin (2000).

We found that there were treatment effects. Subjects exhibited greater risk seeking when the gambles were framed as investment opportunities. There were no significant treatment effects in the loss domain. We also found some rather interesting results regarding the 'location' of the ambiguity. In the gain domain, subjects exhibit significantly greater ambiguity aversion if the ambiguity is in the probability of the event occurring and also in the case where there is ambiguity in both the probability of the outcome and the amount of the outcome. The opposite was true in the loss domain. The subjects exhibited greater ambiguity aversion when the ambiguity was solely in the outcome. In this case, the actual amount that could be lost.

We also found some evidence of sex differences in decision-making. Using the pooled data, women exhibited more risk averse behavior in the gain domain and more risk seeking behavior in the loss domain than men. Delving further into the nature of this behavior, we found that women were significantly more risk and ambiguity seeking over losses in the abstract (gambles framed as lotteries) treatment. Conversely, women were more risk and ambiguity averse over gains in the context (gambles framed as investments) treatment.

We find that subjects exhibit behavioral differences in unambiguous (risky) and transparent ambiguous situations involving uncertainty. Furthermore, the location of this ambiguity is also significant. Additional research is necessary to further clarify the role ambiguity plays in decision making.

Chapter 3. Attitudes toward uncertainty and the service contract purchase decision

1. Introduction

Almost a third of new vehicle buyers purchase a service contract, also know as an extended warranty, when they purchase their new vehicles. These contracts typically provide coverage after the base warranty has expired for up to 7 years or 100,000 miles. This does not cover routine maintenance or repairs due to excessive use. Service contracts have considerable markup, up to 100%, and prices of up to $1,800. Numerous car-buyers guides recommend against the purchase of a service contract.

Given the high cost of service contracts and lack of endorsement from automotive guides, why do so many consumers purchase these items? What are the characteristics of these consumers and what attracts them to service contracts? This paper addresses these questions using the results from a follow-up study of a subset of the consumers surveyed in Chapter One. This involves the collection of additional survey data and an experiment designed to elicit attitudes toward uncertainty. My goal is to investigate which factors are useful in discriminating service contract purchasers from non-purchasers. A novel approach of this paper is the combination of survey and experimental data, which is collected from actual new vehicle buyers. I demonstrate that, in addition to those factors discussed in Chapter One, other factors such as number of vehicles and drivers in the household are significant in explaining service contract

demand. I also show that various measures of attitudes toward uncertainty do not consistently discriminate between purchasers and non-purchasers.

2. Background and research design

2.1. The purchase decision

The dealerships that participated in this research shared a similar order of events in selling a vehicle and the service contract offer. First the customer decides on a vehicle while dealing with a salesperson. Then the customer is taken to another employee who offers the service contract, presents financing options, and finalizes the total sale.

The major limitations of service contracts were mentioned in the introduction: high cost, considerable markup, and limited coverage. However, there are some benefits to purchasing a service contract. These may include roadside assistance, coverage of some minimal routine maintenance, and transferability that can increase the value of the vehicle if the original buyer decides to sell it. In an open-ended question in the original survey regarding attitudes about these contracts, service contract buyers tend to mention the "peace of mind" received from the purchase.

Acknowledging that service contracts have some benefits, the anomaly lies in the fact that these consumers are willing to pay a rather large premium for this coverage. The excessive cost and markup of service contracts has been noted by automotive guides (e.g. AAA, 2001; Ultimate Car Book, 2001), general guides (Consumer Reports, 2001), and newspaper and magazine articles.[9]

Chapter One provides a thorough review of the literature regarding factors affecting the demand for service contracts. These include risk attitudes, usage levels, base warranty length (Padmanabhan and Rao, 1993; Padmanabhan, 1995), and sociodemographic characteristics (Day and Fox, 1985). I found that that risk attitudes, length of ownership, previous service contract purchases, loan duration, children in the household over the age of 16, manufacturers' country of origin, and knowledge of vehicles are all significant factors affecting the service contract purchase decision.

2.2. Outline of the research design

[9] Service contracts have also been mentioned in popular culture. Columnist Dave Barry writes, "Stores *love* service agreements, for the same reason you'd love to have money fall on you from the sky." (Richmond Times Dispatch, 2001) In the TV show "The Simpsons", Moe drives a crayon into Homer's brain to make him stupid. Moe decides that Homer is stupid when Homer declares, "Extended warranties, how could I lose?"

To explore the determinants of service contract demand in more detail, I conducted follow-up studies, consisting of surveys and experiments, using individuals who purchased new vehicles from dealerships in Christiansburg and Richmond, Virginia. An aim of this paper is to explore the predictive power and external validity of experimental methods in insurance decisions. Forty-five new vehicle buyers participated in a study with each study lasting approximately 1 hour and 10 minutes. Participants were paid a $30 show-up fee and earned additional money in the study. The study was designed so that the average subject payment would be $90. Actual average earnings were $102.55.

I collected survey information on 191 new vehicle buyers. This survey, in Appendix B, asked for information about the vehicle's characteristics and usage, risk attitudes (in hypothetical situations), and a number of sociodemographic attributes. The survey used in the follow-up study allowed me to collect information regarding research efforts about new vehicles, other vehicles owned, ability to find rides in case of breakdown, reliability and repair expectations, and familiarity with extended warranties among other items. The follow-up survey is in Appendix D.

The follow-up study was conducted for two reasons. The first was that I could ask for information that I felt was relevant to the service contract purchase decision but was not able to ask for on the original survey. The dealerships would not distribute a survey that was longer than three pages. This limitation forced me to cut some questions from the original. More importantly, the dealerships limited the types of questions that could be asked on the original survey. They did not want any questions that might affect the customers' decisions *unless* it might increase the likelihood of a service contract purchase. I was not able to ask any questions about perceived reliability, repair frequencies, or the availability of substitutes for the new car. There were no limitations on what could be asked in the follow-up study.

The second reason for the follow-up was to conduct an experiment designed to measure the new vehicle buyers' attitudes toward uncertainty. I test the power of these measures in predicting service contract purchases in section 6.2.

I recruited subjects for the follow-up study by sending a mailing to the customers who completed the survey used in Chapter One. This mailing listed my contact information, a brief description of the study, and informed them that they would soon be receiving a call from me asking if they would be interested in participating. Of the 191 new vehicle buyers who

completed the original survey, 45 participated in the follow-up study for a participation rate of 23.6 percent.

Upon entering the follow-up study, the subjects completed a survey and were informed that they earned an additional $60 for answering it. I then explained that they would take part in an experiment where they would have an opportunity to gain additional money and also face the possibility of losing some of the $60 they earned from completing the survey.

2.3. Experimental design

I use the instrument developed in Chapter Two. Subjects complete a series of lottery choice tasks designed to elicit certainty equivalents for a variety of gambles. The instructions are presented in Appendix E. The gambles included variations "…in the underlying probability, the range over probabilities, and the range over payoffs." The subjects completed similar tasks in gain and loss domains. In the gain domain the gambles were framed as investment opportunities. In the loss domain the gambles were framed as insurance decisions. An example of an "investment opportunity" is presented in Table 1.

Decision tasks such as those in Table 1 elicit the willingness-to-accept for the gambles. Firm A is described as a risky investment and Firm B as an investment with a certain return. For the tasks in the loss domain, the first option is described as taking a chance on paying for a repair and the second option as paying for insurance. This elicits the willingness-to-pay to avoid the gamble.

The various gambles are presented in Table 2. The ranges in either the probability or dollar amount introduce "weak ambiguity" in the gambles. I use discrete uniform distributions so that each number in a range is equally likely. Weak ambiguity basically implies compound lotteries.

All of the subjects completed the 20 gambles in the gain and loss domains. 23 subjects completed the gain domain first. 22 subjects completed the loss domain first. The order of the gambles in each domain was randomized.

Table 1. A sample decision sheet

	Firm A	Firm B	Your Choice A or B
Decision 1	85-95% chance at $50	$31.00	
Decision 2	85-95% chance at $50	$32.00	
Decision 3	85-95% chance at $50	$33.00	
Decision 4	85-95% chance at $50	$34.00	
Decision 5	85-95% chance at $50	$35.00	
Decision 6	85-95% chance at $50	$36.00	
Decision 7	85-95% chance at $50	$37.00	
Decision 8	85-95% chance at $50	$38.00	
Decision 9	85-95% chance at $50	$39.00	
Decision 10	85-95% chance at $50	$40.00	
Decision 11	85-95% chance at $50	$41.00	
Decision 12	85-95% chance at $50	$42.00	
Decision 13	85-95% chance at $50	$43.00	
Decision 14	85-95% chance at $50	$44.00	
Decision 15	85-95% chance at $50	$45.00	
Decision 16	85-95% chance at $50	$46.00	
Decision 17	85-95% chance at $50	$47.00	
Decision 18	85-95% chance at $50	$48.00	
Decision 19	85-95% chance at $50	$49.00	
Decision 20	85-95% chance at $50	$50.00	

Decision used:_____ Die Throw:_____ Your Earnings:_____

Table 2. Experimental design: Decision sheets

Gain domain: Investment opportunities				
	Option A choice		Option B choice	
Decision Sheet*	Probability (%)	Amount ($)	Min	Max
1	10	50	1	21
2	10	45-55	1	21
3	10	40-60	1	21
4	5-15	50	1	21
5	5-15	45-55	1	21
6	0-20	50	1	21
7	25	50	1	21
8	25	40-60	1	21
9	15-35	50	1	21
10	50	50	16	36
11	0-100	50	16	36
12	75	50	31	51
13	75	40-60	31	51
14	65-85	50	31	51
15	90	50	31	51
16	90	45,55	31	51
17	90	40,60	31	51
18	85-95	50	31	51
19	85-95	45,55	31	51
20	80-100	50	31	51

* Decision sheets were randomized within each domain.

After completing the decisions for both domains, one decision in each domain was chosen randomly and the subjects were paid for any additional earnings from the gain domain and had to pay for any losses incurred in the loss domain.

Table 2 continued

Loss Domain: Insurance decision				
	Option A choice		Option B choice	
Decision Sheet*	Probability (%)	Amount ($)	Min	Max
1	10	50	0	20
2	10	45,55	0	20
3	10	40,60	0	20
4	5-15	50	0	20
5	5-15	45,55	0	20
6	0-20	50	0	20
7	25	50	0	20
8	25	40-60	0	20
9	15-35	50	0	20
10	50	50	15	35
11	0-100	50	15	35
12	75	50	30	50
13	75	40-60	30	50
14	65-85	50	30	50
15	90	50	30	50
16	90	45,55	30	50
17	90	40,60	30	50
18	85-95	50	30	50
19	85-95	45,55	30	50
20	80-100	50	30	50

* Decision sheets were randomized within each domain.

The majority of the sessions were conducted at the Laboratory for the Study of Human Thought and Action at Virginia Tech, the School of Business at Virginia Commonwealth University, and Mills E. Godwin High School. A few sessions were conducted at other locations to allow for greater subject participation.

3. A representative sub-sample

It is of interest to see if the participants in the follow-up study are representative of the group that completed the original survey. Table 3 presents some descriptive statistics of the original group and the sub-sample.

The statistics are similar for the original group and the follow-up participants. Roughly 40 percent of new vehicle buyers in both groups purchased service contracts. This is above the 30-35 percent national average. Slightly more females participated in the follow-up than

completed the original survey and the same is true of married individuals. Note that the members of both groups ranked their knowledge of vehicle repair likelihood and cost as close to that of the "average buyer." The participants have achieved a slightly higher level of education.

Table 3. Descriptive statistics of original group and participants

Variable	Description	Original group 186 obs. Mean	Std. Dev.	Follow-up Participants 45 obs. Mean	Std. Dev.
Service contract	Percentage of subjects who purchased a SC	42.0	(49.5)	40.0	(49.5)
Knowledge	6 point scale (1 to 6), average is 3.5	3.709	(1.223)	3.644	(1.433)
Age	In years	45.355	(13.305)	49.186	(12.881)
Female	Percentage of subjects	49.5	(50.1)	53.3	(50.5)
Income*	In dollars	80000	(38100)	72500	(33450)
Loan	Percentage of subjects who used a loan	84.2	(36.6)	82.2	(38.7)
Loan duration	In years	3.947	(1.871)	3.889	(1.968)
Previous SC	4 point scale: 0(not applicable) to 3(always purchased) on previous vehicles	1.580	(0.752)	1.600	(0.720)
Married	Percentage of subjects	67.9	(46.8)	71.1	(45.8)
Car	Percentage of subjects that purchased a car	38.4	(48.8)	44.4	(50.3)
SUV	Percentage of subjects purchased an SUV	45.8	(50.0)	35.6	(48.4)
Risk (Ins.)	Percentage of subjects that would purchase trip insurance at price below expected loss	70.5	(45.7)	64.4	(48.4)
Risk (Stereo EW)	Percentage of subjects that would purchase An extended warranty for $1 above expected loss	54.2	(50.0)	40.0	(49.5)
Education	5 point scale: 0 to 4. Value of 2 is some college. Value of 3 is bachelor's degree.	2.632	(1.164)	2.844	(1.065)

* Inferred from a 6 point scale.

Notice that the participants displayed a lower frequency of purchasing insurance and extended warranties in response to hypothetical situations. 64 percent of the participants responded that they would buy trip insurance versus 71 percent of the original group. Furthermore, there is a 14 percent difference in the number of participants willing to buy an extended warranty on a new stereo. This suggests that the participants are not as risk averse as the entire group. Nevertheless, in their actual purchase decisions for service contracts both groups are remarkably similar.

Table 4 presents descriptive statistics for the variables used in the empirical analysis discussed in the remainder of this section.

Table 4. Summary of variables used in analysis

Variable	Description	Mean	Std. Dev.
Purchase	= 1 if service contract purchased for vehicle = 0 otherwise	0.400	(0.495)
Loan duration	in years	3.889	(1.968)
Measure A	= 1 if willing to purchase trip insurance at price exceeding expected loss = 0 otherwise	0.089	(0.288)
Previous SC	frequency of previous SC purchases on other vehicles	1.600	(0.720)
Knowledge	level of knowledge versus average consumer (3.5 is the value of the average consumer)	3.644	(1.433)
HH vehicles	number of vehicles in the household	2.756	(1.246)
HH drivers	number of drivers in the household	2.311	(0.821)
Reliability	comparison of vehicle's reliability versus majority of of those sold in the US. From 1 (considerably worse) to 7 (considerably better)	6.386	(0.970)
Expectations	= 1 if expects vehicle to need repair(s) costing over $1000 before 100,000 miles = 0 otherwise	0.159	(0.370)

Table 5 presents the results of logit models using the most significant factors affecting service contract demand from Chapter One. The first model uses the original sample; the second uses the follow-up participants. The coefficients in both models have the expected signs and are generally comparable in magnitude.

Table 5. Logit models comparing original group and follow-up participants and testing conjectures

Dependent variable is PURCHASE, which equals 1 if a service contract was purchased.

	Model 1 Group	Model 2 Participants	Model 3 Participants
Constant	-2.245 ***	-3.341 **	-2.241
	(0.761)	(1.594)	(3.295)
Loan duration	0.397 ***	0.575 **	0.786 **
	(0.111)	(0.253)	(0.340)
Measure A	1.080 ***	2.037	4.343 *
	(0.412)	(1.540)	(2.242)
Previous SC	0.656 ***	0.852 ^	1.169 *
	(0.227)	(0.529)	(0.674)
Knowledge	-0.263 **	-0.278	-0.120
	(0.139)	(0.259)	(0.339)
HH vehicles	-	-	-1.188 *
			(0.638)
HH drivers	-	-	1.743 *
			(0.906)
Reliability	-	-	-0.645
			(0.483)
Expectations	-	-	0.376
			(1.249)
Pseudo R^2	0.1507	0.2088	0.3081
Log likelihood	-106.496	-23.9606	-20.3097
# observations	184	45	45

*** indicates significance at 1 percent.
** indicates significance at 5 percent.
* indicates significance at 10 percent.
^ indicates significance at 15 percent.
Standard errors in parentheses.

The exception may be that of the coefficient on the risk measure. These results indicate that an original group subject who will purchase trip insurance has a 48% increase in the odds of a service contract purchase while a follow-up participant who will do so has a 77% increase. Note however that the coefficient for the participants is not statistically significant.

4. Additional factors affecting the service contract purchase decision

I collected information on four additional factors that may affect the service contract purchase decision.[10]

Number of vehicles in the household (*HH vehicles*)

An increase in the number of vehicles in the household should decrease the likelihood of a service contract purchase. A reason is that consumers with access to a larger number of vehicles are not as inconvenienced by a repair to their new vehicle. The availability of a substitute makes it easier for the consumer to find alternative transportation in these instances. This decreases the need for rental cars or other benefits that may be provided by service contracts in the event of a breakdown. Another motivation for an increase in the number of vehicles decreasing the likelihood of a service contract purchase is that this may serve as a measure of experience. An individual in a household with a number of vehicles is more likely to have a familiarity with repair frequencies.

Number of drivers in the household (*HH drivers*)

The greater the number of drivers in the household the greater the likelihood of a service contract purchase. Two explanations are plausible. First, an increase in the number of drivers is likely to increase the use of a given vehicle and increase the perceived chance of a repair. Second, the opportunity cost of a vehicle in the shop is likely to be higher as the demands for using the car are greater. In this instance, services provided by a service contract, such as a rental car, would be more valuable.

Perceived reliability (*Reliability*)

The likelihood of a service contract purchase is expected to decrease as the vehicle's perceived reliability increases. The explanation is straightforward; if one does not expect any parts failures or breakdowns then there is no need for a service contract. Follow-up study participants were asked to rate their vehicles' reliability against the majority of new vehicles sold in the United States. The available response range was from 1 (considerably worse) to 7 (considerably better). A response of 4 corresponded with "average". As one might expect, none of the participants rated their vehicle below a 4. The mean response was 6.386 with a standard deviation of 0.967.

Expectation of breakdowns or part failure (*Expectations*)

Each follow-up participant was asked if they expected their vehicle to need repairs totaling over $1,000 before reaching 100,000 miles. $1,000 is not an atypical price for a service contract.[11] This is a binary variable based on a yes/no response to the question. If the consumer has a discount factor near unity and believes the vehicle will need repairs costing more than the typical contract then it would be reasonable for the consumer to purchase a service contract.

4.1. Investigating the factors

The results from a logit model including these factors are listed in the third model of Table 4 on page 87. The model was subjected to a Pearson goodness-of-fit test which failed to reject the null at the 5% level of significance.[12] The dependent variable is binary and takes a value of one if a service contract was purchased, zero otherwise. The coefficients for each have the expected signs. Expecting the vehicle to need repairs in excess of $1,000 before reaching 100,000 miles does increase the likelihood of a service contact purchase. And consumers who perceive their vehicles to be more reliable are less likely to purchase a contract. The coefficients on these variables are not significant however.

The number of drivers and vehicles in the household significantly affect the service contract purchase decision. The negative coefficient for *HH vehicles* suggests that consumers in households with more vehicles are less likely to buy a service contract. There is some support for the claim that the number of vehicles and knowledge about vehicles are positively related; the correlation coefficient for these two factors is 0.281. And as conjectured, a household with more drivers is more likely to make a service contract purchase.

5. Experiment results

Table 6 presents the aggregate data for each decision sheet in both domains. I conduct within-subject testing of the means using two tailed t-tests. These tests are between the non-ambiguous gamble and each of the ambiguous gambles for every expected value.

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[10] These factors are related to the hypotheses and conjectures presented in Chapter One. *Reliability* and *expectations* are proxies for π, the probability that the vehicle works. *HH drivers* falls into the "value of a working vehicle" category. *HH vehicles* is in the "experience" group.

[11] According to J. D. Power and Associates (2000), "The average service contract price in 2000 is approximately $1,100."

[12] P-value of 0.44. Additionally, tests of the conditional mean and conditional variance assumptions, as described in Chapter One, Section 6, failed to reject the null hypotheses.

Table 6. Average valuations for gains and losses

Willingness-to-accept for gains			
	Payoff		
Probability	$50	$45-55	$40-60
10%	8.83	9.87	9.38
	(6.43)	(7.24)	(6.73)
5-15%	8.32	10.11 *	-
	(5.95)	(7.12)	
0-20%	9.04	-	-
	(6.85)		
25%	12.89	-	12.51
	(6.09)		(6.27)
15-35%	11.91	-	-
	(6.25)		
50%	24.45	-	-
	(5.47)		
0-100%	24.21	-	-
	(6.16)		
75%	38.40	-	37.22 **
	(4.56)		(4.46)
65-85%	38.47	-	-
	(5.65)		
90%	41.72	41.43	41.81
	(5.94)	(6.21)	(6.55)
85-95%	40.07 *	41.23	-
	(5.98)	(6.04)	
80-100%	40.09 **	-	-
	(5.76)		

Willingness-to-pay against losses			
	Payoff		
Probability	$50	$45-55	$40-60
10%	-6.49	-8.38 **	-7.55
	(7.40)	(7.35)	(7.18)
5-15%	-8.43 **	-8.98 ***	-
	(6.66)	(7.36)	
0-20%	-9.55 **	-	-
	(7.11)		
25%	-11.23	-	-9.68 *
	(6.38)		(6.38)
15-35%	-9.94	-	-
	(6.48)		
50%	-24.30	-	-
	(5.62)		
0-100%	-23.74	-	-
	(6.62)		
75%	-36.66	-	-37.98 *
	(6.02)		(6.52)
65-85%	-37.06	-	-
	(5.55)		
90%	-39.85	-37.70 ***	-39.36
	(6.80)	(6.45)	(7.10)
85-95%	-38.87	-38.79 *	-
	(7.06)	(7.12)	
80-100%	-39.91	-	-
	(6.96)		

Standard deviations in parentheses.
Two-sided means tests of ambiguous gambles versus non-ambiguous at each expected value.
*** indicates significant difference at 1 percent.
** indicates signicant difference at 5 percent.
* indicates significant difference at 10 percent.

5.1. Descriptive results for the gain domain

In the gain domain, where the decisions are framed as investment opportunities, the subject is choosing between a "risky" investment and a certain return. The lowest certain return chosen can be viewed as the willingness-to-accept (WTA) for the gamble. For the gambles with

an expected value of $5, note that the WTA is greater in the gambles involving ambiguity in the payoff versus the gambles with no ambiguity or those with ambiguity in the probability.[13]

The subjects exhibit a slightly greater WTA for the unambiguous gambles versus the ambiguous gambles with expected values of $12.50, $25, and $37.50. This suggests an aversion to ambiguity for these gambles. The difference is only significant in 1 of the 5 cases however. For the gambles with an expected value of $45, the subjects are roughly neutral toward ambiguity in the payoff but averse to ambiguity in the probability versus the unambiguous gamble.

Generally the subjects exhibit a greater WTA than the expected value for low probability events and a lower value versus the expected value for high probability events. This result is similar to that found in Chapter Two.

It is also interesting to note that responses in 13 of the 16 gambles involving ambiguity exhibit higher standard deviations than the unambiguous gambles with similar expected values. This suggests that the participants were not as comfortable or familiar dealing with ambiguous gambles to win money.

5.2. Descriptive results for the loss domain

In the loss domain, the participants exhibited aversion to ambiguity in both the probability and amount of loss for gambles with an expected loss of $5. This aversion was significant in 4 of the 5 gambles. It is also of interest to note that the standard deviations for the ambiguous gambles were slightly lower than that of the certain gamble, indicating less variation in their aversion to ambiguity.

The results are not as straightforward for the remainder of the gambles in the loss domain. The subjects are ambiguity seeking for the gambles with expected values of $12.50 and $25 while being ambiguity averse to gambles with an expected value of $37.50. For 4 of the 5 ambiguous gambles with an expected loss of $45, the participants exhibit ambiguity-seeking behavior. This behavior is significant in 2 of the cases. There is no clear pattern in the standard deviations over these gambles.

The subjects display a WTP in excess of the expected loss for small probabilities of loss. Their WTP is slightly lower than the expected loss for midlevel probabilities and much lower

[13] To clarify, an example of a gamble with no ambiguity is a 10% chance at $50, a gamble with ambiguity in the payoff is a 10% chance at $40-60, and a gamble with ambiguity in the probability is a 0-20% chance at $50.

than the expected loss for high probabilities. This result is also similar to that of Chapter Two and is not unexpected.[14]

5.3. Regression analysis of attitudes toward uncertainty

The discussion presented in sections 5.1 and 5.2 does not clearly distinguish between the valuations in terms of statistical significance. In this section, I investigate what aspects of the gambles are likely to affect the participants' certainty equivalents. I am interested in not only whether or not the gamble contains weak ambiguity, but also if the location of this ambiguity affects the attitudes toward the gamble. The independent variables used in this analysis are presented in Table 7.

Table 7: Description of variables in regression models

EV	Expected value of gamble
COV	Coefficient of variation of gamble
Order	= 1 if investment decisions completed first = 0 if insurance decisions completed first
Range	measure of ambiguity in the gamble (ex. A gamble of a 0-20% chance at $50 has a range of EVs of $0-10. The value of Range is therefore 10.
Pay	= 1 if ambiguity in the payoff *only* of the gamble = 0 otherwise
Prob	= 1 if ambiguity in the probability *only* of the gamble = 0 otherwise
Both	= 1 if ambiguity in the probability and the payoff of the gamble = 0 otherwise
Female	= 1 if female = 0 if male
Income	family income
Pocket money	amount of cash on subject at start of the experiment
Married	= 1 if married = 0 if single/separated/divorced/widowed
Education	highest level of formal schooling completed

A "*" indicates an interaction between two variables.

I use Random Effects modeling in this section, which allow for control of individual effects. Table 8 presents the results of 4 models conducted in each domain. The dependent variable is the valuation for the gambles; for the gain domain this is the willingness-to-accept and for the loss domain it is the willingness-to-pay.

[14] This lends find support for Einhorn and Hogarth's (1985) anchoring adjustment model.

Table 8. Random effects models using experimental data

Dependent variable is the certainty equivalent.

	Model 1		Model 2		Model 3		Model 4	
	Gain	Loss	Gain	Loss	Gain	Loss	Gain	Loss
Intercept	4.125 ***	4.181 **	4.146 ***	3.694 *	4.223 ***	4.642 **	4.117 ***	5.627 ***
	(0.791)	(1.871)	(1.016)	(2.014)	(1.017)	(2.080)	(1.020)	(2.133)
EV	0.838 ***	0.983 ***	0.838 ***	0.983 ***	0.842 ***	0.996 ***	0.838 ***	1.022 ***
	(0.013)	(0.037)	(0.013)	(0.037)	(0.013)	(0.038)	(0.013)	(0.040)
COV	-0.039	2.413 ***	-0.039	2.413 ***	-0.028	2.676 ***	0.007	3.002 ***
	(0.129)	(0.564)	(0.129)	(0.564)	(0.129)	(0.582)	(0.132)	(0.602)
Order	-	-	-0.041	0.953	-0.041	0.953	-0.042	0.953
			(1.235)	(1.446)	(1.235)	(1.446)	(1.235)	(1.446)
Range	-	-	-	-	-0.023 ^	-0.029 *	-	-
					(0.015)	(0.016)		
Range*Pay	-	-	-	-	-	-	0.018	-0.013
							(0.036)	(0.037)
Range*Prob	-	-	-	-	-	-	-0.027 *	-0.035 **
							(0.015)	(0.017)
Range*Both	-	-	-	-	-	-	0.021	0.086
							(0.053)	(0.056)
R^2	0.8393	0.8071	0.8393	0.808	0.8395	0.8084	0.8398	0.809
Log Likelihood	-2745.57	-2807.5	-2745.57	-2807.33	-2744.46	-2805.73	-2743.46	-2803.37
# obs.	896	900	896	900	896	900	896	900
Haus. Stat.	0.16	0.00	0.14	0.00	0.16	0.00	0.19	0.00
p-value	0.922	1.000	0.933	1.000	0.984	1.000	0.999	1.000

*** indicates significance at 1 percent.
** indicates significance at 5 percent.
* indicates significance at 10 percent.
^ indicates significance at 15 percent.
Standard errors in parentheses.

Model 1

The coefficients in both domains have the expected signs. The significantly positive EV coefficient in the gain domain indicates that valuations increase as the expected value of the gamble increases. In the loss domain, the significantly positive EV coefficient reveals that the participants' willingness-to-pay increases as the expected loss increases.

The negative COV in the gain domain suggests that as the coefficient of variation increases from low to high probability events, the valuations decrease while controlling for the EV. This is exactly what we would expect: we have already seen that the participants' willingness-to-accept was greater than the expected value for low probability events and below expected value for high probability events. The significantly positive COV coefficient in the loss domain indicates that the participants are willing-to-pay more as the COV decreases.[15]

Model 2

This model was done to see if the order in which the participants made their decisions had any affect on the valuations. The order coefficients were not statistically significant in either domain revealing that the order of completion was not a relevant factor in the participants' decisions.

Model 3

This model includes the Range variable. This variable is a measure of the "size" of the ambiguity. It is the absolute value of the span of possible expected values for a gamble. For example, an 80-100% chance at losing $50 would have expected values from negative $40-50. The corresponding Range would be 10, the absolute value of 40-50.

The negative coefficients for this variable in each domain indicate an aversion to ambiguity. In the gain domain, this reveals a decreased willingness-to-accept for the gambles involving weak ambiguity. This coefficient is not quite significant at the 10 percent level. The significant negative coefficient in the loss domain suggests an increased willingness-to-pay to avoid the weakly ambiguous gambles.

[15] In the loss domain the certainty equivalents and expected values are negative numbers, indicative of losses. Therefore the coefficients-of-variation for these gambles are negative numbers that increase as the probability of loss increases.

Model 4

The interactions of the Range variable with the location of the ambiguity are the focus of this model. By location, I mean that the weak ambiguity is either in the probability, payoff, or both simultaneously. The coefficients on the Range*Pay and Range*Both are not significant in either domain. However, the interaction of range and probability is significantly negative in both domains. This informs us that the aversions to ambiguity found in Model 3 are driven primarily by aversion to ambiguity in probabilities for both domains.

Demographics analysis

The analysis presented in Table 9 is an extension of model 3 which includes a number of demographic variables. While none of these demographic variables are statistically significant at any reasonable level, there are some interesting findings. Notice that females were more risk and ambiguity averse and so were those participants with higher educational attainment. Married participants were more risk seeking. And finally, subjects who entered the study with more cash on their person were more risk averse.[16]

5.4. Statistical adequacy of random effects models

I use the Hausman specification test to investigate the statistical adequacy of the models presented in this section. The underlying principle of the test is that, "…if the model specification is correct, estimates by any 2 consistent methods should be close to one another; if they are not close to one another, doubt is cast on the model." (Kennedy, 1992). The null hypothesis is that the model is correctly specified and the unit specific residual is uncorrelated with the independent variables. The chi squared test statistics and p-values are listed at the bottom of each of the models in Tables 8 and 9. The lowest p-value listed is 0.922. Therefore the tests do not reject the null hypothesis for any of the models.

[16] The question regarding the cash on the participant was asked *after* the subject had completed the survey and the experiment.

Table 9. Random effects model with demographic Variables

Dependent variable is the certainty equivalent.

	Gain	Loss
Intercept	4.141 ^	4.802
	(2.662)	(3.524)
EV	0.850 ***	0.996 ***
	(0.013)	(0.039)
COV	-0.058	2.662 ***
	(0.129)	(0.604)
Order	-0.141	0.667
	(1.346)	(1.537)
Range	-0.018	-0.032 *
	(0.015)	(0.017)
Female	-0.038	-1.051
	(1.411)	(1.612)
Income	-0.087	0.031
	(0.711)	(0.812)
Pocket money	-0.007	-0.002
	(0.012)	(0.013)
Married	2.045	1.070
	(1.632)	(1.863)
Education	-0.364	-0.012
	(0.701)	(0.801)
R^2	0.8491	0.8142
# observations	856	860
Haus. stat.	0.00	0.00
p-value	1.000	1.000

*** indicates significance at 1 percent.
** indicates significance at 5 percent.
* indicates significance at 10 percent.
^ indicates significance at 15 percent.
Standard errors in parentheses.

6. Attitudes toward uncertainty and the service contract purchase decision

6.1. The chance of a repair

The Ultimate Car Book (2000) lists the nine vehicle components that are most likely to need repair during the first 100,000 miles of ownership. It states that if the owner intends to keep the vehicle for this length of time, "… it is likely that you will experience most of these repairs at least once." Table 10 lists these 9 components and the transmission. The subjects were

asked what they believed the percentage chance of a repair was for each of these components. Their mean responses are given in the second column.

Table 10. Likelihood of breakdown of components (in percentages)

Component	Mean	Std. Dev.
Alternator	22.51	(26.97)
Front brakes	70.20	(34.77)
Fuel injection	12.58	(19.28)
Fuel pump	14.98	(20.46)
Power steer. Pump	12.11	(17.62)
Starter	14.84	(19.86)
Struts/shocks	27.96	(28.17)
Timing belt	37.22	(37.67)
Transmission	11.22	(17.28)
Water pump	17.89	(21.58)

Three of the components listed are not typically covered by a service contract, as their replacement or adjustment would be considered routine maintenance. These are the front brakes, struts/shocks, and the timing belt. Notice that the average predicted percentage chance of breakdown of the other components is roughly 15 percent. This suggests that new vehicle buyers believe that there is a relatively small chance that these other components will need any repair in the first 100,000 miles.

6.2. Measures of attitudes toward uncertainty

This section is devoted to an exploration of measures of attitudes toward uncertainty in relation to purchasing a service contract. I use 5 measures for these attitudes. Measure A is a binary variable based on the yes/no response of participants to a question about purchasing trip insurance where the insurance cost exceeds the expected loss. Given the findings discussed in section 6.1. above, Measure B is a summary statistic of the participants willingness-to-pay for the loss domain gambles with an expected probability of loss of 10 percent. I sum the values for the 6 gambles for each of the participants. Measure C builds on Measure B by including the values stated for the gambles with an expected probability of loss of 25 percent.

Measure D takes into account the participants attitudes toward ambiguity. Using the gambles with an expected probability of loss of 10 percent, I compare the valuation of the certain gamble to that of the 5 gambles involving ambiguity. If the WTP for an ambiguous gamble exceeds that of the certain gamble, the participant is labeled as averse to ambiguity for this gamble. The range of Measure D is therefore from 0 to 5 where a participant receives a 0 if the

WTP of the certain gamble exceeds that of the 5 ambiguous gambles, is a 1 if the WTP for one of the ambiguous gambles exceeds that of the certain, and so on through a value of 5 if the WTP for the 5 ambiguous gambles exceeds that of the certain gamble.

Measure E is the willingness to pay for insurance to avoid a 10 percent chance at losing $50 for each subject. This measure is used in conjunction with Measure D to control for the subjects level of risk aversion.

Table 11 presents the results from logit models using each of the measures of attitudes toward uncertainty discussed above. Each model was subjected to a Pearson goodness-of-fit test. The tests failed to reject the null hypotheses at the 5% level of significance.[17] The coefficients on the non-measures have the expected signs and are of similar magnitude across the models. The coefficients on the measures, however, are inconsistent.

Model 1

The positive and significant coefficient of Measure A is what was expected and this model was presented earlier in Table 4. It is likely that this measure most accurately captures the participants' attitudes toward uncertainty at the time of the service contract decision as this question was on the original survey that was completed at the time of the new vehicle purchase.

Models 2 and 3

Although the coefficients of the measures are insignificant in both of these models, it is somewhat surprising that they are positive. This indicates that as the willingness-to-pay for insurance increases in the experimental setting the likelihood of a service contract purchase falls.[18] A possible explanation for this is that the participants may not have viewed the money being risked as their own. The subjects were not risking any money that they were carrying when they entered into the study. They received $60 for completing the survey portion at the start of the follow-up study. This money was then risked in the experiment.

[17] P-values of 0.49, 0.36, 0.33, and 0.38, respectively. Additionally, tests of the conditional mean and conditional variance assumptions, as described in Chapter one, Section six, failed to reject the null hypotheses for each of the models.

[18] Remember that the insurance purchases are negative values indicating sure losses.

Table 11. Logit models assessing uncertainty measures

Dependent variable is PURCHASE, which is equal to 1 if a service contract was purchased.

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-5.648 **	-4.250 **	-4.193 **	-5.191 **	-4.691 **
	(2.421)	(2.140)	(2.137)	(2.190)	(2.235)
Measure A	3.43 *	-	-	-	-
	(1.994)				
Measure B	-	0.011	-	-	-
		(0.011)			
Measure C	-	-	0.009	-	-
			(0.008)		
Measure D	-	-	-	0.224	0.125
				(0.195)	(0.219)
Measure E	-	-	-	-	0.062
					(0.566)
Loan duration	0.757 **	0.548 **	0.551 **	0.593 **	0.567 **
	(0.318)	(0.254)	(0.253)	(0.260)	(0.259)
Previous SC	1.049 *	1.19 **	1.215 **	1.184 **	1.276 **
	(0.606)	(0.593)	(0.597)	(0.591)	(0.622)
Knowledge	-0.124	-0.114	-0.102	-0.181	-0.151
	(0.294)	(0.288)	(0.289)	(0.278)	(0.285)
HH vehicles	-0.937 *	-0.519	-0.546	-0.587	-0.569
	(0.557)	(0.492)	(0.498)	(0.486)	(0.521)
HH drivers	1.355 *	0.867	0.914	0.955	0.914
	(0.813)	(0.741)	(0.745)	(0.724)	(0.769)
Pseudo R^2	0.2724	0.224	0.2304	0.228	0.249
Log likelihood	-22.0355	-23.5005	-23.3073	-23.3809	-22.7581
# observations	45	45	45	45	45

*** indicates significance at 1 percent.
** indicates significance at 1 percent.
* indicates significance at 1 percent.
^ indicates significance at 1 percent.
Standard errors in parentheses.

Model 4

Probabilities of vehicle breakdown and repair rates involve a reasonable amount of uncertainty. It is impossible to know the true likelihood of a part failure and the decision to purchase a service contract is basically a bet that the cost of the contract will be less than discounted future repairs. Ambiguity aversion, beyond simple risk aversion, is likely to be an important factor in the decision to purchase service contract.

Measure D is a more accurate reflection of these attitudes than the measures in the previous 2 models. This measure captures a degree of aversion to ambiguity for low probability of loss events. The positive coefficient supports the notion that ambiguity aversion increases the

likelihood of a service contract purchase. While the coefficient is not statistically significant, this may be a promising avenue for future research into predictors of insurance purchases.

Model 5

Model 5 is an extension of the previous model. Measure E is included as a control for the subjects' level of risk aversion to a low probability of loss event. The coefficient is insignificant. Its positive value is not completely unexpected given the findings of models 2 and 3. Measure D is positive indicating an aversion to ambiguity but it is also statistically insignificant at any reasonable level.

7. Discussion

Additional factors that are relevant in the decision to purchase a service contract for a new vehicle were investigated in this study. I found strong support for substitutes, i.e. other vehicles in the household, decreasing the likelihood of a service contract purchase. I also found that as the number of drivers in the household increases the likelihood of a contract purchase increases.

This research lends tentative support to the notion that ambiguity aversion, not just what is typically referred to as risk aversion, plays a role in the decision to purchase insurance in the form of a service contract. In the experimental setting, subjects were found to exhibit aversion to ambiguity in both the loss and gain domains. Using the valuations from the loss domain, subjects exhibiting greater aversion to the ambiguous gambles relative to their values for gambles involving certainty were more likely to purchase a service contract.

In closing, it would be an interesting exercise for future researchers to develop an experiment that would incorporate a stronger notion of ambiguity and involve a way for the subjects to feel that they were risking their own money. This exercise would likely have considerable power in predicting various insurance decisions.

Bibliography

Abdellaoui, M., Barrios,C., and P. Wakker. 2001. "Ordinal and Cardinal Utility: Experimental Arguments Based on Prospect Theory," Working Paper.

Agrawal, J., Richardson, P., and P. Grimm. 1996. "The Relationship between Warranty and Product Reliability," *Journal of Consumer Affairs*, v30 n2: 421-43.

Almeida, M. 1995. "Extended Warranties: Peace of Mind at What Price?" *The New York Times*, July 23, Section 3: 8.

Ashley, R. 1984. "A Simple Test for Regression Parameter Instability," *Economic Inquiry*, v22: 253-268.

Barry, D. 2001. "Dotted Lines Now Include Service Pacts," *Richmond Times Dispatch*, Section E: 1.

Bryant, W., and J. Gerner. 1982. "The Demand for Service Contracts," *Journal of Business*, v55 n3: 345-66.

Camerer, C., and H. Kunreuther. 1989. "Experimental Markets for Insurance," *Journal of Risk and Uncertainty*, v2 n3: 265-99.

Chen, Z., and T.W. Ross. 1994. "Why Are Extended Warranties So Expensive," *Economics Letters*, v45 n2: 253-57.

Chow, C., and R. Sarin. 2000. "Known, Unknown, and Unknowable Uncertainties," *Theory and Decision*, 12pp, forthcoming.

Cooper, R., and T.W. Ross. 1985. "Product Warranties and Double Moral Hazard," *Rand Journal of Economics*, v16: 103-13.

Cramer, J.S. 1991. *The LOGIT Model: An Introduction For Economists.* London: Edward Arnold.

Davidson, R., and J. MacKinnon. 1993. *Estimation and Inference in Econometrics*. Oxford: Oxford University Press.

Dawes, R. M., Grankvist, G., and J. Leland. "Avoiding the "Ellsberg bag" as avoiding a "stacked deck" possibility, rather than avoiding ambiguity." Notes.

Day, E., and R. J. Fox. 1985. "Extended Warranties, Service Contracts and Maintenance Agreements - A Marketing Opportunity?" *Journal of Consumer Marketing*, v2: 77-86.

Del Garda, D. 2000. "The Global Gambles of General Motors," *The Economist*, June 24-30: 67-68.

Di Mauro, C., and A. Maffioletti. 1996. "An Experimental Investigation of the Impact of Ambiguity on the Valuation of Self-Insurance and Self-Protection," *Journal of Risk and Uncertainty*, n13: 53-71.

Douglas E., Glennon, D., and J. Lane. (1993) "Warranty, Quality and Price in the US Automobile Market," *Applied Economics*, v 25 n1 January, pp. 135-141.

Dybvig, P., and N. Lutz. 1993. "Warranties, Durability, and Maintenance: Two-Sided Moral Hazard in a Continuous-Time Model," *Review of Economic Studies*, v60 n3: 575-97.

Eckel, C., and P. Grossman. 2002. "Forecasting Risk Attitudes," Unpublished manuscript, Department of Economics, Virginia Tech, October.

Eckel, C., Grossman, P., Lutz, N., and V. Padmanabhan. 1998. "Playing It Safe: Men, Women, and Risk Aversion," Preliminary draft.

Einhorn, H., and R. Hogarth. 1985. "Ambiguity and Uncertainty in Probabilistic Inference," *Psychological Review*, v92: 433-459.

Eisenberger, R., and M. Weber. 1995. "Willingness-to-Pay and Willingness-to-Accept for Risky and Ambiguous Lotteries," *Journal of Risk and Uncertainty*, n10: 223-233.

Flax, A., and C. Thomas. 1988. "Suit Reveals Repair Frequency, Extended-Warranty Profit," *Automotive News*, March 28.

Fowler, D. 1996. "Are Extended Warranties Worth It?" *The Houston Chronicle*, Business Section: 1.

Fox, C., and A. Tversky. 1991. "Ambiguity Aversion and Comparative Ignorance," *Quarterly Journal of Economics*, v110, n3: 585-603.

Gardenfors, P., and N. Sahlin. 1988. "Unreliable Probabilities, Risk Taking, and Decision Making," *Decision Probability and Utility*, England, Cambridge University Press, 313-314.

Gerner, J., and B. Keith. 1980. "The Demand for Repair Service During Warranty," *Journal of Business*, v53 n4: 397-414.

Gill, H., and D. Roberts. 1989. "New Car Warranty Repair: Theory and Evidence," *Southern Economic Journal*, v55 n3: 662-78.

Henry, J. 1998. "Used Car Service Plans Facing New Threats: Better Warranties, Leasing on the Rise," *Automotive News*, June 22.

_____. 1998. "2 Big Banks Sell Service Contracts," *Automotive News*, October 26.

Hogarth, R., and H. Kunreuther. 1989. "Risk, Ambiguity, and Insurance," *Journal of Risk and Uncertainty*, v2: 5-35.

Holt, C., and S. Laury. 2002. "Risk Aversion and Incentive Effects in Lotteries," *American Economic Review*, December, forthcoming.

J. D. Power and Associates. 2000. "New Vehicle Service Contract Sales Increase in 2000," www.jdpower.com/global/jdpaawards/releases/101000.asp, October 10.

Kelley, C., and J. Conant. 1991. "Extended Warranties: Consumer and Manufacturer Perceptions," *Journal of Consumer Affairs*, v25 n1: 68-83.

Knight, F. 1921. *Risk, Uncertainty, and Profit*. Boston: Houghton Mifflin.

Knight Ridder Newspapers. 1998. "Is Extending a Warranty Worth It?" *St. Louis Post Dispatch*, March 17, Section C: 12.

Lutz, N. 1989. "Warranties as Signals under Consumer Moral Hazard," *Rand Journal of Economics*, v20 n2: 239-55.

Lutz, N., and V. Padmanabhan. 1998. "Warranties, Extended Warranties, and Product Quality," *International Journal of Industrial Organization*, v16 n4: 463-93.

Lutz, N., and V. Padmanabhan. 1995. "Why Do We Observe Minimal Warranties," *Marketing Science*, v14 n4: 417-41.

Maddala, G.S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press.

Padmanabhan, V. 1995. "Usage Heterogeneity and Extended Warranties," *Journal of Economics and Management Strategy*, v4 n1: 33-53.

Padmanabhan, V., and R. Rao. 1993. "Warranty Policy and Extended Service Contracts: Theory and an Application to Automobiles," *Marketing Science*, V12 n3: 230-47.

Powell, M., and D. Ansic. 1997. "Gender Differences in Risk Behavior in Financial Decision-Making: An Experimental Analysis," *Journal of Economic Psychology*, v18 n6: 605-28.

Price, L. J., and N. Dawar. 1995. "The Joint Effects of Brands and Warranties in Signaling New Product Quality," INSEAD Working Paper: 95/86/MKT, PP. 1-43.

Rabin, M. 2000. "Risk Aversion and Expected Utility Theory: A Calibration Theorem," *Econometrica*, v68: 1281-92.

Schubert, R. et al. 1999. "Financial Decision-Making: Are Women Really More Risk-Averse?" *American Economic Review*, v89 n2: 381-85.

Schubert, R. et al. 2000. "Gender Specific Attitudes Toward Risk and Ambiguity: An Experimental Investigation," Working Paper, July.

Soberman, D. 1997. "Product Warranties and Double Adverse Selection," INSEAD Working paper: 97/11/MKT 1997, pp. 1-29.

Sovern, J. 1995. "Toward the Regulation of Secret Warranties," *Advancing the Consumer Interest*, v7 n2: 13-19.

Spanos, A. 1986. *Statistical Foundations of Econometric Modeling*. Cambridge: Cambridge University Press.

_____. 1999. *Probability Theory and Statistical Inference*. Cambridge: Cambridge University Press.

_____. 2000. "Chapter 17: The Linear Regression Model II," Unpublished manuscript, Department of Economics, Virginia Tech.

_____. 2000. "Chapter 20: Binary Regression-Like Models," Unpublished manuscript, Department of Economics, Virginia Tech.

Spence, A. 1977. "Consumer Misperceptions, Product Failure and Producer Liability," *Review of Economic Studies*, v44 n3: 561-72.

Strauss, G. 2000. "SUVs Bleeding at the Gas Pump," *USA Today*, March 3-5, Section A: 1.

Tedeschi, B. 1999. "E-Commerce Report. More Internet Merchants are Awakening To a Lucrative Revenue-Enhancement Possibility: Extended Warranties," *The New York Times*, December 27, Section C: 7.

Zikmund-Fisher, B., and A. Parker. 1999. "Demand for Rent-to-Own Contracts: A Behavioral Economic Explanation," *Journal of Economic Behavior & Organization*, v38: 199-216.

Appendix A.

Derivations and explanations for the claims in Chapter One, Section Three.

First derivatives with respect to π, the probability that the vehicle works.

(i) For the general case:

$$\frac{\partial\, RHS}{\partial \pi} = U(y+v;\, d) - U(y+w;\, d) - U(y+v-t;\, d) + U(y+w+s-t;\, d)$$

We know that $U(y+v;\, d) > U(y+v-t;\, d)$ and $U(y+w+s-t;\, d) \geq U(y+w;\, d)$ so $\partial\, RHS/\, \partial\pi > 0$.

(ii) For the HARA [$U(x;d)= a(x-d)^L$ where $0<L<1$] case:

$$\pi a(y+v-d)^L + (1-\pi)a(y+w-d)^L - \pi a(y+v-t-d)^L - (1-\pi)a(y+w+s-t-d)^L = RHS^*$$

$$\frac{\partial\, RHS^*}{\partial \pi} = a[(y+v-d)^L - (y+w-d)^L - (y+v-t-d)^L + (y+w+s-t-d)^L]$$

We know that this is positive since $a>0$ and $(y+v-d)^L > (y+v-t-d)^L$ and $(y+w+s-t-d)^L > (y+w-d)^L$.

(iii) For the CARA [$U(x;d)= -e^{(-dx)}$] case:

$$\pi(-e^{-d(y+v)}) + (1-\pi)(-e^{-d(y+w)}) - \pi(-e^{-d(y+v-t)}) - (1-\pi)(-e^{-d(y+w+s-t)}) = RHS^{**}$$

$$\frac{\partial\, RHS^{**}}{\partial \pi} = -e^{-d(y+v)} + e^{-d(y+w)} + e^{-d(y+v-t)} - e^{-d(y+w+s-t)}$$

We know that this is positive since $e^{-d(y+w)} \geq e^{-d(y+w+s-t)} > e^{-d(y+v-t)} > e^{-d(y+v)}$ and $d>0$.

(iv) For the EP $\left[U(x:d) = -e^{(-bx^d)}\right]$ case:

$$\pi(-e^{-b(y+v)^d}) + (1-\pi)(-e^{-b(y+w)^d}) - \pi(-e^{-b(y+v-t)^d}) - (1-\pi)(-e^{-b(y+w+s-t)^d}) = RHS^{***}$$

$$\frac{\partial RHS^{***}}{\partial \pi} = -e^{-b(y+v)^d} + e^{-b(y+v-t)^d} + e^{-b(y+w)^d} - e^{-b(y+w+s-t)^d}$$

We know that this is positive from $e^{-b(y+w)^d} \geq e^{-b(y+w+s-t)^d} > e^{-b(y+v-t)^d} > e^{-b(y+v)^d}$.

First derivatives with respect to w, the dollar valuation of a broken vehicle covered by the base warranty.

(i) For the HARA [$U(x;d)= a(x-d)^L$ where $0<L<1$] case:

$$\frac{\partial\, RHS^*}{\partial w} = aL(1-\pi)[(y+w-d)^{L-1} - (y+w+s-t-d)^{L-1}]$$

We know that this is positive from $(y+v-d)^L > (y+v-t-d)^L > (y+w+s-t-d)^L \geq (y+w-d)^L$.

(ii) For the CARA [$U(x;d)= -e^{(-dx)}$] case:

$$\frac{\partial\, RHS^{**}}{\partial w} = (1-\pi)d(e^{-d(y+w)}) - (1-\pi)d(e^{-d(y+w+s-t)})$$

$$= (1-\pi)d[e^{-d(y+w)} - e^{-d(y+w+s-t)}]$$

We know that this is positive from $e^{-d(y+w)} \geq e^{-d(y+w+s-t)} > e^{-d(y+v-t)} > e^{-d(y+v)}$.

(iii) For the EP $\left[U(x:d) = -e^{(-bx^d)}\right]$ case:

$$\frac{\partial RHS^{***}}{\partial w} = (1-\pi)bd(e^{-b(y+w)^d})(y+w)^{d-1} - (1-\pi)bd(e^{-b(y+w+s-t)^d})(y+w+s-t)^{d-1}$$

$$= (1-\pi)bd[(e^{-b(y+w)^d})(y+w)^{d-1} - (e^{-b(y+w+s-t)^d})(y+w+s-t)^{d-1}]$$

We know that this is positive from $e^{-b(y+w)^d} \geq e^{-b(y+w+s-t)^d}$ and $(y+w)^{d-1} \geq (y+w+s-t)^{d-1}$.

First derivatives with respect to t, the price of a service contract.

(i) For the HARA [$U(x;d)= a(x-d)^L$ where $0<L<1$] case:

$$\frac{\partial\, RHS^*}{\partial t} = L\pi a(y+v-t-d)^{L-1} + L(1-\pi)a(y+w+s-t-d)^{L-1}$$

We know that this is positive.

(ii) For the CARA [$U(x;d)= -e^{(-dx)}$] case:

$$\frac{\partial\, RHS^{**}}{\partial t} = \pi de^{-d(y+v-t)} + (1-\pi)de^{-d(y+w+s-t)}$$

We know that this is positive.

(iii) For the EP $\left[U(x:d) = -e^{(-bx^d)}\right]$ case:

$$\frac{\partial RHS***}{\partial t} = b(e^{-b(y+v-t)^d})\pi d(y+v-t)^{d-1} + b(e^{-b(y+w+s-t)^d})(1-\pi)d(y+w+s-t)^{d-1}$$

We know that this is positive.

<u>First derivatives with respect to v, the dollar valuation of a properly working vehicle.</u>
(i) For the HARA [$U(x;d)= a(x-d)^L$ where $0<L<1$] case:

$$\frac{\partial RHS*}{\partial v} = L\pi a(y+v-d)^{L-1} - L\pi a(y+v-t-d)^{L-1}$$

$$= L\pi a[(y+v-d)^{L-1} - (y+v-t-d)^{L-1}]$$

We know that this is negative from $(y+v-t-d)^{L-1} > (y+v-d)^{L-1}$.
(ii) For the CARA [$U(x;d)= -e^{(-dx)}$] case:

$$\frac{\partial RHS**}{\partial v} = d\pi(e^{-d(y+v)}) - d\pi(e^{-d(y+v-t)})$$

$$= d\pi[(e^{-d(y+v)}) - (e^{-d(y+v-t)})]$$

We know that this is negative from $e^{-d(y+v-t)} > e^{-d(y+v)}$.

(iii) For the EP $\left[U(x:d) = -e^{(-bx^d)}\right]$ case:

$$\frac{\partial RHS***}{\partial v} = b(e^{-b(y+v)^d})\pi d(y+v)^{d-1} - b(e^{-b(y+v-t)^d})\pi d(y+v-t)^{d-1}$$

$$= b\pi d[(e^{-b(y+v)^d})(y+v)^{d-1} - (e^{-b(y+v-t)^d})(y+v-t)^{d-1}$$

We know that this is negative from $e^{-b(y+v-t)^d} > e^{-b(y+v)^d}$ and $(y+v-t)^{d-1} > (y+v)^{d-1}$.

<u>First derivatives with respect to s, the dollar valuation of additional coverage from a service contract.</u>

(i) For the HARA [$U(x;d)= a(x-d)^L$ where $0<L<1$] case:

$$\frac{\partial RHS*}{\partial s} = -L(1-\pi)a(y+w+s-t-d)^{L-1}$$

We know that this is negative.

(ii) For the CARA [$U(x;d)= -e^{(-dx)}$] case:

$$\frac{\partial\, RHS^{**}}{\partial s} = -\,(1-\pi)de^{-d(y+w+s-t)}$$

We know that this is negative.

(iii) For the EP $\left[U(x:d) = -e^{(-bx^d)}\right]$ case:

$$\frac{\partial RHS^{***}}{\partial s} = -b(e^{-b(y+w+s-t)^d})(1-\pi)d(y+w+s-t)^{d-1}$$

We know that this is negative.

<u>First derivatives with respect to d, the risk aversion parameter.</u>

(i) For the HARA [$U(x;d)= a(x-d)^L$ where $0<L<1$] case with incomplete insurance:

Since $a>0$ and $L>0$, the sign of $\partial RHS^*/\partial d$ is given by the sign of

$$\pi(y+v-t-d)^{L-1} + (1-\pi)(y+w+s-t-d)^{L-1} - \pi(y+v-d)^{L-1} - (1-\pi)(y+w-d)^{L-1}$$

Rewriting gives us

$$\pi\{\,(y+v-t-d)^{L-1} - (y+v-d)^{L-1}\,\} + (1-\pi)\{\,(y+w+s-t-d)^{L-1} - (y+w-d)^{L-1}\}$$

We know that the first term in brackets is positive and that the second bracketed term is negative.

Therefore $\partial RHS^*/\partial d$ will be negative – and increases in the risk aversion parameter d will increase the probability that the consumer will purchase a service contract – as long as π is relatively small. If π is small enough then RHS is monotonically decreasing in d. However, RHS is not monotonic in d for every value of π.

(ii) For the CARA [$U(x;d)= -e^{(-dx)}$] case with incomplete insurance:

$$\frac{\partial\, RHS^{**}}{\partial d} = \pi(y+v)e^{-d(y+v)} + (1-\pi)(y+w)e^{-d(y+w)} - \pi(y+v-t)e^{-d(y+v-t)} - (1-\pi)(y+w+s-t)e^{-d(y+w+s-t)}$$

$$= \pi\{(y+v)e^{-d(y+v)} - (y+v-t)e^{-d(y+v-t)}\} + (1-\pi)\{(y+w)e^{-d(y+w)} - (y+w+s-t)e^{-d(y+w+s-t)}\}$$

To sign this, consider $\frac{\partial(xe^{-dx})}{\partial x} = e^{-dx}(1-dx)$.

This is clearly positive iff $1 > dx$.

Therefore we have that (since $t>0$) the first term in brackets is positive if $y+v<1$, and is negative if $y+v-t>1$. The second term in brackets (since $s-t>0$) is positive if $y+w>1$ and is negative if $y+w+s-t<1$.

Suppose that y>1 and v-t>0. Then y+v-t>1 and y+w>1, and we have that ∂RHS**/∂d will be negative for π sufficiently large. As in the HARA case, this indicates that there is not monotonic relationship between d and the gain from buying incomplete insurance in the form of a service contract for every π.

(iii) For the EP $\left[U(x:d) = -e^{(-bx^d)}\right]$ case:

$$\frac{\partial RHS***}{\partial d} = b(e^{-b(y+v)^d})\pi(y+v)^d \ln(y+v) - b(e^{-b(y+v-t)^d})\pi(y+v-t)^d \ln(y+v-t)$$
$$+ b(e^{-b(y+w)^d})(1-\pi)(y+w)^d \ln(y+w)$$
$$- b(e^{-b(y+w+s-t)^d})(1-\pi)(y+w+s-t)^d \ln(y+w+s-t)$$

$$= b\pi[(e^{-b(y+v)^d})(y+v)^d \ln(y+v) - (e^{-b(y+v-t)^d})(y+v-t)^d \ln(y+v-t)] +$$
$$b(1-\pi)[(e^{-b(y+w)^d})(y+w)^d \ln(y+w) - (e^{-b(y+w+s-t)^d})(y+w+s-t)^d \ln(y+w+s-t)]$$

To sign this, consider $\dfrac{\partial(e^{-bx^d})(x)^d \ln(x)}{\partial d} = e^{-bx^d} x^d \ln(x)^2[1-bx^d]$.

This is clearly positive if $b < 1/x^d$.

Therefore we have that the first term in brackets is positive and the second term in brackets is negative if $b < 1/(y+v)^d$. Conversely, if $b > 1/(y+v)^d$ then the first term in brackets is negative and the second term in brackets is positive.

Suppose that $b < 1/(y+v)^d$. Then we have that ∂ RHS***/∂d will be negative for π sufficiently small. As in the CARA and HARA cases, this indicates that there is not a monotonic relationship between d and the gain from buying a service contract for every π.

<u>First derivatives with respect to y, income.</u>

(i) For the HARA [$U(x;d)= a(x-d)^L$ where $0<L<1$] case:

$$\frac{\partial\ RHS*}{\partial y} = L\pi a(y+v-d)^{L-1} + L(1-\pi)a(y+w-d)^{L-1} - L\pi a(y+v-t-d)^{L-1} - L(1-\pi)a(y+w+s-t-d)^{L-1}$$
$$= La\,[\pi\{(y+v-d)^{L-1} - (y+v-t-d)^{L-1}\} + (1-\pi)\{(y+w-d)^{L-1} - (y+w+s-t-d)^{L-1}\}]$$

We know that the first term in brackets is negative and that the second bracketed term is positive. Therefore ∂ RHS* / ∂y <0 indicating increases in income will increase the probability that the consumer will purchase a service contract as long as π is relatively small.

(ii) For the CARA [$U(x;d)= -e^{(-dx)}$] case:

$$\frac{\partial\, RHS^{**}}{\partial y} = \pi d e^{-d(y+v)} + (1-\pi) d e^{-d(y+w)} - \pi d e^{-d(y+v-t)} - (1-\pi) d e^{-d(y+w+s-t)}$$

$$= d\,[\pi\{e^{-d(y+v)} - e^{-d(y+v-t)}\} + (1-\pi)\{e^{-d(y+w)} - e^{-d(y+w+s-t)}\}]$$

From $e^{-d(y+w)} \geq e^{-d(y+w+s-t)} > e^{-d(y+v-t)} > e^{-d(y+v)}$ we know that the first term in brackets is negative and the second bracketed term is positive. Therefore ∂ RHS** / ∂y is negative – and increases in income will increase the probability that the consumer will purchase a service contract – as long as π is sufficiently large.

(iii) For the EP $\left[U(x:d) = -e^{(-bx^d)}\right]$ case:

$$\frac{\partial RHS***}{\partial y} = b(e^{-b(y+v)^d})\pi d(y+v)^{d-1} - b(-e^{-b(y+v-t)^d})\pi d(y+v-t)^{d-1}$$

$$+ b(e^{-b(y+w)^d})(1-\pi)d(y+w)^{d-1} - b(e^{-b(y+w+s-t)^d})(1-\pi)d(y+w+s-t)^{d-1}$$

$$= b\pi d[(e^{-b(y+v)^d})(y+v)^{d-1} - (-e^{-b(y+v-t)^d})(y+v-t)^{d-1}]$$

$$+ b(1-\pi)d[(e^{-b(y+w)^d})(y+w)^{d-1} - b(e^{-b(y+w+s-t)^d})(y+w+s-t)^{d-1}]$$

From $e^{-b(y+w)^d} \geq e^{-b(y+w+s-t)^d} > e^{-b(y+v-t)^d} > e^{-b(y+v)^d}$ and that $(y+w)^{d-1} \geq (y+w+s-t)^{d-1} > (y+v-t)^{d-1} > (y+v)^{d-1}$ we know that the first term in brackets is negative and the second bracketed term is positive. Therefore ∂ RHS*** / ∂y is negative – and increases in income will increase the probability that the consumer will purchase a service contract – as long as π is sufficiently large.

Appendix B.

Survey completed by new vehicle buyers at the dealership.

Congratulations on your new vehicle purchase!

I would like to thank you in advance for taking the time to complete this survey. I am collecting this data as part of my Ph.D. dissertation work in economics. For completing this survey, you will receive a $10 gift certificate redeemable at the Haynes Motor Company Parts and/or Services departments. The funding for this research is being provided by a grant from the John D. and Catherine T. MacArthur Foundation.

Please fill in the contact information below. The information you provide is STRICTLY CONFIDENTIAL. It is not for sale or use by any third party, including Haynes Motor Company. No one will be using this data to identify you in any way. The published research will not contain any data that will allow individuals to be identified. This survey is being distributed at other dealerships in Richmond, Roanoke, and Christiansburg, Virginia.

Name: _____
Address: _____
_____
Email: _____
Daytime Phone: _____

I will also be conducting follow-up studies over the next few months. They will be held at a convenient location, and will last about 90 minutes. Your participation is voluntary, but if you participate in a study, you will receive $30 just for showing up and you will be given opportunities to earn additional money playing games that are simple and fun. If participating in this sounds interesting to you, just check the box below and I will send you more information later.

- ☐ I am interested in the follow-up study. Please send more information and I will make a decision about participating at that time.

Finally, if you would like a brief summary of the completed work, available in August 2002, check the box below.

- ☐ I would like a summary of the completed analysis.

Thanks again for your help with this project. The contact information listed below is also on the gift certificate. Feel free to get in touch with me if you have any questions about this research.

Evan C. Moore

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Sales Consultant: _____
Date of Purchase: _____
Purchase price: _____
Vehicle information: Year _____ Make_____ Model _____
Factory (Base) Warranty: ____ Years _____ Miles
Service Contract: ____ Yes _____ No
If Yes, Contract length _____ Years _____Miles
Plan name_____(Total Care, etc.)

Section A. This section seeks information about your purchase, use and care of this vehicle.

1. Is the purchase of this vehicle being financed with a loan?
Yes ☐ No ☐

If Yes, what is the duration of your loan? _____ years

2. Is the person purchasing the vehicle going to be the primary user of the vehicle?
Yes ☐ No ☐

If No, please indicate the primary user.
Spouse ☐ Parent ☐ Child ☐ Other(Please specify) _____

3. What would you say will be the primary use of this vehicle?
Business use ☐ Personal use ☐

4. Will the primary user be using this vehicle to commute to and from the workplace?
Yes ☐ No ☐

5. Please indicate the expected average yearly mileage. Please indicate, in percentages, the type of driving expected.
Average yearly mileage _____ Highway driving _____%
City (in-town) driving _____%
Off-road driving _____%

6. How long do you expect to own this vehicle?
Less than 3 years ☐ 3 to 5 years ☐ 5 to 7 years ☐ 7 to 10 years ☐ More than 10 years ☐

7. How often will each of the following be done to this vehicle? Please answer in terms of mileage and months.

	Miles	Months
Check the fluid levels	_____	_____
Get the oil & filter changed	_____	_____

8. Do you follow the scheduled maintenance services as recommended in your owner's manual?
Always ☐ Usually ☐ Sometimes ☐ Rarely ☐

9. A. Is this the first vehicle that you have owned?
Yes ☐ No ☐
B. Is this the first time you have purchased a new vehicle?
Yes ☐ No ☐

10. "I have _____ bought service contracts on previous (new and/or used) vehicles that I have purchased."
Always ☐ Sometimes ☐ Never ☐ Not Applicable ☐

11. How would you rate your knowledge of automobiles/trucks and repairs (including likelihood of breakdown and total cost of repairs) compared to the average person?

1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
know very little					fully knowledgeable

12. Please describe your thought process regarding the purchase of a service contract for this new vehicle. A few words or sentences are fine.

Section B. In this section you are asked to make specific purchase decisions in typical consumer situations. We would like to know what you would do in these situations. There are no right or wrong answers.

13. Suppose you have planned a vacation with your family. The total cost of the trip is $3000. The National Weather Center reports there is a 5% chance of bad weather that would lead to the cancellation of the trip. In that case, you would lose all the money.

You can buy travel insurance to guard against the possibility of losing all of your money. The insurance would refund you the full $3000 in the event that bad weather forces cancellation of the trip. If the insurance was available at each of the following prices would you purchase it? (Please check the appropriate response for each price level.)

Price of insurance is $100 Yes ☐ No ☐
Price of insurance is $150 Yes ☐ No ☐
Price of insurance is $200 Yes ☐ No ☐

14. You have recently purchased a new stereo system at a price of $1500. A recent article in Consumer Reports says that the product is as reliable as the average stereo system available in the marketplace. There is a 8% (4 in 50) chance that the system will breakdown during the first 3 years of use. If the system breaks down, the repair will cost $500. An extended warranty that covers the entire cost of repairs for the first three years of use is offered for $41. Would you purchase this extended warranty?
Yes ☐ No ☐

Section C. Finally we would like to ask you a few questions about yourself and your family for classification purposes. Please note that the data you provide will be treated with the strictest confidentiality. We will not use the data in any way that allows anyone else to identify you or your family.

15. Could you please give the following details about yourself.
Sex: Male ☐ Female ☐

Year of birth _____
Marital Status: Single ☐
Married ☐
Divorced/Separated/Widowed ☐

If you are married, how would you describe your spouse's involvement in the purchase of this vehicle?
No involvement (I made all of the decisions) ☐
Joint involvement (We made the decisions together) ☐
Complete involvement (Spouse made all of the decisions) ☐

Do any children live in your household? Yes ☐ No ☐
If Yes, what is the number of children that live with you: under the age of 16 _____
over the age of 16 _____

16. What is the highest level of education that you have completed?
Some high school ☐
Completed high school ☐
Some college ☐
Bachelor's degree ☐
Graduate degree ☐
Other (Please specify) _____

17. What was your approximate income last year?
Less than $20,000 ☐
$20,000 - $50,000 ☐
$50,000 - $80,000 ☐
$80,000 - $110,000 ☐
$110,000 - $140,000 ☐
Over $140,000 ☐

18. What was your family's (all of the people in your household) approximate total income last year?
Less than $20,000 ☐
$20,000 - $50,000 ☐
$50,000 - $80,000 ☐
$80,000 - $110,000 ☐
$110,000 - $150,000 ☐
Over $150,000 ☐

Appendix C.

Tables of average valuations.

Table 1. Means and sex differences in pooled data

GAIN DOMAIN							
Prob.	**Payment**	**Mean for all obs.**	**Std. Dev. Of all obs.**	**Male mean**	**Female mean**	**Difference**	**Total # of obs.**
10	50	10.19	5.32	10.41	9.88	0.53	145
5-15	50	9.42	4.95	9.52	9.28	0.24	146
0-20	50	8.42	4.87	8.93	7.70	1.23	144
10	45-55	9.79	4.74	10.21	9.17	1.04	143
10	40-60	10.12	5.55	10.57	9.48	1.09	146
5-15	45-55	9.21	5.09	9.91	8.20	1.70	145
10	0-100	10.16	5.39	10.50	9.80	0.70	82
10	25-75	9.19	4.47	9.77	8.58	1.19	83
50	50	24.11	4.92	24.38	23.74	0.64	145
45-55	50	23.94	5.28	24.12	23.69	0.42	143
50	45-55	24.14	5.26	24.40	23.79	0.61	147
45-55	45-55	23.01	4.82	23.21	22.74	0.48	145
90	50	41.56	5.82	41.93	41.06	0.86	147
85-95	50	39.54	5.82	39.74	39.26	0.48	142
80-100	50	40.75	5.90	41.01	40.40	0.61	145
90	45-55	40.98	5.49	41.72	39.93	1.79	147
90	40-60	40.53	5.40	40.61	40.42	0.20	145
85-95	45-55	40.16	5.29	40.66	39.48	1.17	147
90	47-53	40.56	5.69	40.30	40.83	-0.53	84
90	44-56	40.31	5.18	40.21	40.41	-0.21	84
			LOSS DOMAIN				
Prob.	**Payment**	**Mean**	**Std. Dev.**	**Male**	**Female**	**Difference**	**# of obs.**
10	50	-9.55	5.91	-9.75	-9.27	-0.48	143
5-15	50	-9.99	5.69	-10.33	-9.52	-0.80	146
0-20	50	-10.69	5.67	-11.30	-9.85	-1.45	144
10	45-55	-9.51	5.87	-9.53	-9.48	-0.05	145
10	40-60	-9.74	6.03	-9.86	-9.58	-0.27	144
5-15	45-55	-10.17	5.77	-10.55	-9.64	-0.91	144
10	47-53	-9.43	5.70	-9.86	-8.97	-0.88	81
10	44-56	-10.01	5.77	-10.05	-9.98	-0.07	84
50	50	-26.52	5.11	-26.64	-26.34	-0.29	141
45-55	50	-25.95	5.03	-26.64	-25.02	-1.62	139
50	45-55	-25.94	5.12	-26.17	-25.63	-0.54	143
45-55	45-55	-25.46	5.26	-25.67	-25.17	-0.50	140
90	50	-41.26	4.57	-41.54	-40.85	-0.69	145
85-95	50	-41.14	4.50	-41.28	-40.95	-0.33	143
80-100	50	-40.47	4.40	-40.68	-40.18	-0.50	146
90	45-55	-41.05	4.83	-41.14	-40.92	-0.23	142
90	40-60	-40.60	5.60	-40.99	-40.08	-0.91	144
85-95	45-55	-40.85	4.79	-40.88	-40.80	-0.08	143
90	0-100	-42.37	6.49	-44.20	-40.49	-3.71	79
90	25-75	-41.32	5.36	-42.60	-39.98	-2.62	82

Table 2. Sex differences in abstract treatment

ABSTRACT
WINNING GAMBLES

Prob.	Payment	Male	Female	Difference	Number of Observations Male	Number of Observations Female
10	50	9.78	9.38	0.40	40	32
5-15	50	8.85	9.91	-1.06	40	32
0-20	50	9.23	8.52	0.71	40	33
10	45-55	10.23	9.35	0.88	39	31
10	40-60	10.25	9.25	1.00	40	32
5-15	45-55	9.65	7.94	1.71	40	32
10	0-100	9.48	9.59	-0.11	21	22
10	25-75	10.23	8.86	1.36	22	22
50	50	23.33	24.00	-0.67	39	33
45-55	50	22.64	22.91	-0.27	39	32
50	45-55	22.78	24.27	-1.50	40	33
45-55	45-55	22.77	22.69	0.08	39	32
90	50	40.38	41.55	-1.17	40	33
85-95	50	37.82	39.29	-1.47	38	31
80-100	50	39.21	40.67	-1.46	39	33
90	45-55	40.10	39.70	0.40	40	33
90	40-60	38.90	39.48	-0.59	39	33
85-95	45-55	38.74	39.79	-1.04	39	33
90	47-53	40.27	41.64	-1.36	22	22
90	44-56	38.82	41.55	-2.73	22	22

LOSING GAMBLES

Prob.	Payment	Male	Female	Difference	Number of Observations Male	Number of Observations Female
10	50	-11.66	-8.85	-2.81	38	33
5-15	50	-11.85	-9.27	-2.58	40	33
0-20	50	-13.03	-9.47	-3.56	40	32
10	45-55	-10.75	-9.21	-1.54	40	33
10	40-60	-11.62	-9.36	-2.25	39	33
5-15	45-55	-11.31	-9.82	-1.49	39	33
10	47-53	-11.14	-9.86	-1.27	22	22
10	44-56	-11.41	-9.55	-1.86	22	22
50	50	-27.38	-26.58	-0.81	39	33
45-55	50	-27.14	-25.13	-2.01	37	31
50	45-55	-27.23	-25.75	-1.48	39	32
45-55	45-55	-25.95	-25.24	-0.70	38	33
90	50	-41.59	-40.53	-1.06	39	32
85-95	50	-41.48	-40.75	-0.73	40	32
80-100	50	-40.38	-40.09	-0.29	39	33
90	45-55	-41.63	-39.94	-1.69	40	32
90	40-60	-42.00	-40.24	-1.76	40	33
85-95	45-55	-41.63	-41.24	-0.38	40	33
90	0-100	-45.05	-39.23	-5.83	19	22
90	25-75	-43.62	-40.09	-3.53	21	22

Table 3. Sex differences in context treatment

CONTEXT

WINNING GAMBLES

Prob.	Payment	Male	Female	Difference	Number of Observations Male	Number of Observations Female
10	50	10.96	10.48	0.48	46	27
5-15	50	10.11	8.57	1.54	46	28
0-20	50	8.66	6.70	1.96	44	27
10	45-55	10.20	8.96	1.23	46	27
10	40-60	10.85	9.75	1.10	46	28
5-15	45-55	10.13	8.52	1.61	46	27
10	0-100	11.52	10.06	1.47	21	18
10	25-75	9.29	8.22	1.06	21	18
50	50	25.29	23.43	1.86	45	28
45-55	50	25.40	24.63	0.77	45	27
50	45-55	25.84	23.24	2.60	45	29
45-55	45-55	23.60	22.79	0.81	45	29
90	50	43.31	40.52	2.79	45	29
85-95	50	41.33	39.22	2.10	46	27
80-100	50	42.61	40.10	2.51	44	29
90	45-55	43.13	40.21	2.92	46	28
90	40-60	42.07	41.56	0.51	46	27
85-95	45-55	42.28	39.14	3.14	46	29
90	47-53	40.33	39.89	0.44	21	19
90	44-56	41.67	39.11	2.56	21	19

LOSING GAMBLES

Prob.	Payment	Male	Female	Difference	Number of Observations Male	Number of Observations Female
10	50	-8.13	-9.78	1.64	45	27
5-15	50	-8.98	-9.82	0.84	45	28
0-20	50	-9.70	-10.28	0.58	43	29
10	45-55	-8.44	-9.81	1.37	45	27
10	40-60	-8.33	-9.85	1.52	45	27
5-15	45-55	-9.89	-9.43	-0.46	44	28
10	47-53	-8.45	-7.82	-0.63	20	17
10	44-56	-8.62	-10.47	1.85	21	19
50	50	-25.98	-26.04	0.06	44	25
45-55	50	-26.21	-24.89	-1.32	43	28
50	45-55	-25.24	-25.48	0.24	45	27
45-55	45-55	-25.42	-25.08	-0.34	43	26
90	50	-41.50	-41.21	-0.29	46	28
85-95	50	-41.09	-41.18	0.09	43	28
80-100	50	-40.93	-40.28	-0.66	45	29
90	45-55	-40.70	-42.07	1.38	43	27
90	40-60	-40.05	-39.89	-0.15	43	28
85-95	45-55	-40.20	-40.23	0.03	44	26
90	0-100	-43.43	-42.12	-1.31	21	17
90	25-75	-41.57	-39.83	-1.74	21	18

Appendix D.

Follow-up survey.

A. FINDING THE RIGHT VEHICLE FOR YOU

1) You may have consulted various sources for information regarding new vehicles before purchasing your vehicle. How important was each of the sources listed below in terms of the information provided to you.

	Not at all Important						Extremely Important
Family recommendations	☐	☐	☐	☐	☐	☐	☐
Friends' recommendations	☐	☐	☐	☐	☐	☐	☐
Buyer's Guides	☐	☐	☐	☐	☐	☐	☐
Trade Magazines	☐	☐	☐	☐	☐	☐	☐
On-line resources	☐	☐	☐	☐	☐	☐	☐
Car Dealerships	☐	☐	☐	☐	☐	☐	☐

2) How important was each of the following features in your decision to purchase your vehicle?

	Not at all Important						Extremely Important
Safety	☐	☐	☐	☐	☐	☐	☐
Price	☐	☐	☐	☐	☐	☐	☐
Reliability	☐	☐	☐	☐	☐	☐	☐
Style	☐	☐	☐	☐	☐	☐	☐
Cargo room	☐	☐	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐	☐	☐
Cost of insurance	☐	☐	☐	☐	☐	☐	☐
Resale value	☐	☐	☐	☐	☐	☐	☐

3) Which sources did you consult, if any, regarding the depreciation of your vehicle?
Check all that apply.

☐ Didn't consult any sources
☐ Buyer's Guides (Consumer Reports, AAA Guide, etc.)
☐ Trade Magazines (Car & Driver, Automotive News, etc.)
☐ Other sources_____

4) How many dealerships did you visit while looking for this your vehicle?

☐ 1
☐ 2
☐ 3
☐ 4
☐ More (number: _____)

5) What dealerships did you visit (Ford, Honda, etc.)?

_____

6) If you had not bought this particular vehicle, what vehicle would have been your second choice?
Please select one answer and fill in the blanks for that answer, if any.

☐ A new vehicle Make_____ Model_____ Price_____
☐ A used vehicle Make_____ Model_____ Price_____
☐ I would not have bought a vehicle.

B. NEED FOR THE VEHICLE

7) How closely do the following statements describe how you felt about purchasing your new vehicle?

	Strongly Disagree			Neither			Strongly Agree
It was an immediate necessity.	☐	☐	☐	☐	☐	☐	☐
It's something I could afford.	☐	☐	☐	☐	☐	☐	☐
It's a good investment.	☐	☐	☐	☐	☐	☐	☐
I bought it for fun.	☐	☐	☐	☐	☐	☐	☐

8) How many vehicles do you currently own including your new vehicle?

☐ 1
☐ 2
☐ 3
☐ More (number: _____)

9) How many vehicles are in your household (include those owned by a child, roommate, etc.)?

☐ 1
☐ 2
☐ 3
☐ More (number: _____)

10) If your car suffered a breakdown, how difficult would it be for you to get a ride for each of the following activities?

	Very Difficult						Very Easy
To work	☐	☐	☐	☐	☐	☐	☐
For shopping	☐	☐	☐	☐	☐	☐	☐
For emergencies	☐	☐	☐	☐	☐	☐	☐
For other leisure activities	☐	☐	☐	☐	☐	☐	☐

11) How many people live in your household (including yourself)?

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ More (number: _____)

12) How many people in your household can drive (including yourself)?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ More (number: _____)

C. YOUR VEHICLE'S RELIABILITY

13) How would you rank your vehicle's reliability against the majority of new vehicles sold in the United States?

Considerably Worse			Average			Considerably Better
☐	☐	☐	☐	☐	☐	☐

D. REPAIR EXPECTATIONS

For questions 14 and 15 in this section, the term "repair" *refers to having a part of your vehicle fixed or replaced due to failure or damage.* "Repair" *does NOT mean routine (or necessary) maintenance such as oil changes or replacing brake pads or the timing belt.*

14) After your base warranty expires, do you expect your vehicle to need any repair(s) costing over $1,000, in total, before it has reached 100,000 miles?

- ☐ Yes
- ☐ No

15) Have you had any repairs done on your new vehicle?

- ☐ Yes
- ☐ No

If YES, please list the type of repair, how much it cost, and if it was covered by the warranty?

Type of repair	Repair Cost ($)	Covered by warranty (Yes or No)
_____	_____	_____
_____	_____	_____
_____	_____	_____

16) You may have thought about the likelihood and cost of possible repairs or maintenance for your vehicle before purchasing it. What are the probability of breakdown or failure and the cost of repair for each part of your vehicle listed below in the first 100,000 miles? *Remember that percentages range from 0% (no chance) to 100% (a sure thing). A 50% chance is the same as calling heads or tails when flipping a coin.*

	Probability of breakdown in percentages ***(A number from 0 to 100)***	**Cost of repair($)**
Alternator	_____	_____
Front brake pads	_____	_____
Fuel Injection	_____	_____
Fuel Pump	_____	_____
Power steering pump	_____	_____
Starter	_____	_____
Struts/Shocks	_____	_____
Timing belt/chain	_____	_____
Transmission	_____	_____
Water pump	_____	_____

17) Do you have a mechanic, which isn't affiliated with the dealership, that you intend to use to repair your new vehicle after the warranty has expired?

- ☐ Yes
- ☐ No

E. EXPERIENCE WITH SERVICE CONTRACTS

18) Had you ever heard of a service contract or extended warranty before buying your new vehicle?

- ☐ Yes
- ☐ No

19) Many stores offer extended warranties for an additional charge. Have you bought one for: *(Please check all that apply.)*

- ☐ Home entertainment equipment (TV, stereo, VCR, etc.)
- ☐ Computer
- ☐ Other electronic equipment (camera, etc)
- ☐ Kitchen appliance (oven, microwave, refrigerator, etc.)
- ☐ Lawnmower or other yard equipment
- ☐ Other_____

F. ABOUT YOUR DRIVING

20) How many traffic tickets and accidents have you had in the past 2 years?

Traffic tickets _____
Accidents that were your fault _____
Accidents that were other drivers' fault _____

21) How many "close calls", or almost accidents, have you had in the past month?

☐ 0
☐ 1-2
☐ 3-5
☐ 6-8
☐ 9 or more

22) How frequently do you do each of the following while driving your vehicle?

	Never						Very Frequently
Yell at other drivers	☐	☐	☐	☐	☐	☐	☐
Cut off other drivers	☐	☐	☐	☐	☐	☐	☐
Exceed the speed limit by 10mph	☐	☐	☐	☐	☐	☐	☐
Talk on a cell phone	☐	☐	☐	☐	☐	☐	☐

Appendix E.

Experiment instructions.

Instructions

Do not communicate with any other participant during this experiment. Participants who do not abide by this rule will be excluded from the experiment and from all payments. If you have questions concerning the experiment please ask me.

In your folders are decision sheets with a list of various choice situations. These situations are of two different types: investment decisions and insurance decisions. An explanation of each type of situation and how the outcomes of these situations are determined will be given to you before you make any decisions.

Insurance Decisions

You have recently purchased a new car or truck. This vehicle may suffer some type of mechanical failure or breakdown and need to be repaired. There are decision sheets in your folder with a list of various choice situations. For each decision, you will choose between taking a chance on the vehicle breaking down and paying the cost of repair or purchasing insurance to insure yourself against having to pay for a repair. There is either a specified percentage chance or a range of percentage chances that the vehicle will need a repair. For example, there might be a 75% chance of a repair or a range such as 25-35%. Also, the cost of a repair is either a specified amount or a range. For example, there might be a $40 repair or a $50-60 repair. You will pay for any repair or insurance purchase with the $60 you earned for completing the survey.

How does the insurance decision work?

Two examples of some possible decisions are shown below.

Example 1.

	Option A	Option B	Your Choice A or B
Decision 1	50% chance at $30 repair	Pay $20.00	

Let's look at Decision 1. You can risk having to pay for a $30 repair with a 50% chance OR you can pay $20 to insure against any repair costs. If you choose to purchase insurance for $20, picking Option B, you will pay this amount and keep the rest of your money. That would be $40 in this case ($60 - $20 insurance = $40). If this decision is chosen for payment and you picked Option A then you will keep the $60 if the vehicle does not breakdown.

Example 2.

	Option A	Option B	Your Choice A or B
Decision 2	5-15% chance at $45-55 repair	Pay $1.00	

Let's look at Decision 2. You can risk having to pay for a $45-55 repair with a 5-15% chance OR you can pay $1 to insure against any repair costs. If you choose to purchase insurance for $1, picking Option B, you will pay this amount and keep the rest of your money. That would be $59 in this case ($60 - $1 insurance = $59). If this decision is chosen for payment and you picked Option A then you will keep the $60 if the vehicle does not breakdown.

How does this loss occur? First, we determine the exact percentage chance of the vehicle needing repair and the exact cost of the repair. In Example 1 these are already determined: the percentage chance of the vehicle needing a repair is 50% and the cost of the repair is $30.

In Example 2, we have to determine the exact percentage chance out of the 5-15% range. Each of the percentage chances of the vehicle needing a repair in the range is equally likely. You will draw a chip from a box of 11 white chips to determine the exact percentage chance of the vehicle needing repair. (There are 11 numbers in the range of 5-15% ⇒ 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.) Let's suppose you draw a 9. Then the percentage chance of the vehicle needing repair is 9%. Similarly, you will draw a chip from a box of 11 red chips to determine the cost of the repair. (There are 11 numbers in the range of $45-55 ⇒ 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55.) Each of the repair costs is equally likely. Let's suppose you draw a 53. Then the repair cost is $53.

Second, you will roll two ten-sided dice. (One die has "10s", and the other has "1s" on it. If you roll 00 on one die and 0 on the other, then that is rolling 100). Thus the roll will be a number between 1 and 100. If the number you roll is equal to or smaller than the percentage chance of the vehicle needing a repair, then your vehicle has had a breakdown and you will have to pay for repairs. If the number is higher than the percentage chance of the vehicle needing a repair, you do not have to pay any repair costs.

Continuing with Example 2. Suppose you have chosen to take a chance on the vehicle needing a repair and have drawn chips to determine there is a 9% chance of a repair costing $53. Then if you roll a number between 1 and 9, the vehicle needs a repair and you must pay the repair cost of $53. If you roll a number between 10 and 100, the vehicle does not need any repairs. Now suppose that, instead of taking a chance on the vehicle needing a repair, you chose to pay $1 in Decision 2 of Example 2. Then you will keep $59 ($60 - $1 = $59).

At the end of all of the sessions today, one of your insurance decisions from a decision sheet will be chosen randomly, and you will either take a chance on paying for a repair or pay for insurance. Your best strategy is to treat each decision as if it could be the one you will pay for.

I will now show you how these experiments are conducted.

Now is the time for questions. Feel free to ask any questions that you may have.

All of the participants have received identical decision sheets in the experiment. Please fill out the decision sheets in the order you find them. Remember to put your ID Code on each sheet. After you have completed each sheet please place it immediately in the yellow folder. You are not allowed to view or correct any decision sheets that you have placed in the yellow folder.

Investment Decisions

In this experiment, you are given an opportunity to invest between two different firms, Firm A and Firm B. There are decision sheets in your folder with lists of different decisions. For each decision, you will choose between investing in Firm A which is a risky investment with a larger possible return or investing in Firm B which has a certain return. For Firm A, there is either a specified percentage chance or a range of percentage chances that the firm will be successful. For example, there might be a 75% chance of a return or a range such as 25-35%. Also, the investment return for Firm A is either a specified amount or a range. For example, there might be a $40 return or a $50-60 return on investing.

How does investing work?

Two examples of some possible decisions are shown below.

Example 1.

	Firm A	Firm B	Your Choice A or B
Decision 1	10% chance at $20	$1.00	

Let's look at Decision 1. You can choose to invest in Firm A with a 10% chance at a $20 return OR you can choose to invest in Firm B and receive a certain return of $1.00. If this decision is chosen for payment and you picked Firm A then you will receive $20 if the firm is successful. If you picked Firm B you will receive $1.

Example 2.

	Firm A	Firm B	Your Choice A or B
Decision 2	85-95% chance at $45-55	$31.00	

Let's look at Decision 2 in this example. You can choose to invest in Firm A with an 85-95% chance at a $45-55 return OR you can choose to invest in Firm B and receive a certain return of $31.00. If this decision is chosen for payment and you picked Firm A then you will receive $45-55 if the firm is successful. If you picked Firm B you will receive $31.

How does this investment work? First, we have to determine the exact percentage chance of a return on investment and the exact amount of the return for Firm A. In Example 1 these are already determined: the percentage chance of a return is 10% and the return is $20.

In Example 2, we have to determine the exact percentage chance of a return out of the 85-95% range. Each of the percentage chances of a return in the range is equally likely. You will draw a chip from a box of 11 white chips to determine the exact percentage chance of a return. (There are 11 numbers in the range of 85-95% ⇒ 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95.) Let's suppose you draw a 92. Then the percentage chance of a return is 92%. Similarly, you will draw a chip from a box of 11 red chips to determine the amount of the return on your investment. (There are 11 numbers in the range of $45-55 ⇒ 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55.) Let's suppose you draw a 48. Then the return is $48 if the firm is successful.

Second, you will roll two ten-sided dice to see if the firm is successful. (One die has "10s", and the other has "1s" on it. If you roll 00 on one die and 0 on the other, then that is rolling 100). Thus the roll will be a number between 1 and 100. If the number you roll is equal to or smaller than the percentage chance of a return, the firm

is successful and you will ***receive*** the investment return. If the number is higher than the percentage chance of a return, the firm is not successful and you will ***not*** receive any return on your investment.

Continuing with Example 2. Suppose you have chosen to invest in Firm A and the chips have been drawn to determine there is a 92% chance of a return of $48. Then if you roll a number between 1 and 92, the firm is successful and you receive the $48 return. If you roll a number between 93 and 100, the firm is unsuccessful and you do not receive any return on your investment.

At the end of all of the sessions today, one of your investment decisions from a decision sheet will be chosen randomly, and you will be paid in cash for your decision about this investment opportunity. Your best strategy is to treat each decision as if it could be the one you get paid for.

I will now show you how these experiments are conducted.

Now is the time for questions. Feel free to ask any questions that you may have.

All of the participants have received identical decision sheets in the experiment. Please fill out the decision sheets in the order you find them. Remember to put your ID Code on each sheet. After you have completed each sheet please place it immediately in the blue folder. You are not allowed to view or correct any decision sheets that you have placed in the blue folder.

Vita

Evan Moore was born January 29, 1973, in Richmond, Virginia. He received his B.S. in Economics from Virginia Commonwealth University in 1995. He entered Virginia Polytechnic Institute and State University in August 1997, and received his Ph.D. in December 2002.