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Essays on Accident Forgiveness in Automobile Insurance

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Essays on Accident Forgiveness in Automobile Insurance

BY

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

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ACCEPTANCE

This dissertation was prepared under the direction of the Fan Liu's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

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ABSTRACT

Essays on Accident Forgiveness in Automobile Insurance

BY

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Accident forgiveness, often considered as a type of "premium insurance," protects the insured against a premium increase if an at-fault accident occurs. Although accident forgiveness has received considerable attention in the auto insurance industry, there is little or no literature on accident forgiveness in the actual contract. In this dissertation, I use dynamic modeling to examine optimal insurance contracts with an accident forgiveness option and further use a structural modeling approach to investigate the impacts of risk and time preferences on the accident forgiveness contract purchase. This study attempts to improve our understanding of the implications of this new type of insurance option.

The first essay develops an asymmetric learning model in which insurers compete to attract policyholders. When information about previous at-fault accidents is not shared perfectly by insurers in the market, information asymmetries arise between the initial insurer and the rival insurer, as well as between the insured and the insurer. I design an auto insurance contract with accident forgiveness that charges policyholders higher-than-market premiums according to their risk types in the first period and then experience-rates both types in the second period contingent on their previous at-fault accidents. Contrary to the prior literature, which elicits competition as the reason to temper the effects of experience rating, this model is built such that accident forgiveness is the device to temper experience rating. This

contract attracts policyholders since it “forgives” at-fault accidents and provides “rewards” in terms of coverage and premiums for those who remain accident-free.

Risk and time preferences influence a variety of economic behaviors. In the field of insurance economics, attitudes toward risk and time are likely to affect the insurance purchase decision. As can be observed in the auto insurance market, when offered an optional accident forgiveness policy from insurers, the insured shows different purchase patterns, regardless of driving behavior. The question of whether and how individual risk aversion and discount rates affect the accident forgiveness purchase decision is critical to understanding contract design. In the second essay, by conducting a unique experiment under controlled laboratory conditions, I examine the role of risk and time preferences in accident forgiveness contract purchase and determine that individual discount rates and product prices are significant factors. Interestingly, I also find evidence that less risk-averse policyholders generally behave more like risk-neutral agents when making insurance decisions. Risk attitudes affect insurance decision-making only among those with a relatively high degree of risk aversion.

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Chapter 1

ACCIDENT FORGIVENESS IN THE AUTOMOBILE INSURANCE CONTRACT

1.1 Introduction

In recent years, we have been hearing and seeing more about accident forgiveness policies on TV, billboards, and in Internet forums. Accident forgiveness, often considered as "premium insurance," protects the insured against a premium increase if an at-fault accident occurs. With accident forgiveness, insurance rates do not go up due to an accident. Insurance companies know that drivers are fearful of the financial consequences of being in even the most minor accidents, which is why insurers are promoting accident forgiveness policies. Allstate successfully launched its accident forgiveness option in 2005 as part of its "Your Choice Auto" insurance program. This offering fundamentally changed the type of products traditionally offered by insurers by presenting consumers with more innovative features.[1] Following Allstate's lead, other major auto insurance companies in the U.S. market, such as Geico (Government Employees Insurance Company), Progressive, and Travelers, have also started offering their existing customers this feature (see Table 1.1).

Interestingly, most insurers offering accident forgiveness policies in the United States provide this feature for "free" to their existing policyholders who have maintained an accident-

[1] "Your Choice Auto" consumers can choose from three packages: Platinum Protection, Gold Protection, and the Allstate Value Plan. Based on their individual needs, consumers can choose among such features as accident forgiveness, new safe driving rewards, and enhanced protection for new cars.

Table 1.1. Top 10 Writers of PPA Insurance in the United States (2009)

Rank	Group	Market Share	Offering Accident Forgiveness
1	State Farm Mutual	18.60%	Guaranteed if accident free for 9 years
2	Allstate	10.50%	As part of “Your Choice Auto”
3	Berkshire Hathaway	8.20%	Guaranteed if accident free for 5 years
4	Progressive	7.50%	Guaranteed if accident free for 3 years
5	Zurich Financial Services	6.40%	As part of “Farmers Flex”
6	Nationwide Mutual	4.50%	Guaranteed if accident free for 3 years
7	Liberty Mutual	4.40%	Guaranteed if accident free for 5 years
8	USAA	4.10%	Guaranteed if accident free for 5 years
9	Travelers	2.10%	Guaranteed if accident free for 5 years
10	American Family Mutual	2.00%	Guaranteed if accident free for 3 years

Note: Adapted from SNL Financial LC and insurance companies’ websites.

free record for a number of consecutive years. For example, Geico requires that policyholders be accident free for five years to qualify for the accident forgiveness benefits.[2] With Travelers’ accident forgiveness policy, customers who have been with Travelers for four years or more and accident free for five years will not see a surcharge for their first qualifying accident.[3] However, a few insurers sell accident forgiveness as an optional feature in the insurance contract to all customers (see Table 1.1). For example, Allstate sells accident forgiveness as part of its “Your Choice Auto Insurance” program and Farmers sells this feature as part of its “Farmers Flex” program.[4] In both programs, customers are allowed to purchase accident forgiveness by paying an additional premium.

Although accident forgiveness has received considerable attention in the auto insurance industry, there is little or no literature on accident forgiveness in the actual insurance

[2] See Geico’s official website at http://www.geico.com/information.

[3] See Traveler’s official website at https://www.travelers.com/personal-insurance/auto-insurance.

[4] “Farmers Flex” provides customers with a new set of options and features such as accident forgiveness and a new car pledge package.

contract.[5] This paper contributes to the existing literature by developing an asymmetric learning model to examine optimal insurance contracts in the market with accident forgiveness provided as an optional feature. My study attempts to improve our understanding of this new policy feature in insurance contracting.

This paper develops a two-period model in which insurers compete to attract policyholders. Individuals are risk averse and subject to a possible income loss in each period. As usual,[6] the model presumes asymmetric information by assuming that the probability of loss is not known initially by all insurers and at-fault accidents that occurred in the first period are only observed by the initial insurer. When information about previous at-fault accidents is not shared perfectly by the insurers in the market, information asymmetries arise between the initial insurer and its rival insurer, as well as between the insured and the insurer. Regardless of the assumption of no commitment in the prior literature (e.g., Nilssen, 2000), in this model insurers are able to commit to the two-period contract but policyholders always have the option to switch insurers ex post.[7] I design an accident forgiveness policy that charges policyholders higher-than-market premiums according to their risk types in the first period and experience-rates both types in the second period contingent on their previous at-fault accidents. Contrary to the prior literature, which elicits competition as the reason

[5] Nini (2009) empirically investigates claim reporting behavior in the auto insurance market that provides accident forgiveness to policyholders. The author finds that changes in claim reporting behavior can account for nearly all of the increase in claims. After controlling for differences in observable characteristics, Nini shows that the increase in claim frequency is concentrated in relatively small claims and claims where the policyholder is at-fault, suggesting that consumers without premium protection strategically choose not to report such claims to the insurance company.

[6] Much effort has been spent on thinking about designing an auto insurance contract in a dynamic market with the existence of asymmetric information (e.g., Cooper and Hayes, 1987; Dionne and Doherty, 1994; Kunreuther and Pauly, 1985; Nilssen, 2000; and Rothschild and Stiglitz, 1976).

[7] This paper refers to such a situation as semi-commitment, consistent with the specification of Dionne and Doherty (1994).

to temper the experience rating (e.g., Cooper and Hayes, 1987), this model is built such that accident forgiveness is the device that tempers the experience rating and, of course, is the incentive for policyholders to purchase it. Such an accident forgiveness contract attracts policyholders because it "forgives" at-fault accidents and provides "rewards" in terms of coverage and premiums for those who remain accident-free. By offering this feature to all policyholders in the pool, the insurer appears to not only lock in its loyal customers but also attract additional low-risk customers.

This paper's other noteworthy contribution is analyzing individual accident forgiveness purchases. I treat accident forgiveness explicitly as "premium insurance" where consumers purchase premium protection that gives them the right to make at-fault claims without experiencing an increase in their premiums. An insurance purchase decision, as an investment decision under uncertainty, may be affected by individual risk and time preferences (e.g., Hirshleifer, 1966). By allowing randomization of both risk types of customers over contracts, my results suggest a nondecreasing effect of the discount factor on the individual accident forgiveness purchase. Further, risk-averse individuals are more likely to purchase accident forgiveness if the expected utility provided by the insurance contract is above a certain threshold. This finding differs from those in the prior literature, which suggest that risk-averse individuals always purchase more insurance.

The paper is organized as follows. Section 2 discusses previous studies related to multi-period insurance contracts. Section 3 introduces the features of accident forgiveness in the current insurance market. Section 4 outlines the basic model and examines the characterization for the optimal contract. Section 5 establishes the impact of the discount factor and risk aversion on accident forgiveness purchases. Section 6 draws the study's conclusions.

1.2 Literature Review

Multi-period contracting is observed in different markets. In the auto insurance market, consumers typically make repeat purchases. For example, in many countries, drivers purchase automobile insurance with the same insurer for many years and the insurers use bonus-malus systems to relate insurance premiums to an individual's past experience (e.g., Dionne et al., 2005; Dionne and Vanasse, 1992; Hey, 1985; Lemaire, 1985). Multi-period contracting is also observed in workers' compensation insurance, unemployment insurance, and many other markets. The introduction of multi-period contracts in the analysis raises many issues, such as time discounting, the commitment of the parties, myopic behavior, and information asymmetry. Multi-period insurance contracts are set not only to adjust ex-post insurance premiums or insurance coverage to past experience but also as a sorting device. They can be a complement to or a substitute for standard self-selection mechanisms (Dionne, 2000, p. 194).

Cooper and Hayes (1987) were the first to consider a repeated insurance problem with adverse selection. They use the Nash equilibrium concept in a two-period game where the equilibrium must be separating.[8] Cooper and Hayes introduce a second instrument to induce self-selection: experience rating. Experience rating increases the cost to high-risk individuals masquerading as low-risk individuals by exposing them to second-period contingent coverage and premiums. The formal problem consists of maximizing the low-risk policyholder's two-period expected utility under the incentive compatibility constraints, the

[8]The authors implicitly assume that the conditions to obtain a Nash separating equilibrium in a single-period contract are sufficient for an equilibrium to exist in their two-period model.

nonnegative intertemporal expected profits constraint, and the no-switching constraints. By assuming that the insurers commit to a two-period contract but the contract is not binding on the insured, they show that the presence of a second-period competition limits the use of experience rating as a sorting device. At equilibrium, high-risk individuals obtain full insurance coverage and are not experience rated, whereas low-risk individuals receive only partial insurance coverage and are experience rated.

Dionne and Doherty (1994) introduce renegotiation in long-term relationships in insurance markets. In a similar vein to Cooper and Hayes (1987), two-period contracts are considered where the insured can leave the relationship at the end of the first period and only the insurer is bound by a multi-period agreement. The difference with the Cooper-Hayes model is in the possibility of renegotiation. Indeed, insurers are allowed to propose altering the contract with their insured, which can be accepted or rejected. Dionne and Doherty present an alternative model (extending that of Laffont and Tirole, 1990)[9] that involves semi-pooling in the first period followed by separation in the second. Their model offers two contracts. One contract is selected only by high-risk types and the other by both risk types; thus only the high risks can randomize over two contracts. Dionne and Doherty conclude that partial coverage is offered in the first-period semi-pooling contract along with full coverage offered to high risks in the second period. Further, both high risks and low risks are experience rated in the second period. Other models of multi-period insurance markets are not as closely related to this work as that of Cooper and Hayes (1987) and

[9]Laffont and Tirole (1990) fully characterize the equilibrium of a two-period procurement model with commitment and renegotiation. They analyze whether renegotiated long-term contracts yield outcomes resembling those under either non-renegotiated long-term contracts or a sequence of short-term contracts and they link the analysis with the multiple-unit durable goods monopoly problem.

Dionne and Doherty (1994). For example, Nilssen (2000) focuses on consumer lock-in under a no-commitment assumption and illustrates that an equilibrium may exist with full pooling in the first period and consumer lock-in in the second period.

In this paper, I build a two-period model in a competitive insurance market with separation in both periods. This model, an extension of both Cooper and Hayes (1987) and Dionne and Doherty (1994), reveals that an accident forgiveness policy offered in the market induces a policyholder's willingness to stay with the same insurer. My model shares the basic feature of Dionne and Doherty (1994) regarding multi-period insurance contracts; that is, two contracts are offered, with asymmetric information between the insured and insurers. However, my model differs in several respects. I focus primarily on providing a model with full separation in both periods.[10] Contracts are allowed to be selected by both high risks and low risks, which means that both types can "randomize" over the contracts with accident forgiveness. In the second period, not just the low risks but both the low and high risks are experience rated. Finally, the main difference between my work and the previous literature lies in the analysis of the insurance purchase decision. My findings indicate that the discount factor between periods and the degree of risk aversion are important determinants of accident forgiveness purchases.

[10]Separation in the first period is exactly the phenomenon observed in the automobile insurance market. Practically, it is hard for insurers to pool different types of individuals together and offer them the same contracts.

1.3 Accident Forgiveness

When one is involved in an at-fault accident (or traffic violation), points against one's driving record are considered, depending on the description of the accident (or traffic violation) and the insurer's rating system. Surcharges or discounts on premiums are based on one's driving record. The more points one has, the worse the driving record becomes and the higher the premium. For example, if one has an at-fault accident, according to the current surchargeable point schedule in Massachusetts, the driving record can increase three to four points, depending on the claim amount.[11] However, with an accident forgiveness policy, the points do not increase as much, if at all.[12] By protecting the customer's driving record, accident forgiveness results in a reduction in the auto insurance premium.

In short, the availability of accident forgiveness varies by company. If available, it is simply a built-in feature of an insurer's regular auto insurance policy or can be purchased as an option. Even if this feature is provided, it does not mean that an accident that occurred before the purchase would be forgiven. Instead, it means that if an accident were to occur in the future, it would be forgiven within the conditions and terms specified in the insurance contract. The number of at-fault accidents allowed to be forgiven varies with the insurer.[13] Even if accident forgiveness is part of a policy, having an accident "forgiven" by an insurance company does not mean the accident is completely removed from one's driving record. The

[11] The following is the current surchargeable point schedule in Massachusetts (see the official website of the Massachusetts Office of Consumer Affairs and Business Regulation at http://www.mass.gov). A major traffic violation (such as driving under the influence, or DUI) if worth five points; a major at-fault accident (such as a claim over $2,000), four points; a minor at-fault accident (claim of $500 to $2,000), three points; and a minor traffic violation (such as speeding), two points.

[12] These points will still apply to an at-fault accident and can be assessed by the state.

[13] This paper simply assumes that all at-fault accidents or traffic violations may be forgiven.

accident will remain there even if the insurer offering the "forgiveness" does not consider it when calculating the auto insurance premium.[14]

[14] In the United States, the length of time that an auto accident stays on one's driving record varies according to the state residency. For example, in Illinois any chargeable claim increases the price of insurance for three years following the claim (Israel, 2004).

1.4 The Model

1.4.1 Model Assumptions and the Sequence of the Game

I consider a two-period insurance market. Individuals (or the insured) are assumed to be risk averse and in each period individuals are subject to a risk of financial loss. Individuals differ solely by their probability of loss. High-risk individuals have a higher probability of experiencing a loss (accident) than low-risk individuals. The respective proportions of high and low risks are assumed to permit a single-period Nash separating equilibrium to exist.[15] Risk type is private information to the individuals, and accidents are out of an individual's control so that no moral hazard arises. The insured share the same von Neumann-Morgenstern utility function with the same per-period income.[16] Two insurers (the initial insurer and a rival insurer) in the market compete to attract the insured and are assumed to be risk neutral. I assume that the incumbent initial insurer is the only one in the market to offer accident forgiveness in contracts and observes its policyholders' loss experience (there is no underreporting of accidents). Moreover, borrowing or lending by the insured is not permitted but they are allowed to switch between insurers at no cost.

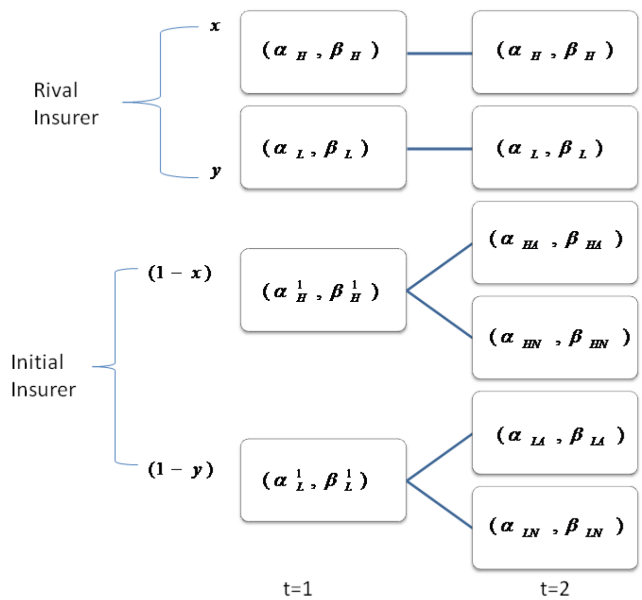
The game depicted in Figure 1.1 runs as follows:

1. At the beginning of the first period, the initial insurer offers an accident forgiveness contract with premium α_H^1 and coverage β_H^1 to high-risk individuals and a premium α_L^1 and coverage β_L^1 to low-risk individuals.

[15] Rothschild and Stiglitz (1976) prove that a competitive insurance market may have no equilibrium if there are relatively few high-risk individuals who must be subsidized.

[16] The utility function $U(.)$ is assumed to be twice continuously differentiable with $U^{''}(.) < 0 < U^{'}(.)$.

Figure 1.1. The Depiction of Two-Period Model



2. The rival insurer simultaneously offers optimal one-period Rothschild/Stiglitz contracts with α_H and β_H as premium and coverage, respectively, to high-risk individuals and, α_L and β_L, respectively, to low-risk individuals. The optimal one-period Rothschild/Stiglitz contracts can be summarized as follows: High-risk individuals receive full insurance; Low-risk individuals receive less than full insurance and the high-risk individuals are indifferent between their contracts and the low-risk ones (Rothschild and Stiglitz,1976).

3. Individuals choose among available contracts. Here $(1 - x)$ refers to the proportion of high-risk individuals purchasing accident forgiveness contracts from the initial insurer and $(1 - y)$ is the proportion for low risk individuals. Premiums are paid and the first period ends. Wealth losses are realized and the insured who experienced a loss are

compensated according to the first-period component of their contracts by receiving the net reimbursement.[17]

4. At the beginning of the second period, contingent on having the first-period accident or not, the initial insurer offers the existing insured four different contracts: α_{HA} and β_{HA} as premium and coverage for high risks who had an accident in the previous period, α_{HN} and β_{HN} as premium and coverage for high risks with no accident in the previous period, α_{LA} and β_{LA} as premium and coverage for low risks who had an accident in the previous period, and α_{LN} and β_{LN} as premium and coverage for low risks with no accident in the previous period.

5. The rival insurer again offers repeated one-period contracts at the beginning of the second period.

6. Individuals choose to either continue their contracts with the initial insurer or switch to the one-period contracts provided by the rival insurer. Premiums are paid and the second period elapses; wealth losses occur and are compensated according to the contracts.

[17] Net reimbursement equals the indemnity paid under the insurance contract in a loss state minus the premium paid out.

1.4.2 Model Setup

The derivation of the optimal contract is obtained by maximizing the following problem (See the Appendix A for notation used in the model):

$$\begin{aligned} \max_{\alpha,\beta} \quad & p_L[U(W-D+\beta_L^1)+\delta[p_L U(W-D+\beta_{LA})+(1-p_L)U(W-\alpha_{LA})]] \\ & +(1-p_L)[U(W-\alpha_L^1)+\delta[p_L U(W-D+\beta_{LN})+(1-p_L)U(W-\alpha_{LN})]], \end{aligned} \tag{1.1}$$

which is the utility of low risks purchasing an accident forgiveness contract in the first period and remaining with the same initial insurer for the second period. This maximization problem is subject to the randomization constraints

$$\begin{aligned} & p_H[U(W-D+\beta_H^1)+\delta[p_H U(W-D+\beta_{HA})+(1-p_H)U(W-\alpha_{HA})]] \\ & +(1-p_H)[U(W-\alpha_H^1)+\delta[p_H U(W-D+\beta_{HN})+(1-p_H)U(W-\alpha_{HN})]] \\ & =(1+\delta)[p_H U(W-D+\beta_H)+(1-p_H)U(W-\alpha_H)], \end{aligned} \tag{1.2}$$

$$\begin{aligned} & p_L[U(W-D+\beta_L^1)+\delta[p_L U(W-D+\beta_{LA})+(1-p_L)U(W-\alpha_{LA})]] \\ & +(1-p_L)[U(W-\alpha_L^1)+\delta[p_L U(W-D+\beta_{LN})+(1-p_L)U(W-\alpha_{LN})]] \\ & =(1+\delta)[p_L U(W-D+\beta_L)+(1-p_L)U(W-\alpha_L)]; \end{aligned} \tag{1.3}$$

the self-selection constraints

$$
\begin{aligned}
&p_H[U(W-D+\beta_H^1)+\delta[p_H U(W-D+\beta_{HA})+(1-p_H)U(W-\alpha_{HA})]] \\
&+(1-p_H)[U(W-\alpha_H^1)+\delta[p_H U(W-D+\beta_{HN})+(1-p_H)U(W-\alpha_{HN})]] \\
&\geq (1-x)\{p_H[U(W-D+\beta_L^1)+\delta[p_H U(W-D+\beta_{LA})+(1-p_H)U(W-\alpha_{LA})]] \\
&+(1-p_H)[U(W-\alpha_L^1)+\delta[p_H U(W-D+\beta_{LN})+(1-p_H)U(W-\alpha_{LN})]]\} \\
&+x(1+\delta)[p_H U(W-D+\beta_L)+(1-p_H)U(W-\alpha_L)],
\end{aligned}
\tag{1.4}
$$

$$
\begin{aligned}
&p_L[U(W-D+\beta_L^1)+\delta[p_L U(W-D+\beta_{LA})+(1-p_L)U(W-\alpha_{LA})]] \\
&+(1-p_L)[U(W-\alpha_L^1)+\delta[p_L U(W-D+\beta_{LN})+(1-p_L)U(W-\alpha_{LN})]] \\
&\geq (1-y)\{p_L[U(W-D+\beta_H^1)+\delta[p_L U(W-D+\beta_{HA})+(1-p_L)U(W-\alpha_{HA})]] \\
&+(1-p_L)[U(W-\alpha_H^1)+\delta[p_L U(W-D+\beta_{HN})+(1-p_L)U(W-\alpha_{HN})]]\} \\
&+y(1+\delta)[p_L U(W-D+\beta_H)+(1-p_L)U(W-\alpha_H)];
\end{aligned}
\tag{1.5}
$$

the accident forgiveness constraints[18]

$$p_H U(W-D+\beta_{HA})+(1-p_H)U(W-\alpha_{HA}) = p_H U(W-D+\beta_H)+(1-p_H)U(W-\alpha_H), \tag{1.6}$$

$$p_L U(W-D+\beta_{LA})+(1-p_L)U(W-\alpha_{LA}) = p_L U(W-D+\beta_L)+(1-p_L)U(W-\alpha_L); \tag{1.7}$$

[18] Accident forgiveness as the policy feature binds the contract the initial insurer can offer in the second period to policyholders who had an accident in the first period. I call these two constraints "accident forgiveness constraints."

and the zero-profit constraint for the insurer

$$(1-x)\{[(1-p_H)\alpha_H^1 - p_H\beta_H^1] + \delta[(1-p_H)[(1-p_H)\alpha_{HN} - p_H\beta_{HN}] + p_H[(1-p_H)\alpha_{HA} - p_H\beta_{HA}]]\}$$
$$+(1-y)\{[(1-p_L)\alpha_L^1 - p_L\beta_L^1] + \delta[(1-p_L)[(1-p_L)\alpha_{LN} - p_L\beta_{LN}] + p_L[(1-p_L)\alpha_{LA} - p_L\beta_{LA}]]\}$$
$$\geq 0. \tag{1.8}$$

The constraints shown in expressions (1.2) and (1.3) are randomization constraints that ensure that both low and high risks are indifferent between their own one-period contracts and the accident forgiveness contracts. With these constraints, the insured with the same risk type will randomize over different contracts. Expression (1.4) is the self-selection constraint for high risks and guarantees that high risks will not mimic low risks. High risks only prefer a randomization over the one-period contract and the accident forgiveness contract for high risks to a randomization over contracts for low risks. Expression (1.5) is the self-selection constraint for low risks. The purpose of purchasing accident forgiveness is to allow policyholders to have at-fault accidents without a premium increase. Expressions (1.6) and (1.7) are accident forgiveness constraints and illustrate that the initial insurer providing accident forgiveness contracts must keep its promise to offer policyholders with a first-period accident the same second-period expected utility as the one they can obtain from uninformed rival insurer. Expression (1.8) as a zero-profit constraint prevents insurers from offering contracts at a loss.

A policy designed for high risks obviously offers full insurance, since partial insurance would simply provide incentives for imitation and offer an opportunity for renegotiation.[19] The self-selection constraints (1.4) for high-risk individuals and (1.5) for low-risk individuals can be rewritten as

$$\begin{aligned}&U(W-\alpha_H^1)+\delta[p_H U(W-\alpha_{HA})+(1-p_H)U(W-\alpha_{HN})]\\&\geq(1-x)\{p_H[U(W-D+\beta_L^1)+\delta[p_H U(W-D+\beta_{LA})+(1-p_H)U(W-\alpha_{LA})]]\\&+(1-p_H)[U(W-\alpha_L^1)+\delta[p_H U(W-D+\beta_{LN})+(1-p_H)U(W-\alpha_{LN})]]\}\\&+x(1+\delta)[p_H U(W-D+\beta_L)+(1-p_H)U(W-\alpha_L)]\end{aligned} \tag{1.4'}$$

and

$$\begin{aligned}&p_L[U(W-D+\beta_L^1)+\delta[p_L U(W-D+\beta_{LA})+(1-p_L)U(W-\alpha_{LA})]]\\&+(1-p_L)[U(W-\alpha_L^1)+\delta[p_L U(W-D+\beta_{LN})+(1-p_L)U(W-\alpha_{LN})]]\\&\geq(1-y)\{U(W-\alpha_H^1)+\delta[p_L U(W-\alpha_{HA})+(1-p_L)U(W-\alpha_{HN})]\}\\&+y(1+\delta)U(W-\alpha_H),\end{aligned} \tag{1.5'}$$

respectively.

Similarly, the randomization constraint (1.2), the accident forgiveness constraint (1.6), and the zero-profit constraint (1.8) can be also rewritten as

$$U(W-\alpha_H^1)+\delta[p_H U(W-\alpha_{HA})+(1-p_H)U(W-\alpha_{HN})]=(1+\delta)U(W-\alpha_H), \tag{1.2'}$$

[19]Full insurance means that the insured has the same utility regardless of loss experience, for example, $U(W-D+\beta)=U(W-\alpha)$ or $\beta=D-\alpha$.

$$U(W - \alpha_{HA}) = U(W - \alpha_H), \tag{1.6'}$$

$$(1-x)\{[(\alpha_H^1 - p_H D)] + \delta[(1-p_H)(\alpha_{HN} - p_H D) + p_H(\alpha_{HA} - p_H D)]\}$$
$$+(1-y)\{[(1-p_L)\alpha_L^1 - p_L\beta_L^1] + \delta[(1-p_L)[(1-p_L)\alpha_{LN} - p_L\beta_{LN}] + p_L[(1-p_L)\alpha_{LA} - p_L\beta_{LA}]]\}$$
$$\geq 0. \tag{1.8'}$$

1.4.3 Optimal Contracts with Asymmetric Information

This section characterizes and comments on the optimal two-period contracts with accident forgiveness.

Optimal contracts characterization To characterize optimal contracts by solving the maximization problem, one needs to determine whether the constraints are binding. Due to the fact that competition and freedom of entry without transaction costs ensure that the profit for each type of contract will be driven to zero, the zero-profit constraint is binding with a Lagrangian multiplier $\lambda_z > 0$.

The self-selection constraint with $\lambda_{hss} > 0$ for high risks is necessary to ensure that the high risks do not select the contracts for low risks. As usual, the constraint for low risks cannot possibly be binding, because if the high risks were indifferent between the two contracts, the low risks would strictly prefer their own contracts since only the high risks have incentives to mimic the low risks.[20] Thus, $\lambda_{lss} = 0$.

[20] In principal-agent theory, a principal faces two self-selection constraints: one for high risks not to mimic low risks and one for low risks not to mimic high risks. Only one of these constraints is binding and the other constraint that is indeed satisfied when ignored in the principal's optimization program can be verified ex post (Bolton and Dewatripont, 2005).

Because the accident forgiveness constraints are binding, it follows

$$\alpha_{HA} = \alpha_H, \alpha_{LA} = \alpha_L, \beta_{HA} = \beta_H, \beta_{LA} = \beta_L. \tag{1.9}$$

With Lagrange multipliers, let us substitute these values into the problem to simplify the derivation and take the first-order condition of the maximization problem. Then one obtains

$$U'(W - \alpha_L^1) = \frac{\lambda_z(1-p_L)(1-y)}{(1-p_L) + \lambda_{lr}(1-p_L) - \lambda_{hss}(1-p_H)(1-x)}, \tag{1.10}$$

$$U'(W - D + \beta_L^1) = \frac{\lambda_z p_L(1-y)}{p_L + \lambda_{lr}p_L - \lambda_{hss}p_H(1-x)}, \tag{1.11}$$

$$U'(W - \alpha_{LN}) = \frac{\lambda_z(1-p_L)^2(1-y)}{(1-p_L)^2 + \lambda_{lr}(1-p_L)^2 - \lambda_{hss}(1-p_H)^2(1-x)}, \tag{1.12}$$

$$U'(W - D + \beta_{LN}) = \frac{\lambda_z p_L(1-p_L)(1-y)}{(1-p_L)p_L + \lambda_{lr}(1-p_L)p_L - \lambda_{hss}p_H(1-p_H)(1-x)}. \tag{1.13}$$

Because $p_L < p_H$, comparing $U'(W - \alpha_L^1)$ from (1.10) and $U'(W - D + \beta_L^1)$ from (1.11) yields

$$U'(W - \alpha_L^1) < U'(W - D + \beta_L^1),$$

and, with the assumption of the utility function, $U' > 0$ and $U'' < 0$, we see

$$U(W - \alpha_L^1) > U(W - D + \beta_L^1), \tag{1.14}$$

which identifies the partial coverage for (α_L^1, β_L^1) as the contract offered in the first period.

Similarly, using $U'(W-\alpha_{LN})$ from (1.12) and $U'(W-D+\beta_{LN})$ from (1.13), one obtains

$$U(W-\alpha_{LN}) > U(W-D+\beta_{LN}), \tag{1.15}$$

which also points to the partial coverage for the contract $(\alpha_{LN}, \beta_{LN})$ offered in the second period to low-risk individuals with no loss in the first period.

To determine α_{HN} as the premium for high risks with no loss in the first period, I adopt the concept of a "rent-constraint contract," proposed by Laffont and Tirole (1990).[21] The idea is as follows. Considering that high risks would receive the full-insurance, fair-priced policy in the repeated one-period contracts from the rival insurer, they would deviate to adopt the strategy of accident forgiveness contracts, which involves an up-front premium in the first period if the expectation of cost is no higher than the actuarially fair price from the repeated one-period contracts. Thus, to participate in the accident forgiveness contract, high risks with no first-period loss must receive a rent that is implicitly embodied by the premium α. With competition, the insurer cannot offer a rent to the high risks greater than that corresponding to the transfers paid in the first period, which are determined by the value of x and y. Hence, the premium α_{HN} can be written as $\alpha_{HN}(x,y)$ and the rent given to the high-risk individuals with no first-period loss can be derived from

$$(1-x)(\alpha_H^1 - p_H D) + (1-y)[(1-p_L)\alpha_L^1 - p_L\beta_L^1] + \delta[(1-x)(1-p_H)(\alpha_{HN}(x,y) - p_H D)] = 0.$$

[21] Laffont and Tirole (1990) explain the rent-constraint contract as a contract in which the principal would wish to lower the rent but cannot because of the existence of the initial contract.

Solving for $\alpha_{HN}(x, y)$ yields

$$\alpha_{HN}(x,y) = p_H D - \frac{[(1-x)(\alpha_H^1 - p_H D) + (1-y)[(1-p_L)\alpha_L^1 - p_L\beta_L^1]]}{\delta(1-x)(1-p_H)}, \tag{1.16}$$

which can be further written as

$$\alpha_{HN}(x,y) = p_H D - \frac{T(x,y)}{\delta(1-x)(1-p_H)}, \tag{1.16'}$$

where

$$T(x,y) = (1-x)(\alpha_H^1 - p_H D) + (1-y)[(1-p_L)\alpha_L^1 - p_L\beta_L^1] \tag{1.17}$$

is the net transfer paid to the insurer in the first period from both types. Obviously, $T(x, y) = 0$ when $x = 1$ and $y = 1$ (e.g., no one purchases the accident forgiveness policy).

Here, it is assumed that the rent paid to the low risks in the second period is zero.[22] It is seen that low risks with no loss in the first period will receive an actuarially fair premium α_{LN}. Moreover, to induce them to participate in the accident forgiveness contracts, more coverage β_{LN} will be given in the second period.

Apparently, the rent offered to high risks to participate in this contract is from both intertemporal and cross-sectional subsidization. In other words, only if the insurer makes a profit in the first period by charging a higher-than-market premium will it support the rent given to policyholders in the second period, which results in $\alpha_H^1 > \alpha_{HA} > \alpha_{HN}$ and $\alpha_L^1 > \alpha_{LA} > \alpha_{LN}$. The high upfront premium for the two-period contract can be thought

[22] Laffont and Tirole (1990) demonstrate that there should be no efficiency gain if introducing the additional rent by choosing a different normalization.

of as an entry cost to the accident forgiveness contract with an experience-rating pricing scheme.

Therefore, for given probabilities x $(0 < x < 1)$ and y $(0 < y < 1)$ that both high and low risks will separate, the optimal two-period contract with accident forgiveness under competitive conditions and with the insured permitted to switch contracts is characterized as follows.

A separating policy exists for the first period, which is full coverage for high risks and partial coverage for low risks. This is consistent with the one-period Rothschild/Stiglitz contracts. However, a higher-than-market premium is charged for both types.

A separating policy exists for the second period, which is full coverage for high risks even if they suffered first-period losses and partial coverage for low risks.

Pricing, however, is different. An experience-rated second-period policy is given for low risks; that is, low risks who suffered no first-period loss receive more coverage with an actuarially fair premium and those who did suffer losses receive Rothschild/Stiglitz contracts for low risks in the second period. High risks also obtain an experience-rated second-period policy; that is, high risks who suffered no first-period loss receive the rent and those who suffered losses receive the Rothschild/Stiglitz contracts for high risks in the second period. The rent is from both intertemporal and cross-sectional subsidization.

Comments To more fully characterize the optimal contract, I comment on three important issues.

Asymmetric information. When information about previous driving records is not pooled across insurers, if an accident or violation occurs, it is observed only by the initial insurer responsible for covering it and not by any rival insurers[23]; thus asymmetries of information arise. Contrary to what is believed by many to be common practice (e.g., automobile accidents as well as traffic violations are complete and freely available), states vary in accident reporting regulations (see Table 1.2), and information maintained by state agencies, such as motor vehicle records (MVRs), is not always available and is often far from complete. More specifically, in some states, DUIs and other major traffic-related convictions can even be expunged (see Table 1.3) from one's motor vehicle record. The source of information asymmetry may also be the time lag in the learning process between the initial insurer and its rivals. In other words, the initial insurer, in some sense, can be thought of as the Stackelberg leader in the updating process. It is likely for the initial insurer to have a comparative advantage over its rivals in monitoring its own policyholders. Over time, the initial insurer obtains Bayesian updates on its policyholders' loss distributions that are not simultaneously available to its rivals. For example, if the insured vehicle is involved in an accident, it usually takes some time for rival insurers to access this information, whereas the initial insurer is required to be notified immediately. Moreover, through contractual relationships with its policyholders, the initial insurer may also learn of more relevant risk-related personal information, such as a medical history, which is unobservable to other insurers.

Insurer's commitment to the contract. The way my model has been set up, it is assumed that insurers can commit to the insurance contract through either enforced legislation or

[23]Consumer incentives to strategically withhold accident information from insurers are disregarded here.

Table 1.2. State Accident Reporting Requirements

State	Reported to DMV	Reported to Law Enforcement
Alabama, Alaska, Arkansas, Indiana, Missouri, Nevada, New Hampshire, Ohio, Oklahoma, Pennsylvania, Rhode Island, Vermont, Wyoming	Yes	No
Arizona, Delaware, Georgia, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Michigan, Montana, Nebraska, North Carolina, North Dakota, South Dakota, Virginia	No	Yes
California, Colorado, Florida, Illinois, Iowa, Maryland, Massachusetts, Minnesota, New Jersey, New Mexico, New York, Oregon, South Carolina, Tennessee, Texas, Utah, Washington, West Virginia, Wisconsin	Yes	Yes
Connecticut, Mississippi, Washington DC	No	No

Note: Adapted from state DMV websites.

reputational effects. This is consistent with the general provision in the personal auto policy drafted by the Insurance Services Office.[24] In the termination provision, the named insured can cancel at any time by returning the policy to the insurer. The insurer also has the right of cancelation but for only three reasons[25]: (1) The premium has not been paid, (2) the driver's license of any insured has been suspended or revoked, or (3) the policy was obtained through material misrepresentation. Futhermore, many states place additional restrictions on the insurer's right to cancel or not renew an auto insurance policy (e.g., state law may require a longer period of advance notice to the insured).

[24]See 2005 edition of the Personal Auto Policy by the Insurance Services Office and Rejda (2009, Ch. 22 pp. 513-514)

[25]See Rejda (2009, Appendix B, pp. 668-669)

Table 1.3. State DMV DUI Expungement Condition

State	DUI Expungement	Condition
Alabama, Alaska, Arizona, Arkansas, Hawaii, Idaho, Illinois, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Minnesota, Mississippi, Montana, Nebraska, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, West Virginia, Wisconsin, Wyoming, Washington DC	No	
California	Yes	Complete all the conditions of your DUI sentence.
Colorado	Yes	Only if the DUI happened before you turned 21 and you have no other convictions to be expunged.
Connecticut	Yes	Wait 3 years if the DUI was a misdemeanor; wait 5 years if it was a felony.
Delaware	Yes	You can only expunge the DUI if an acquittal or dismissal terminated the underlying charge.
Florida	Yes	Only an option if the DUI charge didn't involve manslaughter.
Georgia	Yes	You must have no other pending criminal charges and no other convictions of the same or similar crime in the last 5 years.
Indiana	Yes	Only if your case was reversed or dismissed.
Maryland	Yes	Only if your case was dismissed or a judge or jury acquitted you.
Michigan	Yes	The court decides on a case-by-case basis.
Missouri	Yes	Only if it was your first DUI.
Nevada	Yes	Only if the DUI wasn't a felony.
New Hampshire	Yes	After 10 years.
New Jersey	Yes	All expungements are considered as misdemeanors.
North Carolina	Yes	If you're found not guilty or have a criminal charge dismissed.
Pennsylvania	Yes	As long as your license wasn't revoked for being a habitual offender and you weren't a commercial driver at the time.
South Dakota	Yes	Varies by county.
Utah	Yes	After 10 years, as long as the conviction wasn't a felony.
Virginia	Yes	Only if the charges were dropped, you were acquitted, or you received an absolute pardon.

Note: Adapted from state DMV websites.

The degree of "punishment." The prior literature has already illustrated that the presence of second-period competition for consumers may limit but not destroy the use of experience rating as a sorting device (e.g., Cooper and Hayes, 1987). Since semi-commitment settings are assumed, policyholders are not bound to the insurer. This results in punishment for a first-period accident being tempered by the presence of rival insurers offering one-period contracts in the second period. Therefore someone can argue that the insured does not necessarily need to purchase accident forgiveness to be relieved of the previous accident. However, one needs to determine that accident forgiveness as an insurance policy feature offered at the beginning of the contracting in this model not only protects the insured from higher future premiums but also rewards the insured with more favorable contract terms. In other words, accident forgiveness is a device to temper the experience rating as well as lower the incentive to switch.

1.5 Purchase Decisions

Another question worth asking is whether any essential element affects the accident forgiveness purchase. The economic explanation of insurance purchases is a story of shifting risk. For consumers, insurance purchases can be conceptualized as decisions in which they are faced with risks that have some distributions of losses across probabilities. To reduce these risks, consumers pay premiums and are compensated by benefits if the losses occur.

Prior literature examining the determinants for consumer insurance purchase decisions mostly emphasizes how product quality, switching cost, and price affect consumer decisions (e.g., Cummins et al., 1974; Dahlby and West, 1986; Laury and McInnes, 2003; Schlesinger and Schulenburg, 1993) or argues that distorted beliefs concerning the probability and size of potential losses affect consumer decisions about insurance (e.g., Johnson et al., 1993; Kunreuther and Pauly 2004, 2005). However, insurance decision-making as behavior under uncertainty may involve time discounting and risk attitude. This paper investigates the importance of individual risk and time preferences in the insurance purchase decision.

This section completes the derivation of optimal contracts by determining the probability of purchasing accident forgiveness contracts as a function of the discount factor and the degree of risk aversion.

1.5.1 Discount Factor

The discount factor is a provocative subject with important implications for many aspects of economic behavior and public policy (e.g., Warner and Pleeter, 2001). In particular, the discount factor is essential in making purchase decisions. The macroeconomics literature has provided evidence showing the relation between the discount factor and life insurance purchase in a life cycle model (e.g., Fischer, 1973; Yaari, 1965).[26] Articles related to dynamic insurance contracts also illustrate the importance of the discount factor. Rubinstein and Yaari (1983) show that multi-period insurance contracts can increase the welfare of both the insurer and the insured when the number of periods is large and the discount rate is small. Dionne and Doherty (1994) demonstrate the positive relation between the discount factor and high risk drivers' participation in the first-period pooling insurance. Kunreuther (1996) uses the discount factor to explain why individuals have limited interest in voluntary insurance purchases.

In multi-period contracting models with asymmetric information, the discount factor is very important, such that it may affect optimal allocation in equilibrium. Laffont and Tirole (1990) complete their derivation of the optimal procurement contract by proposing that the proportion of good types' separation from a semi-pooling contract does not increase with the discount factor.[27] Dionne and Doherty (1994) share the same feature of the nonincreasing theorem but for an optimal insurance contract. Here, I posit that if both low and high risks are introduced to randomize over different contracts, there exists a nondecreasing effect of the discount factor on the accident forgiveness purchases for both types.

Proposition 1. *The proportion of policyholders, both low and high risk, who purchase contracts with accident forgiveness is nondecreasing with the discount factor.*

[26] Yaari (1965) considers the subjective discount rate in the problem of uncertain lifetimes and life insurance in the context of the expected utility hypothesis using a continuous time model. Fischer (1973) includes a discount factor in the utility-of-consumption function and describes it as a measure of the defectiveness of imagination or impatience.

[27] Laffont and Tirole (1990) refer good types to firms with lower project costs.

Proof. Suppose y is the low risks' equilibrium randomizing probability for a given discount factor δ and, similarly, $\widetilde{y}$ is for $\widetilde{\delta}$. Assume that $\delta < \widetilde{\delta}$, then the low risks' utility for two periods with optimal y for δ can be written as

$$U(y,\delta,\alpha,\beta) = (1-y)\{U(\alpha_L^1,\beta_L^1)+\delta[p_L U(\alpha_{LA},\beta_{LA})+(1-p_L)U(\alpha_{LN},\beta_{LN})]\}+y\{(1+\delta)U(\alpha_L,\beta_L)\}, \tag{1.18}$$

utility with optimal $\widetilde{y}$ for $\widetilde{\delta}$ can be written as

$$U(\widetilde{y},\widetilde{\delta},\alpha,\beta) = (1-\widetilde{y})\{U(\alpha_L^1,\beta_L^1)+\widetilde{\delta}[p_L U(\alpha_{LA},\beta_{LA})+(1-p_L)U(\alpha_{LN},\beta_{LN})]\}+\widetilde{y}\{(1+\widetilde{\delta})U(\alpha_L,\beta_L)\}, \tag{1.19}$$

utility with $\widetilde{y}$ for δ can be written as

$$U(\widetilde{y},\delta,\alpha,\beta) = (1-\widetilde{y})\{U(\alpha_L^1,\beta_L^1)+\delta[p_L U(\alpha_{LA},\beta_{LA})+(1-p_L)U(\alpha_{LN},\beta_{LN})]\}+\widetilde{y}\{(1+\delta)U(\alpha_L,\beta_L)\}, \tag{1.20}$$

and utility with y for $\widetilde{\delta}$ can be written as

$$U(y,\widetilde{\delta},\alpha,\beta) = (1-y)\{U(\alpha_L^1,\beta_L^1)+\widetilde{\delta}[p_L U(\alpha_{LA},\beta_{LA})+(1-p_L)U(\alpha_{LN},\beta_{LN})]\}+y\{(1+\widetilde{\delta})U(\alpha_L,\beta_L)\}. \tag{1.21}$$

Since y is an optimum for δ and $\widetilde{y}$ is an optimum for $\widetilde{\delta}$, then $U(y,\delta,\alpha,\beta) \geq U(\widetilde{y},\delta,\alpha,\beta)$ and $U(\widetilde{y},\widetilde{\delta},\alpha,\beta) \geq U(y,\widetilde{\delta},\alpha,\beta)$. This yields

$$U(y,\delta,\alpha,\beta) + U(\widetilde{y},\widetilde{\delta},\alpha,\beta) \geq U(\widetilde{y},\delta,\alpha,\beta) + U(y,\widetilde{\delta},\alpha,\beta).$$

So, adding (1.18) and (1.19) and then subtracting (1.20) and (1.21) yields

$$
\begin{aligned}
&\{U(\alpha_L^1, \beta_L^1) + \delta[p_L U(\alpha_{LA}, \beta_{LA}) + (1-p_L)U(\alpha_{LN}, \beta_{LN})]\}(\widetilde{y} - y) \\
&+\{(1+\delta)U(\alpha_L, \beta_L)\}(y - \widetilde{y}) \\
&+\{U(\alpha_L^1, \beta_L^1) + \widetilde{\delta}[p_L U(\alpha_{LA}, \beta_{LA}) + (1-p_L)U(\alpha_{LN}, \beta_{LN})]\}(y - \widetilde{y}) \\
&+\{(1+\widetilde{\delta})U(\alpha_L, \beta_L)\}(\widetilde{y} - y) \\
&\geq 0
\end{aligned}
\tag{1.22}
$$

and (1.22) can be further written as

$$
(y - \widetilde{y})(\widetilde{\delta} - \delta)[p_L U(\alpha_{LA}, \beta_{LA}) + (1-p_L)U(\alpha_{LN}, \beta_{LN}) - U(\alpha_L, \beta_L)] \geq 0. \tag{1.22'}
$$

From the optimal contract characterization, $U(\alpha_{LA}, \beta_{LA}) = U(\alpha_L, \beta_L)$, $U(\alpha_{LN}, \beta_{LN}) > U(\alpha_L, \beta_L)$, and $\widetilde{\delta} > \delta$ as assumed, and it is obvious that $y \geq \widetilde{y}$. Because y and $\widetilde{y}$ are optimum for δ and $\widetilde{\delta}$, respectively, $(1 - \widetilde{y}) \geq (1 - y)$ proves the nondecreasing relation between the discount factor and the proportion of low risks purchasing accident forgiveness contracts. In a similar vein, using the same procedure, this nondecreasing relation can be proven for high-risk policyholders as well. □

This proposition states that when faced with a higher discount factor, the insured is more willing to pay extra money to have a contract with accident forgiveness. The intuition is follows. When the discount factor is low, it is costly for the insured to pay a positive transfer in the first period to increase insurance possibilities in the second period. However, when the discount factor is high, compared to the rival insurer's one-period contract offered in the market, the accident forgiveness policy not only protects the insured from a higher insurance rate if he experiences losses in the first period but also rewards him in the second period for having no loss. Individuals who care more about their second-period expected utility obviously prefer to purchase this accident forgiveness policy. Thus, it is clear that the accident forgiveness purchase decision is driven to some extent by the discount factor.

1.5.2 Risk Aversion

This section examines how accident forgiveness purchases are affected by individual risk attitude.

The standard economic theory is that risk-averse individuals confronted with sizable hazards are willing to pay a more diversified insurer to bear the risk (e.g., Dionne and Harrington, 1992). Schlesinger and Schulenberg (1987) argue that, in the usual insurance literature, because a higher degree of risk aversion implies a greater relative emphasis on downside risk, an increase in the level of risk aversion leads to the purchase of a higher level of insurance coverage. Similar logic is employed by Johnson et al. (1993), who state that risk-neutral consumers would purchase coverage at an actuarially fair price and that risk aversion raises this reservation price. Ganderton et al. (2000) state that all risk-neutral or risk-averse individuals would purchase insurance and undertake all relevant precautions to the extent that the extra benefits from such actions exceed the marginal costs, less some risk premium in the case of risk aversion. Laury and McInnes (2003) find that if one is even slightly risk averse, one should always purchase insurance.

The question arises as to whether the insured are going to purchase accident forgiveness for more protection if they become more risk averse. In other words, is standard economic theory also applicable to accident forgiveness purchases?

Proposition 2. *There exists a threshold in terms of utility for both high and low risks above which the proportion of policyholders who purchase contracts with accident forgiveness is nondecreasing in their degree of risk aversion.*

Proof. Let us assume a constant relative risk aversion (CRRA) utility function with $U_\gamma(\alpha,\beta) = \frac{\omega(\alpha,\beta)^{1-\gamma}}{1-\gamma}$, where ω is a function of α and β and $\gamma \neq 1$ for convenience.[28] Here γ is the parameter to measure risk aversion, with $\gamma = 0$ corresponding to risk neutrality, $\gamma < 0$ to risk loving, and $\gamma > 0$ to risk averse. Suppose γ_1 and γ_2 with $\gamma_2 > \gamma_1 > 0$. As usual, if γ_1 and γ_2 are assumed to have optima y_1 and y_2, respectively, the low risks' utility for two periods can be written as

$$\begin{aligned} U(y_1,\gamma_1,\alpha,\beta) = \quad & (1-y_1)\{U_{\gamma_1}(\alpha_L^1,\beta_L^1) + \delta[p_L U_{\gamma_1}(\alpha_{LA},\beta_{LA}) + (1-p_L)U_{\gamma_1}(\alpha_{LN},\beta_{LN})]\} \\ & + y_1\{(1+\delta)U_{\gamma_1}(\alpha_L,\beta_L)\}, \end{aligned} \tag{1.23}$$

$$\begin{aligned} U(y_2,\gamma_2,\alpha,\beta) = \quad & (1-y_2)\{U_{\gamma_2}(\alpha_L^1,\beta_L^1) + \delta[p_L U_{\gamma_2}(\alpha_{LA},\beta_{LA}) + (1-p_L)U_{\gamma_2}(\alpha_{LN},\beta_{LN})]\} \\ & + y_2\{(1+\delta)U_{\gamma_2}(\alpha_L,\beta_L)\}, \end{aligned} \tag{1.24}$$

$$\begin{aligned} U(y_2,\gamma_1,\alpha,\beta) = \quad & (1-y_2)\{U_{\gamma_1}(\alpha_L^1,\beta_L^1) + \delta[p_L U_{\gamma_1}(\alpha_{LA},\beta_{LA}) + (1-p_L)U_{\gamma_1}(\alpha_{LN},\beta_{LN})]\} \\ & + y_2\{(1+\delta)U_{\gamma_1}(\alpha_L,\beta_L)\}, \end{aligned} \tag{1.25}$$

[28]The CRRA utility function is widely used in the literature on insurance purchase decisions (e.g., Brown and Poterba, 2000; Charupat and Milevsky, 2002; Hong and Rios-Rull, 2007). The results for a constant absolute risk aversion (CARA) utility function are also discussed in the Appendix B.

$$U(y_1, \gamma_2, \alpha, \beta) = (1 - y_1)\{U_{\gamma_2}(\alpha_L^1, \beta_L^1) + \delta[p_L U_{\gamma_2}(\alpha_{LA}, \beta_{LA}) + (1 - p_L)U_{\gamma_2}(\alpha_{LN}, \beta_{LN})]\}$$
$$+ y_1\{(1 + \delta)U_{\gamma_2}(\alpha_L, \beta_L)\}. \tag{1.26}$$

Adding (1.23) and (1.24) and then subtracting (1.25) and (1.26) yields

$$\begin{aligned}
&(y_1 - y_2)\{U_{\gamma_2}(\alpha_L^1, \beta_L^1) + \delta[p_L U_{\gamma_2}(\alpha_{LA}, \beta_{LA}) + (1 - p_L)U_{\gamma_2}(\alpha_{LN}, \beta_{LN})] \\
&- U_{\gamma_1}(\alpha_L^1, \beta_L^1) - \delta[p_L U_{\gamma_1}(\alpha_{LA}, \beta_{LA}) + (1 - p_L)U_{\gamma_1}(\alpha_{LN}, \beta_{LN})] \\
&+ (1 + \delta)U_{\gamma_1}(\alpha_L, \beta_L) - (1 + \delta)U_{\gamma_2}(\alpha_L, \beta_L)\} \\
&\geq 0.
\end{aligned} \tag{1.27}$$

With $\alpha_{LA} = \alpha_L$ and $\beta_{LA} = \beta_L$, (1.27) can be further rewritten as

$$(y_1 - y_2)\{[U_{\gamma_2}(\alpha_L^1, \beta_L^1) - U_{\gamma_1}(\alpha_L^1, \beta_L^1)] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)]$$
$$+ \delta(1 - p_L)\{[U_{\gamma_2}(\alpha_{LN}, \beta_{LN}) - U_{\gamma_1}(\alpha_{LN}, \beta_{LN})] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)]\}\} \geq 0. \tag{1.27'}$$

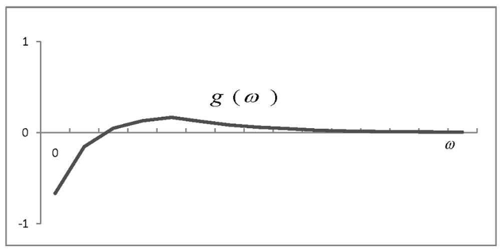
To predict the sign of $(y_1 - y_2)$ in (1.27'), we need to discuss the sign of $[U_{\gamma_2}(\alpha_L^1, \beta_L^1) - U_{\gamma_1}(\alpha_L^1, \beta_L^1)] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)] + \delta(1 - p_L)\{[U_{\gamma_2}(\alpha_{LN}, \beta_{LN}) - U_{\gamma_1}(\alpha_{LN}, \beta_{LN})] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)]\}$. To simplify the discussion, we define

$$g(\omega(\alpha, \beta)) = U_{\gamma_2}(\omega(\alpha, \beta)) - U_{\gamma_1}(\omega(\alpha, \beta)), \tag{1.28}$$

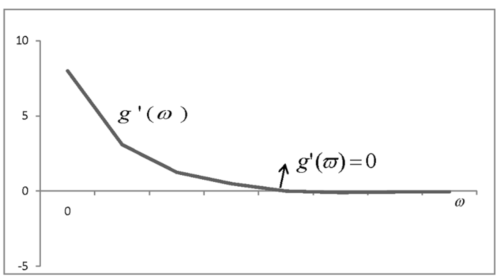
where $\omega(\alpha, \beta)$ represents different contracts (e.g., contract (α_L^1, β_L^1) or (α_L, β_L)). Then, we only need to consider the possible sign of

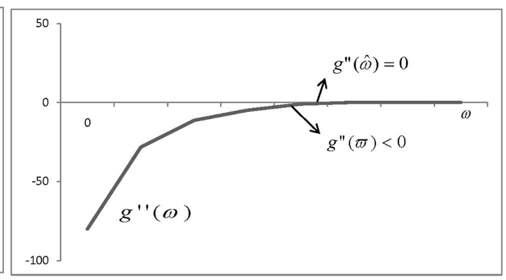
$$g(\omega(\alpha_L^1, \beta_L^1)) - g(\omega(\alpha_L, \beta_L)) + \delta(1 - p_L)[g(\omega(\alpha_{LN}, \beta_{LN})) - g(\omega(\alpha_L, \beta_L))]. \tag{1.29}$$

Figure 1.2. $g(\omega)$ Function and Partial Derivatives of $g(\omega)$



(a) $g(\omega)$ Function





(b) First-Order Partial Derivative of $g(\omega)$ (c) Second-Order Partial Derivative of $g(\omega)$

The function $g(\omega)$ has the curvature shown in Figure 1.2(a). To discuss the sign of (1.29), let us derive both first and second-order derivatives. The first-order derivative $g^{'}(\omega) = \omega^{-\gamma_2} - \omega^{-\gamma_1}$ is positive if ω is smaller than the cutoff point ϖ and negative (or g is decreasing) otherwise, as shown in Figure 1.2(b). The second-order derivative $-\gamma_2\omega^{-\gamma_2 - 1} + \gamma_1\omega^{-\gamma_1 - 1}$ is negative if ω is smaller than the cutoff point $\widehat{\omega}$ and positive otherwise, as shown in Figure 1.2(c). Although we know that $\omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1)$, the sign of (1.29) is also determined by the cutoff points ϖ and $\widehat{\omega}$. Here are three possible cases.

Case 1: $\overline{\omega} > \omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1)$.[29] It is straight forward to see that

$$g(\omega(\alpha_L, \beta_L)) - g(\omega(\alpha_L^1, \beta_L^1)) > g(\omega(\alpha_{LN}, \beta_{LN})) - g(\omega(\alpha_L, \beta_L)), \tag{1.30}$$

from which

$$\begin{aligned} &[U_{\gamma_2}(\alpha_L^1, \beta_L^1) - U_{\gamma_1}(\alpha_L^1, \beta_L^1)] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)] \\ &+\delta(1-p_L)\{[U_{\gamma_2}(\alpha_{LN}, \beta_{LN}) - U_{\gamma_1}(\alpha_{LN}, \beta_{LN})] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)]\} < 0, \end{aligned} \tag{1.31}$$

and with (1.27'), $(1-y_2) \leq (1-y_1)$. This result illustrates the nonincreasing relation between the proportion of low risks purchasing accident forgiveness contracts and the degree of their risk aversion.

Case 2: $\widehat{\omega} > \omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1) > \overline{\omega}$. With $g^{'}(\omega) < 0$ and $g^{''}(\omega) < 0$,

$$g(\omega(\alpha_L, \beta_L)) - g(\omega(\alpha_{LN}, \beta_{LN})) > g(\omega(\alpha_L^1, \beta_L^1)) - g(\omega(\alpha_L, \beta_L)), \tag{1.32}$$

which indicates the undetermined sign of $(y_1 - y_2)$.

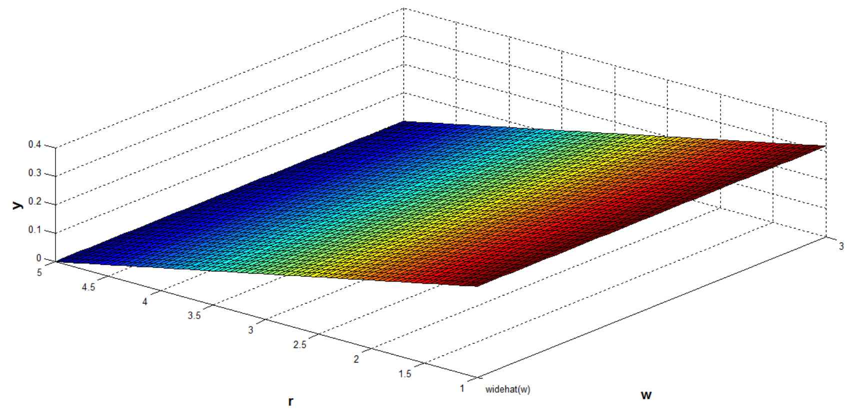
Case 3: $\omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1) > \widehat{\omega}$. With $g^{'}(\omega) < 0$ and $g^{''}(\omega) > 0$,

$$g(\omega(\alpha_L^1, \beta_L^1)) - g(\omega(\alpha_L, \beta_L)) > g(\omega(\alpha_L, \beta_L)) - g(\omega(\alpha_{LN}, \beta_{LN})), \tag{1.33}$$

which indicates that $(1-y_2) \geq (1-y_1)$. Unlike the previous two cases, this result points to a nondecreasing relation between the proportion of low risks purchasing accident forgiveness

[29] To simplify the discussion, let us assume that $\omega(\alpha_L, \beta_L) - \omega(\alpha_L^1, \beta_L^1) = \omega(\alpha_{LN}, \beta_{LN}) - \omega(\alpha_L, \beta_L)$.

Figure 1.3. 3D Plot of ω, γ, and y in Case 3



contracts and the degree of risk aversion. As shown in Figure 1.3, for those $\omega > \widehat{\omega}$, a higher level of γ is associated with a lower level of y (or a higher level of $1 - y$).

Similar results can also be proven for high-risk policyholders. □

The economic theory underlying the insurance predicts that more risk-averse drivers (e.g., good drivers with a clean driving history) will be more willing to purchase accident forgiveness policies. However, in practice, it is apparently not that simple. An informal survey among acquaintances shows that some good drivers hesitate to pay for accident forgiveness, even knowing that it protects their future premiums, whereas others consider it a great deal. This proposition identifies a situation where more risk-averse individuals are more likely to purchase accident forgiveness policy if the expected utility provided by this insurance contract is higher than a utility threshold (e.g., the individual's reservation utility). To statistically test this proposition and further investigate the impact of risk attitude on accident forgiveness contract purchases, Chapter 2 describes and conducts a well-designed experiment.

1.6 Conclusions

This paper is devoted to studying accident forgiveness policies as an option in auto insurance contracts. Assuming a two-period contract, with a higher-than-market premium charged in the first period, policyholders purchasing an accident forgiveness policy will be protected against an increased second-period premium in the event of an at-fault accident. If there is no accident, the policyholders are rewarded with more favorable contract terms in the second period. In this model, experience rating can serve the same purpose, although its effectiveness is tempered by the presence of accident forgiveness. By offering this feature to all the insured instead of only low risks in the pool, the initial insurer may have an advantage in attracting more customers.

The analysis of accident forgiveness purchase decisions finds that a higher discount factor provides an incentive to policyholders to purchase accident forgiveness since the possibility of any at-fault accident becomes of greater concern to their future premiums (or utility). Moreover, examination of the impact of individual risk aversion on accident forgiveness purchases suggests that, contrary to the previous findings that suggest a significantly positive relation between risk aversion and the insurance purchase, there exists a threshold below which accident forgiveness will be less affected by the degree of risk aversion. This interesting finding may be helpful in providing a better understanding of why policyholders who are good drivers may not be willing to purchase accident forgiveness at some point.

1.7 Appendices

1.7.1 Appendix A: Notation

The notation used in this model is as follows:

- $i = L, H$: subscripts for high risk (H) types or low risk (L) types
- $k = N, A$: subscripts for accident (A) or no accident (N) in the first period
- D: size of insurable loss and assumed constant
- W: initial wealth and assumed constant
- p_i: probability of having losses for risk type i
- $U(.)$: individual utility function for the insured
- α: premium payable under insurance contract
- β: net indemnity paid under insurance contract in loss state
- (α_i, β_i): one-period Rothschild/Stiglitz contract for risk type i
- (α_i^1, β_i^1): insurance contract with accident forgiveness in the first period for risk type i
- $(\alpha_{ik}, \beta_{ik})$: insurance contract accident forgiveness in the second period for risk type i contingent on k in the first period
- x: proportion of high risks purchasing one-period contracts
- y: proportion of low risks purchasing one-period contracts
- δ: discount factor
- γ: degree of risk aversion
- λ_{hss}: Lagrangian multiplier for high risks' self-selection constraint
- λ_{lss}: Lagrangian multiplier for low risks' self-selection constraint
- λ_{hr}: Lagrangian multiplier for high risks' randomization constraint
- λ_{lr}: Lagrangian multiplier for low risks' randomization constraint
- λ_{ha}: Lagrangian multiplier for high risks' accident forgiveness constraint
- λ_{la}: Lagrangian multiplier for low risks' accident forgiveness constraint
- λ_z: Lagrangian multiplier for zero-profit constraint

1.7.2 Appendix B: Proof in the Case of CARA Utility

Proof of Proposition 2. Let us assume a CARA utility function with $U(\gamma, \omega) = 1 - e^{-\gamma\omega}$, where $\gamma > 0$ for convenience. If γ is the parameter to measure the risk aversion, suppose two insured customers, one with γ_1 and the other with γ_2, and $\gamma_2 > \gamma_1$. The low-risk individuals' utility for two periods can still be written as expressions (1.23), (1.24), (1.25), and (1.26).

Because γ_1 and γ_2 are assumed to have optima y_1 and y_2, respectively, one still has

$$U(y_1, \gamma_1, \alpha, \beta) + U(y_2, \gamma_2, \alpha, \beta) \geq U(y_2, \gamma_1, \alpha, \beta) + U(y_1, \gamma_2, \alpha, \beta),$$

which can be further written as

$$\begin{aligned}&(y_1 - y_2)\{[U_{\gamma_2}(\alpha_L^1, \beta_L^1) - U_{\gamma_1}(\alpha_L^1, \beta_L^1)] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)]\\ &+\delta(1 - p_L)\{[U_{\gamma_2}(\alpha_{LN}, \beta_{LN}) - U_{\gamma_1}(\alpha_{LN}, \beta_{LN})] - [U_{\gamma_2}(\alpha_L, \beta_L) - U_{\gamma_1}(\alpha_L, \beta_L)]\}\} \geq 0.\end{aligned}$$

Similar to what has been proven in the case of the CRRA utility, one can derive a new function

$$g(\omega) = U_{\gamma_2}(\omega) - U_{\gamma_1}(\omega) = e^{-\gamma_1\omega} - e^{-\gamma_2\omega}. \tag{A1}$$

It is easy to determine that the cutoff point on the first-order derivative curve is

$$\overline{\omega} = \frac{ln\frac{\gamma_1}{\gamma_2}}{\gamma_1 - \gamma_2}. \tag{A2}$$

For $\omega < \overline{\omega}$, $g^{'}(\omega) > 0$.

The second-order derivative of the g function also has a cutoff point, which can be expressed as

$$\widehat{\omega} = \frac{ln\frac{\gamma_1^2}{\gamma_2^2}}{\gamma_1 - \gamma_2}. \tag{A3}$$

For $\omega < \widehat{\omega}$, $g^{''}(\omega) < 0$ and for the previous cutoff value $\overline{\omega}$, it is easy to see that $g^{''}(\omega) < 0$ for any $\omega \leq \overline{\omega}$.

It is also assumed that $\omega(\alpha_L^1, \beta_L^1)$, $\omega(\alpha_L, \beta_L)$, and $\omega(\alpha_{LN}, \beta_{LN})$ represent $\omega's$ with different insurance contracts. From the design of the contracts, policyholders have $\omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1)$. Further, it is assumed that $\overline{\omega} > \omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1)$ and $\omega(\alpha_L, \beta_L) - \omega(\alpha_L^1, \beta_L^1) = \omega(\alpha_{LN}, \beta_{LN}) - \omega(\alpha_L, \beta_L)$. Then it is straightforward to see that

$$g[\omega(\alpha_L, \beta_L)] - g[\omega(\alpha_L^1, \beta_L^1)] > g[\omega(\alpha_{LN}, \beta_{LN})] - g[\omega(\alpha_L, \beta_L)],$$

which proves $y_1 - y_2 \leq 0$.

If one assumes that $\widehat{\omega} > \omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1) > \overline{\omega}$, with $g^{'}(\omega) < 0$ and $g^{''}(\omega) < 0$, then

$$g[\omega(\alpha_L, \beta_L)] - g[\omega(\alpha_{LN}, \beta_{LN})] > g[\omega(\alpha_L^1, \beta_L^1)] - g[\omega(\alpha_L, \beta_L)],$$

which indicates the undetermined sign of $(y_1 - y_2)$.

If one assumes that $\omega(\alpha_{LN}, \beta_{LN}) > \omega(\alpha_L, \beta_L) > \omega(\alpha_L^1, \beta_L^1) > \overline{\omega}$, with $g^{'}(\omega) < 0$ and $g^{''}(\omega) > 0$, it is obvious that

$$g[\omega(\alpha_L^1, \beta_L^1)] - g[\omega(\alpha_L, \beta_L)] > g[\omega(\alpha_L, \beta_L)] - g[\omega(\alpha_{LN}, \beta_{LN})],$$

which proves $y_1 - y_2 \geq 0$. $\square$

Apparently, the results from the CARA utility assumption are similar to those proven with the CRRA utility assumption.

Chapter 2

WHY BUY ACCIDENT FORGIVENESS POLICIES?

2.1 Introduction

Risk and time preferences influence a variety of economic behaviors, such as investment and portfolio choice. In the field of insurance economics, attitudes toward risk and time play central roles in insurance decision-making.

An auto insurance accident forgiveness policy, also known as a "premium insurance" policy, protects policyholders against a premium increase in the next period if an at-fault accident occurs in the previous period. While accident forgiveness policies are popular, the driving forces behind individual purchases are unclear.

A premium "locked-in" low rate guarantee as one of the features of an accident forgiveness policy invokes the importance of time preferences in the purchase. Policyholders who prefer to secure their future insurance premiums or, in other words, smooth their utility over future periods are believed to have different purchase preferences over this policy compared to those who are more concerned about current consumption relative to the future. Moreover, as stated by Harrison and Rutström (2008), attitude toward risk is one of the primitives of economies and characterizations of the distribution of risk attitudes can be used to analyze the choice behavior under uncertainty. Prior research (e.g., Laury and McInnes, 2003; Kunreuther and Pauly, 2005) predicts that risk-averse individuals always demand more insurance. However, this may not apply to the purchase of accident forgiveness. An experiment conducted in this paper shows that some good drivers (drivers with a low probability of having accidents) are not interested in purchasing this optional policy to protect their potential loss, even when the insurance price is actuarially fair. For both the insurer and the insured, the question of how risk and time preferences affect individual accident forgiveness purchases is critical to understanding such policy design.

In this paper, I address this question by conducting an experiment under controlled laboratory conditions. The experiment consists of the following tasks: a lottery choice task, a discount rate task, a simulated driving task, and an insurance purchase task. The random lottery pair design is used in the lottery choice task to infer risk attitudes. I combine the lottery choice task with the discount rate task to jointly infer discount rates over utility since it is the concavity of the utility function that is important, and under expected utility theory (EUT) this is synonymous with risk attitude. The simulated driving task is used to assess subjects' driving behavior. By offering insurance contracts conditional on observed driving behavior in the insurance purchase task, I can construct a close representation of a naturally-occurring auto insurance market in which insurance premiums are based upon driver risk classifications.

The statistical specification in this paper involves the joint estimation of risk attitudes, time preferences, and insurance decisions. I consider models that allow for both observable individual characteristics and structural errors and assume both exponential and hyperbolic (Mazur) specifications of the discount rate function. The estimates show moderate risk aversion (γ=0.36) and a discount rate of 1.28 (or 0.88, assuming hyperbolic discounting), on average. To test the hypotheses of the impact of risk and time preferences on accident forgiveness purchases, I examine the data obtained from the experiment and find that individual discount rates and policy prices have significantly negative effects on accident forgiveness purchases. More importantly, inconsistent with the prior literature, which argues the positive impacts of risk aversion on insurance purchases, my data show that subjects with a lower degree of risk aversion behave more like risk-neutral agents when making insurance decisions. In other words, their degree of risk aversion does not contribute to their insurance purchases. However, those with a higher degree of risk aversion make insurance decisions that are significantly driven by their risk attitudes.

My study is unique in several ways: First, prior studies focus on explaining the determinants of individual insurance purchases for the severe consequences arising from low-probability high-loss events (e.g., earthquakes and floods). This paper contributes to the existing literature by addressing the impact of risk and time preferences on insurance decision-making over events with moderately high probability but relatively low loss (e.g., premium increases after auto accident).[1] By centering the analysis on accident forgiveness purchases, this study improves our understanding of this new policy as well as reveals important implications for insurance policy makers.

Second, only a few studies address the joint elicitation of risk and time preferences. Andersen et al. (2008) was the first to focus on the formal theoretical link between elicited risk attitudes and individual discount rates. I extend the existing literature by using full information maximum likelihood in the joint elicitation of risk and time preferences. More

[1] A premium increase or surcharge after accidents ranges from 10% to 50% (see http://www.dmv.org).

specifically, I further elicit risk and time preferences jointly with insurance decisions. Moreover, instead of using a probit model over the entire sample to investigate the impact of risk preferences on accident forgiveness purchases, I adopt a conditional probit model in which the level of risk aversion is controlled. Three subsamples are drawn by the centile of risk aversion (e.g., below the 25th percentile, between the 25th and 75th percentiles, and above the 75th percentile). The result shows that the impacts of risk aversion on accident forgiveness purchases vary among these subsamples. The significantly positive effect is only observable in the subsample with a higher level of risk aversion and this interesting finding is consistent with the threshold explanation developed in Chapter 1 (Proposition 2 in Section 1.5.2).

Third, prior experimental literature studying insurance purchase decisions rarely classifies a subject's risk type. However, in practice, this is important. For most lines of insurance products (e.g., homeowner insurance and auto insurance), insurers provide insurance contracts to policyholders conditional on their risk types. Different risk types of policyholders may follow different decision rules when purchasing insurance. By offering subjects an insurance contract conditional on their driving behavior observed in the simulated driving task, the design of this experiment enables us to infuse the experiment with realism.

Section 2 reviews both the insurance and the experimental literature on insurance decision-making. Section 3 proposes testable hypotheses. Section 4 presents the experimental design, which allows the joint estimation of risk and time preferences with insurance purchase decisions. Section 5 outlines the estimation procedure. Section 6 examines the data from the experiment and econometric analysis. Section 7 summarizes what may be improved in the experimental design and Section 8 draws some general conclusions. The appendices document the instructions and parameters used in the experiment.

2.2 Literature Review

Consumers often face decisions as to whether to purchase insurance. There is a vast literature on insurance purchase decision-making.

Anderson (1974) evaluates the National Flood Insurance Program and concludes that consumer awareness of a product's existence and the level premium rates determine insurance purchases. Kunreuther et al. (2001) and Kunreuther and Pauly (2004) formulate the idea of decision-making costs and imperfect information in ways that help explain "anomalies" in insurance markets. The authors find that individuals may face an explicit or implicit cost to discovering the true probability of rare events and this cost constitutes a threshold that might inhibit purchase. Further, Kunreuther and Pauly (2006) propose more details about why consumer insurance-purchasing activities do not always produce results in the best interest of the individuals at risk. The authors reveal that individuals for whom insurance may be a financially attractive investment may be reluctant or unable to collect the information they need to make decisions due to the time, effort, and costs associated with the process. In addition, individuals may exhibit "misprocessing behavior," including a misperception of the risks, with simplified decision rules and reluctance to consider new alternatives. Krantz and Kunreuther (2007) pursue a more Aristotelian theory of decision making, where preferences are constructed based on the decision context and decision makers focus on goals, rather than on maximizing happiness or utility. The authors attempt to show that this alternative approach leads to new explanations of how people make insurance decisions. This paper focuses on insurance decision-making over events with moderately high probability but relatively small loss (e.g., premium losses resulting from auto accidents) and investigates how risk and time preferences affect insurance decisions.

Controlled laboratory experiments are an ideal testbed for insurance purchase decision analysis (Laury et al., 2009). The most widely cited laboratory study of insurance purchase decisions was conducted by Slovic et al. (1977). This involves a carefully-crafted experiment in which subjects fill out a questionnaire that elicits their willingness to purchase actuarially fair insurance in up to eight different situations. The probabilities and sizes of the losses are systematically varied across questions, holding constant the expected value of the loss and the actuarially fair premium. The authors find that the percentage of subjects purchasing insurance is relatively low when the probability of loss is very low (and therefore the loss amount is high) and systematically increases with the probability of loss.

McClelland et al. (1993) conduct an experimental study of insurance purchase decisions in which groups of eight subjects participate in a Vickrey fifth-price auction and only half of the subjects are able to buy insurance during a given round. The authors find that these laboratory results are consistent with field evidence for low-probability hazards, for which people appear to either dismiss the risks or worry too much about them. Ganderton et al. (2000) present a series of experiments that confronted subjects with also focusing on low-probability, high-loss situations. Subjects could earn income in each period and, in repeated decision-making rounds, were asked whether they wished to purchase insurance at a stated price. The authors illustrate that as loss events become more likely, loss amounts increase, or the cost of insurance falls, subjects are more likely to buy indemnifying insurance, even for the class of low probability risks that usually present problems in standard EUT.

Laury and McInnes (2003) conduct an experiment that tests whether showing subjects actuarially fair insurance prices reduces deviations from optimal (Bayesian) decision making. The authors find significant differences in the decision rules used, depending on whether one observes insurance prices. Although the majority of choices correspond to Bayesian updating, the incidence of optimal decisions is higher in sessions with an insurance option. Further, Laury et al. (2009) undertake a systematic study to reexamine the issue of whether individuals tend to underinsure against low-probability, high-loss events relative to high-probability, low-loss events. Their results counter prior experimental evidence, since they observe subjects buying more insurance for lower-probability events than for higher-probability events, given a constant expected loss and load factor, and the authors conclude that this may be attributed to factors other than the relative probabilities of the loss events.

Insurance behavior in the laboratory is very sensitive to how the losses are framed and the types of incentives used. When insurance decisions are presented in abstract terms, with no money on the line, subjects were indeed less likely to insure against smaller probability losses (Laury et al., 2009).[2] This study builds on prior literature on the design of the experiment by framing insurance decisions in a less abstract context (Laury et al., 2009; Slovic et al., 1977) and expressing losses in dollar terms. More specifically, subjects in the experiment face the potential loss of part or all of their earned amount from other tasks and are asked to make decisions whether to purchase insurance. Further, by assessing subject's driving behavior from the simulated driving task and offering insurance contracts conditional

[2] In the study of McClelland et al. (1993), subjects participated in a Vickrey fifth-price auction. However, behavioral patterns for bidding in an auction may not reflect decision-making patterns in naturally occurring insurance markets.

on the observed driving behavior, my experimental design reflects decision-making patterns in naturally occurring auto insurance markets.

2.3 Hypotheses

My goal is to develop an experiment to study the impacts of risk and time preferences on accident forgiveness purchases. Before I present my experimental design, I wish to describe two testable hypotheses concerning the effects of individual discount rates and the degree of risk aversion and how they relate to the decision to purchase accident forgiveness coverage.

2.3.1 Individual Discount Rates

Time preference is a provocative subject with important implications for many aspects of economic behavior and public policy (Warner and Pleeter, 2001). It is particularly essential in insurance decision-making. The macroeconomic literature provides evidence of the relation between the discount factor and life insurance purchases in a life cycle model (e.g., Fischer, 1973; Yaari, 1965).[3] Articles related to dynamic insurance contracts further demonstrate the importance of time preferences. Rubinstein and Yaari (1983) show that multi-period insurance contracts can increase the welfare of both the insurer and the insured when the number of periods is large and the discount rate is small. Dionne and Doherty (1994) find a positive relation between the discount factor and high-risk driver participation in the first-period pooling insurance. Kunreuther (1996) uses time preferences to explain why individuals have limited interest in voluntary insurance purchases.

[3] Yaari (1965) considers the subjective discount rate when studying the problem of uncertain lifetimes and life insurance in the context of the expected utility hypothesis using a continuous time model; Fischer (1973) includes a discount factor in the utility-of-consumption function and describes it as a measure of the defectiveness of imagination or impatience.

As premium insurance, an important characteristic of accident forgiveness is that future premiums will be locked in (e.g., there will be no surcharges on premiums) if this optional policy is purchased. I argue that more patient policyholders prefer to smooth their utility rather than have distinct differences over time. In other words, they care more about their future premiums. To secure future premiums, they are more likely to purchase optional accident forgiveness policies to increase the possibility of future insurance. This suggests that policyholders with lower discount rates are more likely to have a higher demand for accident forgiveness.

2.3.2 Degree of Risk Aversion

The impact of individual risk attitudes on insurance purchase decisions is the subject of some debate in the literature. Schlesinger and Schulenberg (1987) argue that because a higher degree of risk aversion implies a greater relative emphasis on downside risk, an increase in the level of risk aversion leads to the purchase of a higher level of insurance coverage. Ganderton et al. (2000) state that all risk-neutral or risk-averse individuals would purchase insurance and undertake all relevant precautions to the extent that the extra benefits from such actions exceed the marginal costs, less some risk premium in the case of risk aversion. Laury and McInnes (2003) point out that all risk-averse people should purchase insurance, regardless of whether one group is significantly more risk averse than the other. Kunreuther and Pauly (2005) argue that as long as people are risk averse, people will be willing to pay a premium greater than or equal to the expected value of losses from a set of uncertain events against which they will be covered. The maximum amount that an individual will be willing to pay for coverage depends on her degree of risk aversion. However, the threshold explanation (McClelland et al., 1993) predicts that risk-averse individuals will not buy insurance unless they view the hazard as a problem worthy of concern. This threshold concept makes good intuitive sense, since the authors point out that without some sort of threshold for concern, people would spend their entire lives excessively protecting themselves against loss events.

As observed in the experiment, risk-averse drivers (e.g., drivers with good driving behavior) do not always purchase optional insurance. Even with an actuarially fair premium, some still hesitate to purchase it. In line with the threshold explanation derived in Chapter 1, I argue that more risk-averse policyholders will be more likely to purchase accident forgiveness if their degree of risk aversion is above a given threshold. The basic intuition is as follows. An individual's risk attitude determines the curvature of the utility function. For policyholders with a relatively higher degree of risk aversion, the price for accident forgiveness may be acceptable in terms of what they feel they are getting for the money. Then the more risk-averse policyholders become, the more likely they will purchase accident forgiveness. Meanwhile, policyholders with a lower degree of risk aversion behave more like risk-neutral individuals. While risk averse, their degree of risk aversion does not affect their insurance purchases. Other factors such as personal experience and the affordability of insurance prices are more likely to contribute to their decisions.

2.4 Experimental Procedures

A total of 60 subjects were recruited from across the Georgia State University campus to participate in the experiment in December 2011. Their ages ranged from 18 to 57 (mean = 22.5±5.9) and 39 of them subjects were female. The general recruitment message did not mention a fee for showing-up or any specific range of possible earnings. Every subject received a copy of the instructions and had time to read them after being seated in the lab. Instructions for all tasks are presented in Appendix A.

In brief, each subject was asked to respond to four categories of tasks, including choices over risky prospects, sooner versus later payment choices, simulated driving, and insurance purchases. Most of these tasks involved a series of binary choices. All subjects also completed a demographic survey covering their characteristics, as well as cigarette and alcohol use.

2.4.1 Choices over Risky Prospects

To elicit risk preferences, the experiment used the random lottery pair experimental design of Hey and Orme (1994). A major advantage of this design over the others is that the task is simple and context free. The task involves a modest extension of the display of Harrison and Rutström (2009) in which lotteries are presented to the subjects in color on a computer screen and the information on the probabilities of each pie slice is included. Figure 2.1 presents an example of such screen-shots, with the subject observed for the task.

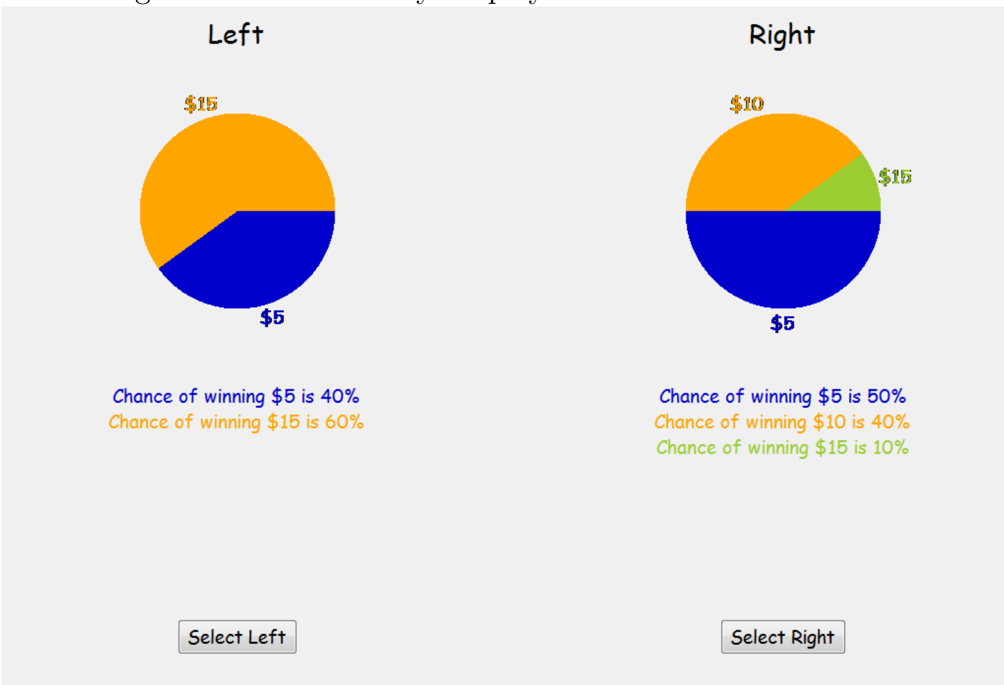
A gain frame as well as a mixed frame of lotteries were included. In the gain frame tasks, the prizes in each lottery are nonnegative and in the mixed frame some of the lotteries involve gains and some involve losses. A total of 68% of the subjects were presented with the gain frame. In all, 40 lottery pairs were drawn at random from a set of 60 lottery pairs, as shown in Table 2.12 of the Appendix. In the gain frame tasks, the prizes in each lottery were \$0, \$5.00, \$10.00 and \$15.00. In the mixed frame tasks subjects were given an initial endowment of \$8.00 and the prizes were -\$8.00, -\$3.00, \$3.00 and \$8.00.[4] Therefore, the final outcomes for the mixed frame, inclusive of the endowment, were \$0, \$5.00, \$11.00 and \$16.00. The probabilities used in each lottery ranged roughly evenly over the unit interval with values of 0, 0.13, 0.25, 0.37, 0.5, 0.62, 0.75, and 0.87. These are based on the lottery pairs developed by Harrison and Rutström (2009) and were presented sequentially. Although there was often some similarity in the prizes and probabilities from task to task, the subject did not know the exact lotteries to come, which can make the task of forming portfolios very demanding (Hey and Lee, 2005a, 2005b). Subjects were instructed that one of the pairs from the task would be randomly selected and that they would receive the alternative they chose for that pair in the form of cash at the end of the session. Such random selection is intended to avoid possible wealth effects from paying all choices sequentially during the experiment and portfolio effects from paying all choices at the end of the experiment (Cox et al., 2011).

2.4.2 Sooner versus Later Payment Choices

Eliciting individual discount rates over monetary outcomes in the laboratory involves asking the subject (implicitly or explicitly) to invest in a laboratory instrument. I applied the experimental procedure introduced by Coller and Williams (1999) and expanded by Harrison et al. (2002) in which subjects choose to receive a fixed amount on a given date or a fixed

[4]Negative prizes in the lotteries indicate potential loss.

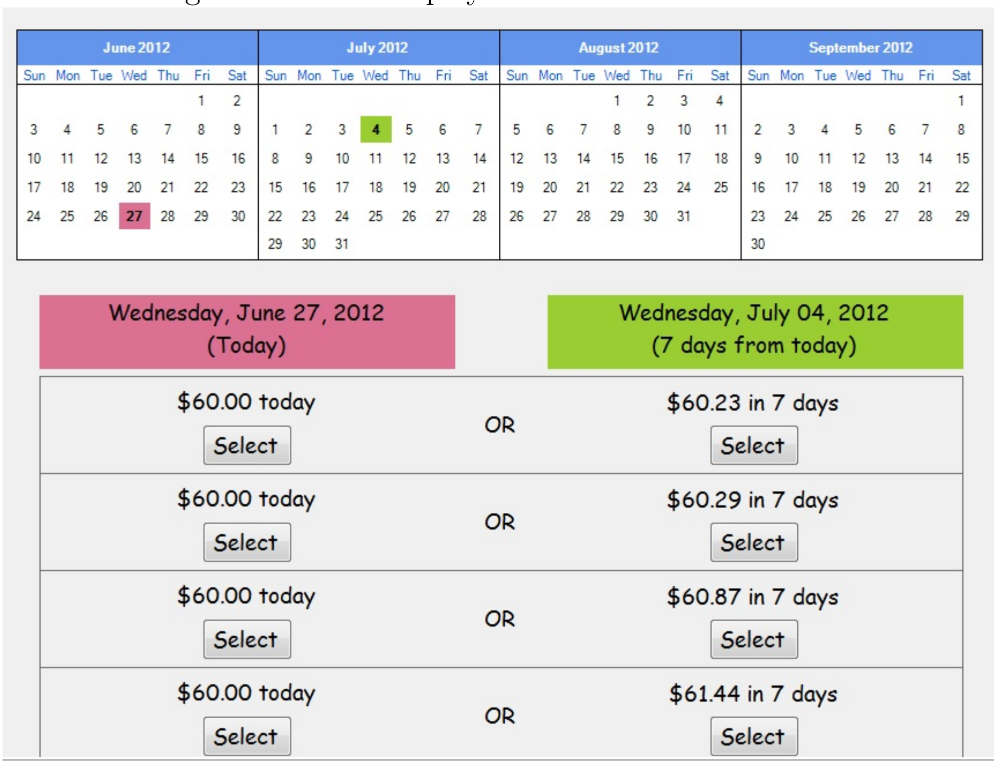
Figure 2.1. The Lottery Display for Risk Preference Tasks



amount plus $x some days later, where $x implies a rate of return on "saving" the amount in the lab for some days.

This task used principal amounts of $30.00 and $60.00 and time horizons of seven, 14, 21, 28, 35, 42, 49, 56, 63, and 70 days (one to 10 weeks). Each subject made 40 choices: For each horizon, they were offered four choices, with annual growth rates selected at random between 5% and 200%. There was no front-end delay on the earlier option, so the choice was between receiving money now and receiving it later, as illustrated in Figure 2.2. One decision row was selected at random, to be paid out at the chosen date. All subjects were paid in cash at the end of sessions for any immediate payment choices, as well as by PayPal™for any time-delayed payment choices.[5] To ensure credibility of the payment instrument, a signed certificate was given as a guarantee of the time-delayed payment.[6]

Figure 2.2. The Display for Time Preferences Task



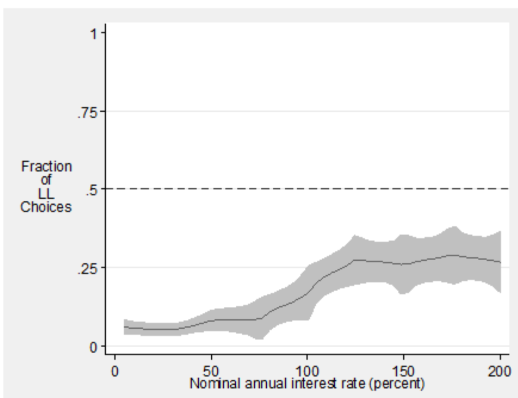
The fraction of choices subjects made by selecting later payments in the discount rate tasks is captured in Figure 2.3. Using a local polynomial regression with a 95% confidence interval, even with higher interest rates (e.g., an annual growth rate of 200%), the fraction of later payment choices (or fraction of LL choices in Figure 2.3) with a principal amount of

[5]PayPal™is a private company providing an online payment service. On the payment date, I instructed PayPal™to initiate a transfer for the subject's payment amount to the e-mail address provided. PayPal™then sent the subject an e-mail with a link to its online site where the subject could either register as a user or log in if already member. The money was then immediately available for online purchases or the subject could request that PayPal™send the money in a check with a few days' delay or transfer the money directly to the subject's bank account.

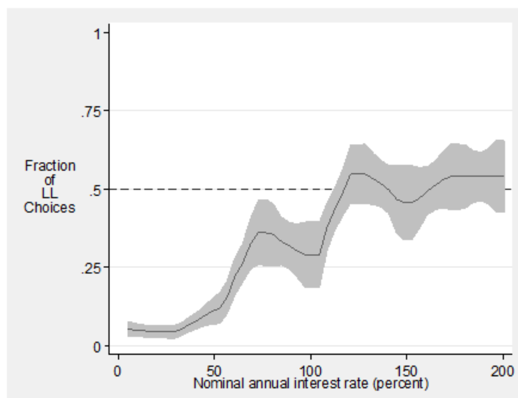
[6]The certificate was signed by the director of the Center for the Economic Analysis of Risk at Georgia State University. The payment date, payment amount, and payment methods were clearly specified on the certificate.

$30.00 is still very low (below 25%), as illustrated in Figure 2.3(a). In other words, regarding payment choices between receiving $30.00 today and $30.00 plus $x some days later, most subjects opted to receive immediate payments. The low fraction of later payment choices may be explained by the fact that smaller amounts are discounted more than larger amounts. On the other hand, the fraction of later payment choices with a principal amount of $60.00 is much higher, as shown in Figure 2.3(b), and carries more information that can be used to elicit individual discount rates. Hence, further analysis is focused on choices with $60.00 as the principal amount.

Figure 2.3. Choices of Later Payment and Interest Rate Offered



(a) Principal Amount of $30.00



(b) Principal Amount of $60.00

2.4.3 The Simulated Driving Task

Understanding the policyholder's driving behavior is essential due to the fact that the pricing of accident forgiveness is conditional on the policyholder's driving skills. To infer a subject's driving behavior in the laboratory environment, this study used a driving simulator similar to that shown in Figure 2.7 of Appendix A. Driving simulators have been used in many contents. For example, Strayer et al. (2003) used simulated driving tasks to examine the effects of hands-free cell phone conversations on traffic safety. Rutström (2011) assessed the risk attitudes of drivers and characteristic biases in how they form beliefs over travel times by using a simulated driving scenario.

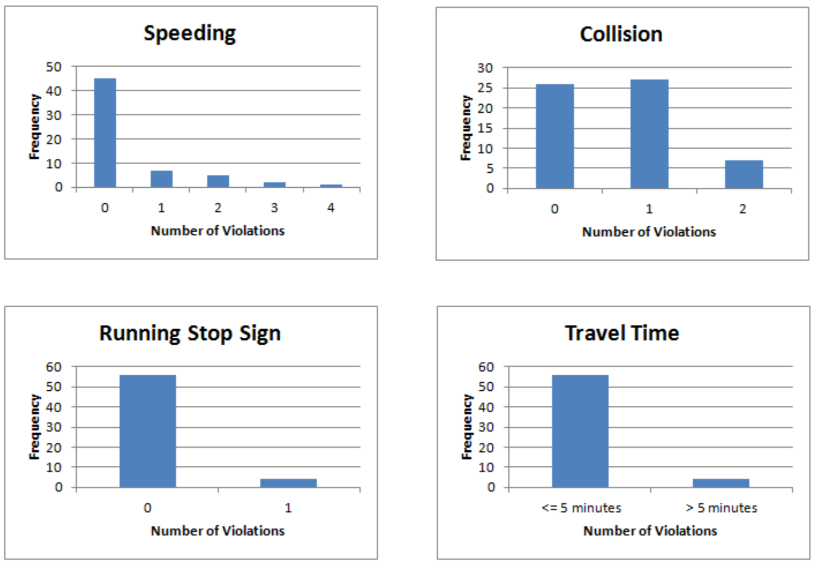
The simulator comprised networked microprocessors and one high-resolution display. In addition, a steering wheel, gas pedal, brake pedal, and automatic transmission were part of the simulator equipment. The simulator incorporated proprietary vehicle dynamics, traffic scenarios, and road surface software to provide realistic scenes and traffic conditions. Measures of real-time driving performance, such as travel time, driving speed, brake, gas, and steering wheel inputs, were stored to grade subject's driving skills.

The task consisted of an unpaid practice drive and a paid drive. Subjects were provided with detailed instructions for each drive. By carrying out the unpaid drive, subjects familiarized themselves with the equipment. Different routes were designed for the unpaid and paid drives to reduce any negative learning effects that could bias the estimation.

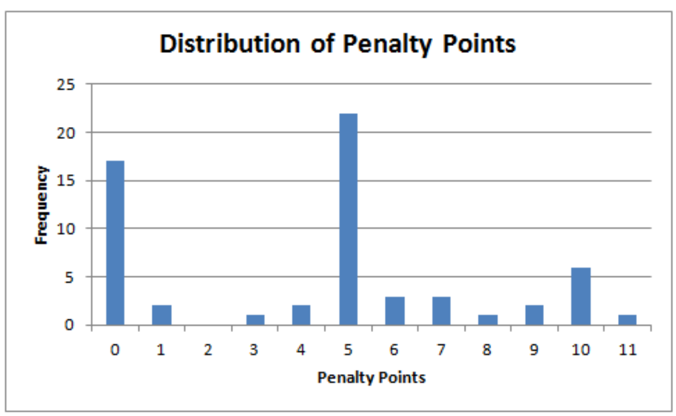
Earnings for this task were determined by each subject's driving performance. Violations and the relevant penalties[7] were clearly specified in the instructions. Violations included speeding, collision, and running a red light or a stop sign. To control for time effects on driving performance, subjects were also required to finish the driving task within a specific time frame.[8] Failure to do so resulted in a reduced payment.[9] The earnings for the paid drive was either $30.00 or $60.00, depending on the total number of penalty points earned.[10]

[7]For the detailed penalty schedule, please see Table 2.11 in Appendix A.
[8]Subjects were instructed to finish the paid drive within five minutes.
[9]For every 10-second delay, subjects received one penalty point.
[10]Subjects who obtained more than five penalty points were paid $30.00.

Figure 2.4. Violations and Penalty Points



(a) Frequency of Violations



(b) Distribution of Penalty Points

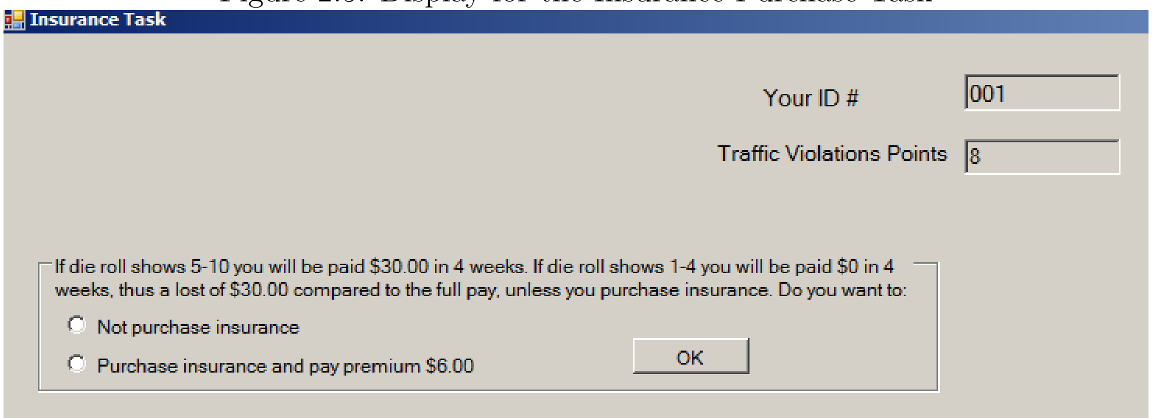
Further, earnings from this task would be used as endowments for participating in the next insurance purchase tasks. Figure 2.4 illustrates the frequency of violations in each category and the distribution of violation points in the sample.

2.4.4 The Insurance Purchase Task

Framing must be carefully dealt with when conducting experiments in the context of insurance. Experimental evidence shows that framing an insurance task as an abstract gamble or as a loss makes a difference to subjects. Hershey and Schoemaker (1980), using hypothetical questions, find that subjects exhibit more risk aversion in choices that are presented in an insurance context than in mathematically equivalent choices presented as standard gambles. Similarly, Laury et al. (2009) state that when insurance decisions are presented in abstract terms, with no money on the line, it is hard to elicit subjects' preferences of insuring against losses and subjects are more likely to buy insurance. To elicit individual preferences over accident forgiveness, insurance decisions were framed in a less abstract context and losses were expressed in dollar terms. Earnings obtained from the driving task were then used as endowments to minimize a found-money effect and to make the loss more real to subjects (Camerer and Hogarth, 1999; Harrison et al., 2005).

Determined by their driving performance in the previous task, subjects were classified as either high risk or low risk, with high risks being those who earned $30.00 from the driving task. Subjects were asked to make an insurance purchase decision for each question in a set of six questions varying in the loss settings, as shown in Figure 2.5. The subjects faced a potential loss of part or all of this earned amount but potential losses were never larger than a subject's available amount in order to avoid confounding the size of losses with bankruptcy considerations.[11] Subjects of the same risk type faced the same set of insurance purchase questions. By offering optional insurance to fully cover potential loss, I imply subjects' preferences for an accident forgiveness policy.

Figure 2.5. Display for the Insurance Purchase Task



When examining the insurance decision by the experiment, it is not a simple question to ask subjects whether to purchase insurance without adjusting the probability of loss and the insurance load. One feature of the premium loss is its relatively high probability. For example, the probability of the premium loss from auto accidents can be much higher than that caused by a flood or an earthquake. This experiment sets probabilities of a potential loss at (0.4, 0.6) for high risks and (0.1, 0.2) for low risks while controlling the constant expected value of the loss with $6.00 for low risks and $12.00 for high risks. In addition, the insurance loads are set to be 0.5, 1.0, and 1.5. When the load is set at 0.5, the price of

[11]Loss from a premium increase after an at-fault accident is relatively low with a relatively high probability compared to loss from other events (e.g., earthquakes). By providing full coverage to the potential loss in the task, I replicate the main feature of the accident forgiveness policy, which is simply full coverage for the loss from the premium increase.

insurance is 50% of the expected value of the loss, indicating subsidization; when the load is 1.0, the insurance is actuarially fair; and when the load is 1.5, the price of insurance is 1.5 times the expected value of the loss, indicating an overcharge or high loading. Combining the choices for the probability of loss and the insurance load represents a within-subjects factorial design and yields the six decisions for each type, as shown in Table 2.14. At the end of this task, one decision row is selected at random to be played out.

2.5 Econometrics

To estimate risk attitudes, two broad methods are used. One approach is to calculate the bounds implied by the observed choices, typically using utility functions that have only a single parameter to be inferred (e.g., Holt and Laury, 2002). The limitation of this approach is that one must infer the bounds that make the subject indifferent between the switch points, and such inferences become virtually incoherent statistically when there are two or more parameters. The other more preferable approach involves direct estimation by maximum likelihood of some structural model of a latent choice process in which the core parameters defining risk attitudes can be estimated, in the manner pioneered by Camerer and Ho (1994) and Hey and Orme (1994).[12] This is the approach used here and is outlined as follows.

Assume that utility function is defined by

$$U(x) = \frac{(w+x)^{(1-\gamma)}}{1-\gamma}, \tag{2.1}$$

where w is some measure of background consumption (e.g., endowment), x is the lottery prize in the risk preference tasks, and $\gamma \neq 1$ is the parameter to be estimated. For $\gamma = 1$, assume $U(x) = ln(w+x)$ if needed. Thus, γ is the coefficient of CRRA: $\gamma = 0$ corresponds to being risk neutral, $\gamma < 0$ to being risk loving, and $\gamma > 0$ to being risk averse. Let there be k possible outcomes (e.g., $k = 4$) in the lottery. Under EUT the probabilities for each outcome k, p_k, are those induced by the experimenter, so the expected utility is simply the

[12]Details of this structural estimation approach are reviewed by Harrison and Rutström (2008).

probability-weighted utility of each outcome in each lottery i,

$$EU_i = \sum_{k=1,\ldots,4} (p_k \times U_k). \tag{2.2}$$

The expected utility for each lottery pair is calculated for a candidate estimate of γ and the index

$$\nabla EU = EU_R - EU_L \tag{2.3}$$

is calculated, where EU_L is the "left" lottery and EU_R is the "right" lottery in the risk preference tasks. This latent index, based on latent preferences, is then linked to the observed choices using a standard cumulative normal distribution function $\Phi(.)$, as[13]

$$prob(lottery_R) = \Phi(\nabla EU). \tag{2.4}$$

An important extension of this core model is to allow for subjects to make errors (e.g., mistakes due to carelessness and inattentiveness). The notion of error here is the probability of choosing a lottery that is not one when the EU of that lottery exceeds the EU of the other lottery. One important error specification, due originally to Fechner and popularized by Hey and Orme (1994), posits the latent index as

$$\nabla EU = \frac{(EU_R - EU_L)}{\mu} \tag{2.5}$$

[13] A logit specification can also be applied.

instead of equation (2.3) where μ is a structural "noise parameter" used to allow errors from the perspective of the deterministic EUT model.

Thus, the likelihood of the observed responses, conditional on EUT and the CRRA specifications being true, depends on the estimates of γ and μ given the above statistical specifications and observed choices. The conditional log-likelihood would be

$$lnL^{RA}(\gamma, \mu; y, w, X) = \sum_i ((ln\Phi(\nabla EU)|y_i = 1) + (ln\Phi(1 - (\nabla EU))|y_i = 0)), \tag{2.6}$$

where $y_i = 1$ (or 0) denotes the choice of the option "right" (or "left") lottery in risk preference task i and X is a vector of individual characteristics reflecting age, sex, race, and so on.

When eliciting individual discount rates, it is the concavity of the utility function that is important, and under EUT this is synonymous with risk attitudes. Andersen et al. (2008) point out that one cannot infer the level of the individual discount rate without knowing that there exists an identification problem which implies that risk attitudes and discount rates cannot be estimated based on discount rate experiments alone but, instead separate tasks to identify the influence of risk preferences must also be implemented. The authors propose a structural model that involves the joint estimation of risk and time preferences.

Specifically, if one assumes that EUT holds for the choices over risky alternatives and that discounting is exponential, then the subject is indifferent between two income options M_L and M_R if and only if

$$U(M_L) = \frac{1}{(1+\delta)^t} U(M_R), \tag{2.7}$$

where $U(M_L)$ is the utility of the monetary outcome M_L for immediate delivery, δ is the discount rate, t is the horizon for the delivery of the later monetary outcome M_R, and the utility function U is separable and stationary over time.

A similar specification for risk aversion is employed for the discount rate choices. The discounted utility of the "left" option (sooner payments) is given by

$$PV_L = \frac{(M_L)^{1-\gamma}}{1-\gamma} \tag{2.8}$$

and the discounted utility of the "right" option (later payments) is given by

$$PV_R = \frac{1}{(1+\delta)^t}\frac{(M_R)^{1-\gamma}}{1-\gamma}. \tag{2.9}$$

An index of the difference between these present values, conditional on γ and δ, can then be defined as

$$\nabla PV = \frac{(PV_R - PV_L)}{\nu}, \tag{2.10}$$

where ν is a noise parameter for the discount rate choices, just as μ is for the risk aversion choices.

Thus, the likelihood of the discount rate responses, conditional on EUT, CRRA, and exponential discounting specifications being true, depends on the estimates of γ, δ, μ, and ν, given the observed choices. The conditional log-likelihood is

$$lnL^{DR}(\gamma,\delta,\mu,\nu;y,w,X) = \sum_i((ln\Phi(\nabla PV)|y_i = 1) + (ln\Phi(1-(\nabla PV))|y_i = 0)), \tag{2.11}$$

where $y_i = 1$ (or 0) denotes the "right" or "left" choice, respectively, in the discounting rate task i.

The joint log-likelihood of the risk aversion and discount rate responses can then be written as

$$lnL(\gamma, \delta, \mu, \nu; y, w, X) = lnL^{RA} + lnL^{DR}. \tag{2.12}$$

Further, when eliciting individual insurance preferences, both the concavity of the utility function and the discount rates are important. A similar specification is employed. The present value of the "buying" option is given by[14]

$$PU_{buy} = \frac{1}{(1+\delta)^t} \frac{(w-\alpha)^{1-\gamma}}{1-\gamma} \tag{2.13}$$

and the present value of the "not buying" option is given by

$$PU_{nbuy} = \frac{1}{(1+\delta)^t}[p * \frac{(w-D)^{1-\gamma}}{1-\gamma} + (1-p) * \frac{w^{1-\gamma}}{1-\gamma}], \tag{2.14}$$

where w is the endowment earned from the driving task, D is the potential loss, p is the loss probability for each insurance task, and α is the insurance premium.

The index of the difference can then be defined as

$$\nabla PU = PU_{buy} - PU_{nbuy}. \tag{2.15}$$

[14]To simplify the problem, full coverage is assumed.

Following the same logic, one can derive the joint log-likelihood of the risk aversion, discount rates, and insurance purchase responses as

$$lnL(\gamma, \delta, \mu, \nu; y, w, X) = lnL^{RA} + lnL^{DR} + lnL^{INS} \tag{2.16}$$

with the conditional log-likelihood of the insurance purchase as

$$lnL^{INS}(\gamma, \delta, \mu, \nu; y, w, X) = \sum_i ((ln\Phi(\nabla PU)|y_i = 1) + (ln\Phi(1 - (\nabla PU))|y_i = 0)) \tag{2.17}$$

where $y_i = 1$ (or 0) denotes the choice of "buying" or "not buying", respectively, in the insurance purchase task i.

2.6 Results

2.6.1 Joint Estimation

Table 2.1 presents the maximum likelihood estimates for joint estimation risk attitudes and discount rates allowing homogeneity. In addition to assuming exponential discounting, this section also considers hyperbolic (Mazur) discounting. A hyperbolic specification (Mazur, 1987) assumes that individuals have discount rates that decline with the horizon they face. The functional form (2.9) can be replaced by

$$PV_R = \frac{1}{1+\delta * t}\frac{(M_R)^{1-\gamma}}{1-\gamma}. \tag{2.18}$$

The CRRA parameter γ is estimated at 0.356. The estimate of the discount rate is around 1.284 in the exponential discounting and 0.889 in the hyperbolic discounting. Further, there is evidence of noise in the decision process since the p-values for both μ and ν are statistically significant.

It is an easy matter to allow γ and δ to be linear functions of the observable characteristics of individuals. Binary indicators are included for sex, age over 25, and race (Asian, Black, or White).[15] Dummies are also included for those having a problem with smoking or alcohol. Each of the core parameters γ and δ is specified as a linear function of these characteristics and the model is estimated using maximum likelihood. Tables 2.2 and 2.4 report joint estimations allowing heterogeneity with exponential and hyperbolic discounting, respectively. Allowing for demographic effects for γ and δ improves the prediction of the

[15] The base category is a group of other races, including Hispanic-Americans and mixed race.

Table 2.1. Joint Estimates of the EUT Model Allowing Homogeneity

(a) *Assuming Exponential Discounting*

Parameter	Estimate	Standard Error	p-Value	95% Conf. Interval	
γ	0.356	0.032	0.000	0.293	0.419
δ	1.284	0.199	0.000	0.893	1.674
μ (for RA)	0.939	0.080	0.000	0.782	1.096
ν (for IDR)	1.366	0.289	0.000	0.799	1.934

(b) *Assuming Hyperbolic (Mazur) Discounting*

Parameter	Estimate	Standard Error	p-Value	95% Conf. Interval	
γ	0.353	0.032	0.000	0.290	0.416
δ	0.889	0.101	0.000	0.691	1.088
μ (for RA)	0.941	0.080	0.000	0.783	1.100
ν (for IDR)	1.372	0.290	0.000	0.803	1.942

Note 1: γ refers to risk attitude.
Note 2: δ refers to the discount rate.
Note 3: μ refers to structural error for risk attitudes (RA).
Note 4: ν refers to structural error for individual discount rates (IDR).

model by increasing the aggregate log-likelihood from −2420.1541 to −2341.4523 with the exponential discounting specification and from −2413.9438 to −2331.7474 with the hyperbolic discounting specification. Women and non-smokers are significantly more risk averse in the sample. Whites are more risk averse than Black or Asian subjects. Meanwhile, the marginal effects for individual discount rates are reported in Tables 2.3 and 2.5. Individual discount rates are more sensitive to race than to other factors. Whites seem more patient than other races in the discounting tasks.

2.6.2 Tests of Hypotheses

The probit model is applied to investigate the role of risk attitudes and discount rates in accident forgiveness purchases. The tests of the hypotheses are divided into two parts. The

Table 2.2. Joint Estimates of the EUT Model Allowing Heterogeneity: Exponential Discounting

Parameter	Estimate	Standard Error	p-Value	95% Conf. Interval	
$Age25_{\gamma}$	0.081	0.063	0.197	-0.042	0.206
$Female_{\gamma}$	0.109	0.049	0.027	0.012	0.205
$Asian_{\gamma}$	0.187	0.083	0.025	0.023	0.351
$Black_{\gamma}$	0.245	0.074	0.001	0.098	0.391
$White_{\gamma}$	0.286	0.092	0.002	0.106	0.467
$Smoker_{\gamma}$	-0.233	0.065	0.000	-0.360	-0.105
$AlcoholUse_{\gamma}$	-0.079	0.064	0.219	-0.205	0.047
$Cons_{\gamma}$	0.081	0.082	0.323	-0.080	0.243
$Age25_{\delta}$	0.048	0.395	0.902	-0.726	0.824
$Female_{\delta}$	-0.232	0.026	0.387	-0.758	0.294
$Asian_{\delta}$	-1.447	0.447	0.001	-2.323	-0.571
$Black_{\delta}$	-0.958	0.305	0.002	-1.556	-0.359
$White_{\delta}$	-1.961	0.512	0.000	-2.965	-0.958
$Smoker_{\delta}$	0.214	0.243	0.378	-0.262	0.692
$AlcoholUse_{\delta}$	0.245	0.330	0.457	-0.401	0.892
$Cons_{\delta}$	1.439	0.367	0.000	0.719	2.159
μ (for RA)	0.832	0.073	0.000	0.688	0.975
ν (for IDR)	1.074	0.214	0.000	0.653	1.494

Note 1: γ refers to risk attitude.
Note 2: δ refers to the discount rate.
Note 3: μ refers to structural error for risk attitudes (RA).
Note 4: ν refers to structural error for individual discount rates (IDR).

Table 2.3. Marginal Effects: Exponential Discounting

Parameter	Estimate	Standard Error	p-Value	95% Conf. Interval	
$Age25_{\delta}$	0.211	1.745	0.904	-3.209	3.631
$Female_{\delta}$	-0.873	1.140	0.444	-3.109	1.361
$Asian_{\delta}$	-3.227	1.542	0.036	-6.250	-0.203
$Black_{\delta}$	-2.601	1.368	0.057	-5.282	0.080
$White_{\delta}$	-3.626	1.524	0.017	-6.614	-0.637
$Smoker_{\delta}$	1.011	1.417	0.476	-1.766	3.789
$AlcoholUse_{\delta}$	1.174	1.838	0.523	-2.428	4.777

Note 1: Marginal effects are measured at the means of the independent variables.
Note 2: δ refers to the discount rate.

Table 2.4. Joint Estimates of the EUT Model Allowing Heterogeneity: Hyperbolic (Mazur) Discounting

Parameter	Estimate	Standard Error	p-Value	95% Conf.	Interval
$Age25_\gamma$	0.088	0.064	0.169	-0.037	0.215
$Female_\gamma$	0.117	0.050	0.020	0.018	0.217
$Asian_\gamma$	0.208	0.080	0.010	0.050	0.366
$Black_\gamma$	0.264	0.079	0.001	0.109	0.419
$White_\gamma$	0.313	0.089	0.000	0.138	0.487
$Smoker_\gamma$	-0.238	0.065	0.000	-0.367	-0.109
$AlcoholUse_\gamma$	-0.095	0.067	0.158	-0.228	0.037
$Cons_\gamma$	0.057	0.082	0.484	-0.103	0.219
$Age25_\delta$	-0.008	0.273	0.975	-0.545	0.527
$Female_\delta$	-0.171	0.175	0.328	-0.516	0.172
$Asian_\delta$	-0.971	0.267	0.000	-1.496	-0.446
$Black_\delta$	-0.597	0.159	0.000	-0.910	-0.284
$White_\delta$	-1.404	0.360	0.000	-2.111	-0.697
$Smoker_\delta$	0.131	0.160	0.411	-0.182	0.445
$AlcoholUse_\delta$	0.210	0.204	0.302	-0.189	0.610
$Cons_\delta$	0.647	0.184	0.000	0.286	1.008
μ (for RA)	0.834	0.072	0.000	0.693	0.976
ν (for IDR)	1.061	0.209	0.000	0.651	1.471

Note 1: γ refers to risk attitude.
Note 2: δ refers to the discount rate.
Note 3: μ refers to structural error for risk attitudes (RA).
Note 4: ν refers to structural error for individual discount rates (IDR).

Table 2.5. Marginal Effects: Hyperbolic (Mazur) Discounting

Parameter	Estimate	Standard Error	p-Value	95% Conf.	Interval
$Age25_\delta$	-0.016	0.518	0.975	-1.033	1.001
$Female_\delta$	-0.301	0.325	0.354	-0.940	0.336
$Asian_\delta$	-1.187	0.367	0.001	-1.906	-0.468
$Black_\delta$	-0.859	0.286	0.003	-1.421	-0.297
$White_\delta$	-1.441	0.342	0.000	-2.112	-0.771
$Smoker_\delta$	0.269	0.364	0.460	-0.444	0.983
$AlcoholUse_\delta$	0.447	0.460	0.331	-0.454	1.350

Note 1: Marginal effects are measured at the means of the independent variables.
Note 2: δ refers to the discount rate.

first part includes general models and the second part includes conditional models that reflect different levels of risk aversion.

Table 2.6 presents the results assuming exponential discounting and Table 2.9 assuming hyperbolic discounting. Model 1 in Table 2.6(a) includes only the variable δ and the premium while Model 3 also includes the key variable γ. For both models, the individual discount rate parameter δ is an important factor in insurance decision-making and its effect is highly significant ($p < 0.05$). The negative coefficient confirms my hypothesis that policyholders with lower discount rates (or high discount factors) are more likely to purchase an accident forgiveness policy. Table 2.7 reports the marginal effects of discount rates evaluated at all levels of risk aversion. The results show that more patient individuals are more likely to purchase accident forgiveness at all levels of risk aversion.

Surprisingly, the effect of risk attitudes on insurance purchases exhibits a pattern. Contrary to the prior literature (e.g., Laury and McInnes, 2003; Kunreuther and Pauly, 2005), which predicts a positive effect of the degree of risk aversion on insurance purchases, this positive effect is insignificant overall ($p = 0.577$ in Model 2 and $p = 0.269$ in Model 3 of Table 2.6(a)). This implies that, measured at the means, the effect of risk aversion on the demand for insurance is not significant.

However, when the level of risk aversion is controlled for, significantly positive effects of risk aversion on insurance purchases are observed. More specifically, three subsamples are defined by centile of risk aversion over all samples. Models 4 to 6 in Table 2.6(b) include observations with a degree of risk aversion below the 25th percentile, between the 25th and 75th percentiles and above the 75th percentile, respectively. Note that for less risk averse

Table 2.6. Insurance Purchase Probit Models, Assuming Exponential Discounting

(a) *General Models*

Variables	Model 1	Model 2	Model 3
δ (discount rate)	-0.253**		-0.386**
	(0.099)		(0.154)
γ (risk attitude)		0.379	-1.131
		(0.680)	(1.023)
Premium	-0.114***	-0.106***	-0.118***
	(0.021)	(0.021)	(0.022)
Constant	1.596***	1.030***	2.204***
	(0.289)	(0.304)	(0.609)
Observations	360	360	360

(b) *Conditional Models*
(based on γ below the 25th percentile, 25th to 75th percentiles, and above the 75th percentile)

Variables	Model 4 ($\gamma \leq 0.22$)	Model 5 ($0.22 \leq \gamma < 0.45$)	Model 6 ($\gamma \geq 0.45$)
δ (discount rate)	-0.192	-0.913***	1.025
	(0.163)	(0.342)	(0.935)
γ (risk attitude)	0.156	-1.938	17.794***
	(2.055)	(2.395)	(7.170)
Premium	-0.192***	-0.128***	-0.112**
	(0.039)	(0.030)	(0.055)
Constant	2.361***	3.204**	-8.908**
	(0.850)	(1.270)	(3.848)
Observations	90	180	90

Note 1: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Note 2: The 25th and 75th percentiles of γ are 0.22 and 0.45, respectively.

individuals, risk attitude does not contribute to insurance coverage decisions. On the other hand, the risk preferences of those with a higher degree of risk aversion significantly affect their insurance purchases ($p < 0.01$ in Model 6 of Table 2.6(b)). This pattern is consistent with the threshold argument described in Section 2.3.2, that more risk averse policyholders will be more likely to purchase accident forgiveness if their degree of risk aversion is above a given threshold.

Table 2.8 reports the conditional marginal effects of risk preferences evaluated over different levels of risk aversion and illustrates how the marginal effects of risk aversion γ significantly differ, depending on an individual's level of risk aversion. Figure 2.6 shows that for individuals with a relatively high degree of risk aversion (e.g., subjects with risk aversion $\gamma \geq 0.45$ in the samples), an increase in their degree of risk aversion raises the insurance demand significantly.

Further, the effects of insurance prices in all models are observed to be significant. This suggests that when premiums are relatively high individuals have less incentive to purchase insurance, which is consistent with previous studies (e.g., Cummins et al., 1974).

Table 2.7. Conditional Marginal Effects of Time Preferences (δ) Evaluated at Different Risk Aversion Levels

γ	dy/dx	Std. Err.	z	P<$\|z\|$	95% Conf. Interval	
0	-0.103	0.025	-4.05	0.000	-0.153	-0.053
0.1	-0.109	0.030	-3.60	0.000	-0.169	-0.050
0.2	-0.116	0.036	-3.16	0.002	-0.187	-0.044
0.3	-0.121	0.042	-2.86	0.004	-0.204	-0.038
0.4	-0.125	0.047	-2.66	0.008	-0.218	-0.033
0.5	-0.129	0.050	-2.57	0.010	-0.228	-0.030

Table 2.8. Conditional Marginal Effects of Risk Preferences (γ) Evaluated at Different Risk Aversion Levels

γ	dy/dx	Std. Err.	z	P<$\|z\|$	95% Conf. Interval	
0	0.042	0.563	0.08	0.940	-1.062	1.147
0.05	0.042	0.559	0.08	0.940	-1.054	1.139
0.10	0.042	0.555	0.08	0.939	-1.046	1.131
0.15	0.042	0.551	0.08	0.939	-1.039	1.123
0.20	0.041	0.547	0.08	0.939	-1.031	1.115
0.25	-0.563	0.615	-0.92	0.360	-1.770	0.642
0.30	-0.585	0.675	-0.87	0.385	-1.909	0.737
0.35	-0.605	0.724	-0.83	0.404	-2.025	0.815
0.40	-0.620	0.761	-0.81	0.415	-2.113	0.872
0.45	4.843	1.028	4.71	0.000	2.827	6.859
0.46	5.314	1.313	4.05	0.000	2.740	7.888
0.47	5.691	1.559	3.65	0.000	2.634	8.748
0.48	5.951	1.726	3.45	0.001	2.566	9.336
0.49	6.077	1.789	3.40	0.001	2.569	9.585
0.50	6.061	1.738	3.49	0.000	2.653	9.469

Figure 2.6. Conditional Marginal Effects of Risk Aversion γ with 95% Confidence Intervals (Evaluated at $\gamma = 0.45, 0.46, \ldots, 0.50$)

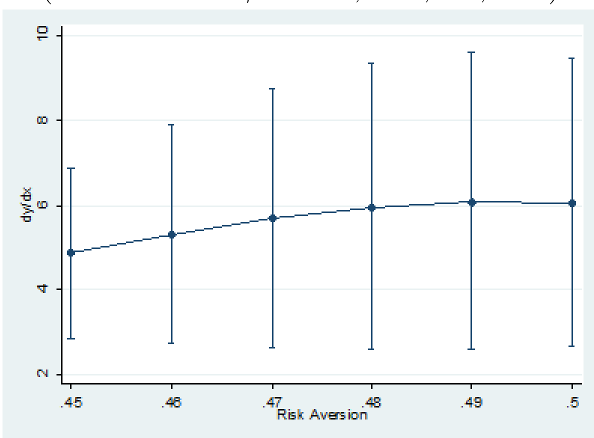


Table 2.9. Insurance Purchase Probit Models, Assuming Hyperbolic Discounting

(a) *General Models*

Variables	Model 1	Model 2	Model 3
δ (discount rate)	-0.721***		-1.194***
	(0.272)		(0.446)
γ (risk attitude)		0.379	-1.472
		(0.680)	(1.072)
Premium	-0.116***	-0.106***	-0.122***
	(0.021)	(0.021)	(0.022)
Constant	1.899***	1.030***	2.878***
	(0.363)	(0.304)	(0.802)
Observations	360	360	360

(b) *Conditional Models*
(based on γ below the 25th percentile, 25th to 75th percentiles, and above the 75th percentile)

Variables	Model 4 ($\gamma \leq 0.22$)	Model 5 ($0.22 \leq \gamma < 0.45$)	Model 6 ($\gamma \geq 0.45$)
δ (discount rate)	-0.479	-1.865**	1.790
	(0.466)	(0.777)	(1.382)
γ (risk attitude)	0.399	-1.687	18.028***
	(1.888)	(2.367)	(6.426)
Premium	-0.187***	-0.129***	-0.112**
	(0.038)	(0.032)	(0.055)
Constant	2.449**	3.563**	-9.282***
	(1.006)	(1.467)	(3.451)
Observations	90	180	90

Note 1: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Note 2: The 25th and 75th percentiles of γ are 0.22 and 0.45, respectively.

2.7 Reflection

Learning the best way of conducting an experiment is crucial to obtaining useful and valid results. Experiments allow a researcher to try to learn something new about the world, an explanation of "why" something happens. When designing an experiment, a researcher must follow all of the steps of the scientific method, from making sure that the hypothesis is valid and testable, to using controls and statistical tests. This section reviews the experimental procedure and comments on what could be improved.

Subjects. The experiment in this paper used students (undergraduates and graduates) from Georgia State University as subjects. The use of students in studies of consumer behavior is widespread (Enis et al., 1972). Entire classrooms of potential respondents are readily available to academic researchers at little or no cost and these subjects generally follow instructions rapidly and accurately. But these advantages obscure the key question: Do these student responses accurately reflect the behavioral patterns of other consumers (e.g., auto policyholders) in the market? Few would deny that students are consumers, but they are typically psychologically, socially, and demographically different from other segments of the population. For example, age is an essential element for consumer segments in the auto insurance market (Crocker and Snow, 1986). Auto insurance premiums are set much higher for policyholders aged 16 to 25. The reason is simple: Per mile driven, younger drivers are more likely to crash than older drivers (National Highway Traffic Safety Administration, 2008 Traffic Safety Facts). Most subjects in the sample are between 18 and 25 (82%) and most are therefore covered under their parents' auto policies. A lack of driving or policy purchase experience may affect their choices when making accident forgiveness purchases. That is to say, students' responses to insurance purchase questions may have some variances with those of general policyholders in the market. I believe improvements could certainly be made in this study by recruiting field participants. An efficient way to do this is to collaborate with insurers and use their policyholders as subjects in the insurance policy study. Recruiting real policyholders in the experiment would undoubtedly bring about better insight into insurance policy design.

Driving Behavior. By observing subjects' driving behavior in the simulated driving task, each subject's risk type is determined and used for pricing them in the insurance purchase task. Using a simulated driving task is believed to successfully replicate subjects' driving behavior (e.g., Strayer et al., 2003). However, this approach may have drawbacks. Driving on a simulator requires good hand-to-eye coordination. Although subjects were given one practice drive with the simulator before the paid drive, some subjects may still be uncomfortable with the driving scenarios due to different individual learning curves. Thus, driving behaviors observed from the driving task may be partially explained by relatively poor skills on the simulator rather than true driving skills. In a similar vein, some subjects are"safe" drivers not because they have better driving skills but because they are better at computer racing games. One possible way to solve this problem is to use a driving simulator that enables a subject to drive in a virtual space while operating the controls of an actual vehicle.[16] However, this can be very expensive.[17] Another way is to provide questionnaires that ask about a subject's driving history (e.g., speeding tickets and at-fault accidents). Inducing subjects to tell the truth about their driving history may improve our understanding of the driving behavior observed in the simulated driving task.

Insurance Contract. In the insurance purchase task, by offering optional insurance to fully cover the potential loss, we imply subjects' preferences for an accident forgiveness policy. However, an accident forgiveness policy in the real market is provided as an optional endorsement attached to the main policy.[18] If this is the case, decisions about accident forgiveness policies may be affected by portfolio effects. For example, policyholders who purchase both collision and comprehensive benefits may hesitate to get accident forgiveness because they think they already spent enough money on auto insurance while those who only purchase liability insurance just cannot wait to have it. An ideal solution would be to offer subjects a basic auto policy (e.g., liability, collision and comprehensive policy) first and then ask them to make decisions on accident forgiveness. In such way, we may obtain more information about their decision-making processes.

[16]This type of driving simulator is widely used for driver safety education. For example, the Drive Square Simulation System™ manufactured by Drive Square is the most versatile driving simulator on the market. See http://www.drivesquare.com for details.

[17]Driving simulators range in size and price, from $20,000 desktop systems to $100,000,000 full-vehicle simulators.

[18]An endorsement is a written document attached to an insurance policy that modifies the policy by changing the coverage afforded under the policy. An endorsement can add coverage for acts or things not covered as a part of the original policy and can be added at the inception of the policy or later during the term of the policy.

2.8 Conclusions

While most of experimental literature dwells on controlled laboratory experiments to study insurance purchase decisions, close resemblance to the real insurance market is rare. This study is exploratory because some of the instruments and procedures have not been previously employed for the purpose of generating behavioral data on insurance policy issues in the same way that they are in this study.

In my design, the experiment consists of the following tasks: a lottery choice task, a discount rate task, a simulated driving task, and an insurance purchase task. The lottery choice task and the discount rate task are used to infer risk attitudes and discount rates. Due to the fact that the pricing of accident forgiveness is conditional on the policyholder's driving skills in the market, a simulated driving scenario is used in the driving task to assess the subject's driving behavior. By offering insurance contracts conditional on the observed driving behavior in the insurance purchase task, I construct a close representation of a naturally-occurring auto insurance market in which insurance premiums are based upon driver risk classifications.

Prior literature examining the determinants for individual insurance purchase decisions mostly emphasizes how product quality, switching costs, and price affect consumer decisions (e.g., Schlesinger and Schulenburg, 1993) or argues that distorted beliefs concerning the probabilities and sizes of potential losses affect consumer decisions about insurance (e.g., Kunreuther and Pauly, 2004, 2005). Despite this evidence, much is yet to be understood on the roles of risk and time preferences in insurance decision-making. This paper builds on the prior literature on insurance decision-making and theorizes about the role that risk and time preferences play on purchase decisions of accident forgiveness policies. More specifically, two hypotheses are proposed with respect to the effects of individual discount rates and the degree of risk aversion on the accident forgiveness purchase decision: (a) Policyholders with lower discount rates are more likely to have a higher demand for accident forgiveness and (b) more risk-averse policyholders are more likely to purchase accident forgiveness if their degree of risk aversion is above a given threshold. A summary of findings is provided in Table 2.10.

The findings illustrate that both individual discount rates and insurance price are negatively associated with accident forgiveness purchases. Interestingly, the data show that subjects with a relatively low degree of risk aversion behave more like risk neutral agents when making insurance decisions. In other words, their degree of risk aversion does not contribute to their insurance purchases. However, the insurance decisions of those with a higher degree of risk aversion are significantly driven by their risk attitudes. These findings imply that a specific segment of policyholders may be targeted in promoting accident forgiveness policies and that for policyholders whose purchase decisions are less driven by risk attitude, additional incentives (e.g., a good driver discount) may be considered to be bundled with an accident forgiveness policy.

Table 2.10. Summary of Findings

	Low Level of Risk Aversion	High Level of Risk Aversion
δ (discount rate)	*negative* effects on purchasing AF	*negative* effects on purchasing AF
γ (risk attitude)	no effect	*positive* effects on purchasing AF

Note 1: The high level of risk aversion refers to the degree of risk aversion above the 75th percentile.
Note 2: AF refers to accident forgiveness policies.

2.9 Appendices

2.9.1 Appendix A: Instructions

Choices over risky prospects This is a task where you will choose between prospects with varying prizes and chances of winning. You will be presented with a series of pairs where you will choose one of them. There are 40 pairs in the series. For each pair, you should choose the one you prefer to play. You will actually get the chance to play one of these you choose, and you will be paid according to the outcome of that choice.

If you are selected to do this task with the mixed frame, an initial endowment $8 will be given at the beginning of the task. So, these losses are simply framed losses and you will be faced with no personal loss.

Here is an example of what the computer display of such a pair of prospects will look like (see Figure 2.1).

The outcome of the prospects will be determined by the draw of a random number between 1 and 100. Each number between, and including, 1 and 100 is equally likely to occur. In fact, you will be able to draw the number yourself using two 10-sided dice.[19]

In the above example the left one pays five dollars ($5) if the number on the ball drawn is between 1 and 40, and pays fifteen dollars ($15) if the number is between 41 and 100. The blue color in the pie chart corresponds to 40% of the area and illustrates the chances that the ball drawn will be between 1 and 40 and the prize will be $5. The orange area in the pie chart corresponds to 60% of the area and illustrates the chances that the ball drawn will be between 41 and 100 and the prize will be $15.

Now look at the pie in the chart on the right. It pays five dollars ($5) if the number drawn is between 1 and 50, ten dollars ($10) if the number is between 51 and 90, and fifteen dollars ($15) if the number is between 91 and 100. As with the one on the left, the pie slices represent the fraction of the possible numbers which yield each payoff. For example, the size of the $15 pie slice is 10% of the total pie.

Each pair of prospects is shown on a separate screen on the computer. On each screen, you should indicate which one you prefer to play by clicking on one of the buttons beneath the prospects.

After you have worked through all of the pairs, you will then roll two 10-sided dice until a number between 1 and 40 comes up to determine which pair will be played out. Finally, you will roll the two 10-sided dice to determine the outcome of the one you chose.

For instance, suppose you picked the one on the left in the above example. If the random number was 37, you would win $5; if it was 93, you would get $15. If you picked the one on the right and drew the number 37, you would get $5; if it was 93, you would get $15.

The payoff for this task will be paid out at the end of the session with cash.

Sooner versus later payment choices In this task you will make a number of choices between receiving an amount of money on a “sooner” date or a different amount of

[19] One die shows 0-9, the other shows 00-90. If they hit 0 and 00, it is defined as 100.

money on a “later date”. The sooner date will always be today while the later date will vary from 1 to 10 weeks from today. An example of decision screen is shown below (see Figure 2.2). You will make all decisions on a computer.

This screen shows four decisions. Each decision is presented on a different row. You will choose between these two options by clicking the button under the option you prefer.

We will present you with 10 of these decision screens, with each screen having 4 choices for you to make (totally 40 choices). You must make all 4 choices on the decision screen before moving to the next decision screen. While on a single decision screen, the only difference between decisions is that the dollar amounts of the future payment will change. However, different decision screens will have different dollar amounts and future payment dates.

You will be paid for one of these decisions. You will select one of 10 decision sheets by rolling a 10-sided die, and then rolling a 4-sided die again to pick one decision on that screen.

You will receive the money on the date stated in your preferred option: If you receive some money today, then it is paid out at the end of the task with cash; If you receive some money to be paid in the future, then it will be paid to you via PayPal™on the specified date.

If you receive some money to be paid in the future you will also receive a written confirmation at the end of the experiment which guarantees that the money is to be paid to you on that date.

Practice drive instructions In this practice drive you are going to drive on a simulator (see Figure 2.7) in a suburban environment for about 3 minutes (from the starting point at the intersection of 7th Avenue and A Street to the parking lot at the intersection of 7th Avenue and G Street). Please see the attached map (Figure 2.8) for the detailed driving directions.

You must follow all basic traffic rules while you are driving in the simulator. After you are done with this drive we will review your driving report generated by the software and recorded by the experimenter. The following lists the violations that will be counted in your driving report:

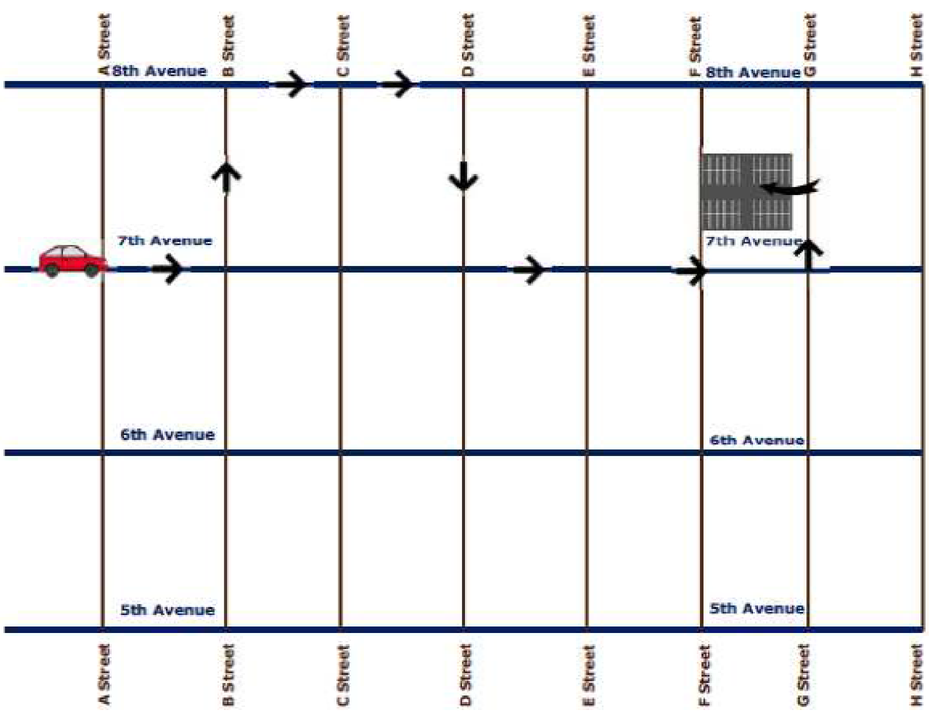
- Running red lights
- Running stop signs
- Speeding (5 miles above the imposed speed limit)
- Collisions

This is for practice only and you will earn no money based on this drive. Do you have any questions?

Paid drive instructions How do you feel? Do you have any feeling of nausea at all? Would you like to get up and move around, perhaps have some water?

Figure 2.7. Driving Simulator

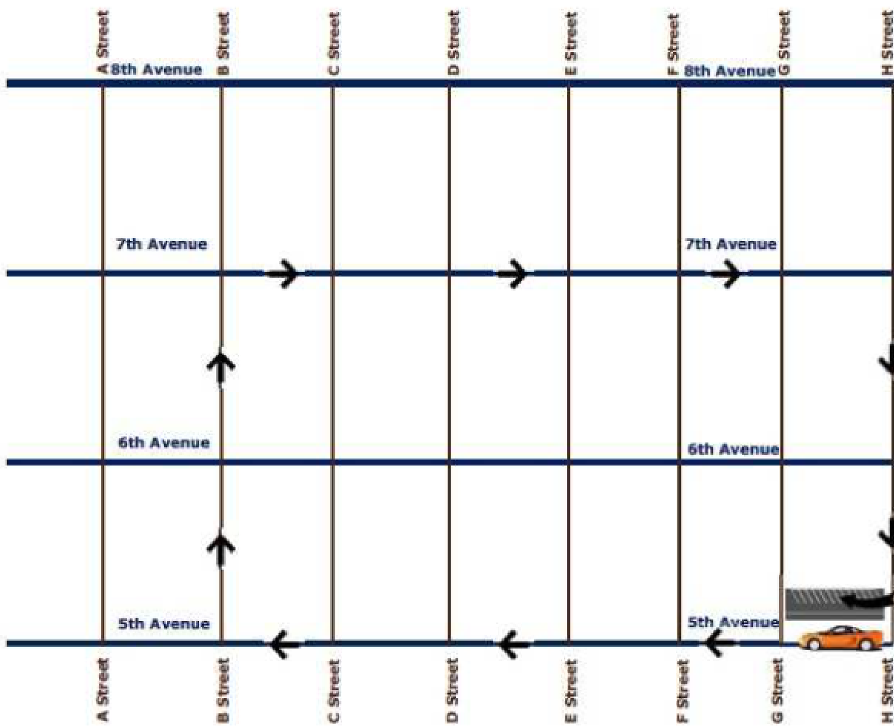
Figure 2.8. Map for the Unpaid Practice Drive



It is time to have paid drive in the simulator. It will be similar to the test drive you did, but you will be paid for this formal drive. Your earnings will be determined by your driving performance.

In this formal drive, you are going to drive in a suburban environment (from the starting point at the intersection of 5 Avenue and G Street to the ending point at the intersection of 5 Avenue and H Street). Please see the attached map (Figure 2.9) for the detailed driving directions. You are required to finish this driving task within 5 minutes. Remember that you must follow all basic traffic rules while you are driving in the simulator.

Figure 2.9. Map for the Paid Drive



After you are done with this drive we will review your driving report generated by the software. The following lists (Table 2.11) the violations that will be counted in your driving report:

If you have less than 5 points (including 5 points) for traffic violations, you will earn \$60.00; otherwise, you will earn \$30.00.

Your earnings for this task will be used as principal for the next insurance task. Only after you finish both tasks, your net earnings will be calculated at the end of the session.

Insurance purchases In this task you will make choices about a series of prospects. Each prospect has the possibility of a negative outcome. In each prospect, you will be allowed to buy insurance against the negative outcome, although you are not required to

Table 2.11. Driving Violation Penalties

Violations	Penalties
Collisions	5 points each
Running stop signs	2 points each
Running red lights	2 points each
Travel time longer than 5 min	1 point every 10 seconds
Speeding (5 miles above the imposed speed limit)	1 point each

buy the insurance. There are 6 pairs in the series. For each pair, you should choose the one you prefer to have (purchase insurance or not). You will get the chance to play one of the decisions you choose, and you will be paid according to the outcome of that prospect.

You will use the amount you have earned from the previous driving task as the initial endowment in this task. All losses here are simply framed losses and you will never incur any personal losses.

Here is an example of what the computer display of such a pair of insurance choices will look like (see Figure 2.5):

In the above example the first choice shows no insurance purchase and if the 10-sided die shows 1-4, the subject will lose \$30.00 they earned from driving task. The second choice shows insurance purchase by paying \$9.60 as the premium and he will lose nothing and get full pay no matter which number the die shows (the net earnings will be \$30.00 - \$9.60).

Similar to this pair, there will be 6 pairs. After you finish all these pairs, you will have a chance to review all previous decisions without revising any of them. You will then roll a 6-sided die to determine which pair of choices will be played out. Finally, you will roll a 10-sided die to determine the outcome of the choice you chose.

The net earnings from both driving task and insurance choices task will be paid via PayPal™after 4 weeks. You will receive a written confirmation which guarantees that the money is to be paid to you on that date.

2.9.2 Appendix B: Survey Questions

Q1: What is your age?

Q2: What is your gender?
Female
Male

Q3: Which of the following categories best describes you?
White
African-American
African
Asian-American
Asian
Hispanic-American
Hispanic
Mixed Race
Other

Q4: What is your major?
Accounting
Economics
Finance
Business Administration, other than Accounting, Economics, or Finance
Education
Engineering
Health Professions
Public Affairs or Social Services
Biological Sciences
Does not apply
Math, Computer Sciences, or Physical Sciences
Social Sciences or History
Humanities
Psychology
Other Fields
Does not apply

Q5: What is your class standing?
Freshman
Sophomore
Junior
Senior
Masters
Doctoral

Does not apply

Q6: What is the highest level of education you expect to complete?
Bachelor's degree
Master's degree
Doctoral degree
First professional degree
High school diploma or GED
Less than high school

Q7: What was the highest level of education that your father (or male guardian) completed?
Less than high school
GED or High School Equivalency
High school
Vocational or trade school
College or university

Q8: What was the highest level of education that your mother (or female guardian) completed?
Less than high school
GED or High School Equivalency
High school
Vocational or trade school
College or university

Q9: What is your citizenship status in the United States?
U.S. Citizen
Resident Alien
Non-Resident Alien
Other Status

Q10: Are you a foreign student on a Student Visa?
Yes
No

Q11: Are you currently...
Single and never married?
Married?
Separated, divorced or widowed?

Q12: On a 4-point scale, what is your current GPA if you are doing a Bachelor's degree, or what was it when you did a Bachelor's degree? This GPA should refer to all of your course work, not just the current year. Please pick one:

Between 3.75 and 4.0 GPA (mostly A's)
Between 3.25 and 3.74 GPA (about half A's and half B's)
Between 2.75 and 3.24 GPA (mostly B's)
Between 2.25 and 2.74 GPA (about half B's and half C's)
Between 1.75 and 2.24 GPA (mostly C's)
Between 1.25 and 1.74 GPA (about half C's and half D's)
Less than 1.25 (mostly D's or below)
Have not taken courses for which grades are given.

Q13: How many people live in your household? Include yourself, your spouse and any dependents. Do not include your parents or roommates unless you claim them as dependents.

Q14: Please select the category below that best describes the total amount of INCOME earned in 2010 by the people in your household (as "household" is defined in question 13). Consider all forms of income, including salaries, tips, interest and dividend payments, scholarship support, student loans, parental support, social security, alimony, and child support, and others.
$15,000 or under
$15,001 - $25,000
$25,001 - $35,000
$35,001 - $50,000
$50,001 - $65,000
$65,001 - $80,000
$80,001 - $100,000
$100,001 - $150,000
over $150,000
Prefer not to answer

Q15: Please select the category below that best describes the total amount of INCOME earned in 2010 by your parents. Again, consider all forms of income, including salaries, tips, interest and dividend payments, social security, alimony, and child support, and others.
$15,000 or under
$15,001 - $25,000
$25,001 - $35,000
$35,001 - $50,000
$50,001 - $65,000
$65,001 - $80,000
$80,001 - $100,000
over $100,000
Don't Know
Not applicable
Prefer not to answer

Q16: Do you work part-time, full-time, or neither?
Part-time
Full-time
Neither

Q17: How much money do you typically spend each day using cash and your debit card (in dollars)?

Q18: Do you currently smoke cigarettes?
No
Yes

Q19: If you do smoke, approximately how many packs do you smoke in one day?

Q20: A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?

Q21: If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

Q22: In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

Q23: How would you characterize your religious beliefs? Please check the one that best represents them.
Atheism
Buddhism
Christianity - Baptist
Christianity - Catholic
Christianity - Lutheran
Christianity - Methodist
Christianity - Other
Hinduism
Islam
Judaism
Nonreligious or Agnostic
Other
Prefer not to answer

Q24: Have you bet more than you could really afford to lose?
Never
Sometimes

Most of the time
Almost always

Q25: Still thinking about the last 12 months, have you needed to gamble with larger amounts of money to get the same feeling of excitement?
Never
Sometimes
Most of the time
Almost always

Q26: When you gambled, did you go back another day to try to win back the money you lost?
Never
Sometimes
Most of the time
Almost always

Q27: Have you borrowed money or sold anything to get money to gamble?
Never
Sometimes
Most of the time
Almost always

Q28: Have you felt that you might have a problem with gambling?
Never
Sometimes
Most of the time
Almost always

Q29: Has gambling caused you any health problems, including stress or anxiety?
Never
Sometimes
Most of the time
Almost always

Q30: Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?
Never
Sometimes
Most of the time
Almost always

Q31: Has your gambling caused any financial problems for you or your household?
Never
Sometimes
Most of the time
Almost always

Q32: Have you felt guilty about the way you gamble or what happens when you gamble?
Never
Sometimes
Most of the time
Almost always

Q33: How often do you have a drink containing alcohol?
Never
Monthly or less
Two to four times a month
Two to three times per week
Four or more times per week

Q34: How many drinks containing alcohol do you have on a typical day when you are drinking?
1 or 2
3 or 4
5 or 6
7 to 9
10 or more

Q35: How often do you have six or more drinks on one occasion?
Never
Less than monthly
Monthly
Two to three times per week
Four or more times per week

Q36: How often during the last year have you found that you were not able to stop drinking once you had started?
Never
Less than monthly
Monthly
Two to three times per week
Four or more times per week

Q37: How often during the last year have you failed to do what was normally expected from you because of drinking?
Never
Less than monthly
Monthly
Two to three times per week
Four or more times per week

Q38: How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?
Never
Less than monthly
Monthly
Two to three times per week
Four or more times per week

Q39: How often during the last year have you had a feeling of guilt or remorse after drinking?
Never
Less than monthly
Monthly
Two to three times per week
Four or more times per week

Q40: How often during the last year have you been unable to remember what happened the night before because you had been drinking?
Never
Less than monthly
Monthly
Two to three times per week
Four or more times per week

Q41: Have you or someone else been injured as a result of your drinking?
No
Yes, but not in the last year
Yes, during the last year

Q42: Has a relative or friend, or a doctor or other health worker, been concerned about your drinking or suggested you cut down?
No
Yes, but not in the last year
Yes, during the last year

2.9.3 Appendix C: Parameters of Experiments

Table 2.12: Lotteries in Experiments

Pairs	Prize 1	Prize 2	Prize 3	Prize 4	Prob L1	Prob L2	Prob L3	Prob L4	Prob R1	Prob R2	Prob R3	Prob R4
G1	0	5	10	15	0.38	0.62	0	0	0.75	0	0	0.25
G2	0	5	10	15	0.62	0	0.38	0	0.75	0	0	0.25
G3	0	5	10	15	0.13	0.38	0.49	0	0	1	0	0
G4	0	5	10	15	0.38	0	0.62	0	0.49	0	0.13	0.38
G5	0	5	10	15	0	0.25	0.5	0.25	0	0.13	0.74	0.13
G6	0	5	10	15	0.75	0	0	0.25	0.62	0	0.38	0
G7	0	5	10	15	0	0.5	0.5	0	0.13	0.25	0.62	0
G8	0	5	10	15	0	0.25	0	0.75	0	0.13	0.49	0.38
G9	0	5	10	15	0	0.75	0	0.25	0	0.62	0.38	0
G10	0	5	10	15	0.13	0.25	0.62	0	0	0.62	0.38	0
G11	0	5	10	15	0	0.74	0.13	0.13	0	0.62	0.38	0
G12	0	5	10	15	0	0.37	0.26	0.37	0	0.25	0.5	0.25
G13	0	5	10	15	0	0.62	0.38	0	0	0.75	0	0.25
G14	0	5	10	15	0.25	0	0.5	0.25	0.13	0	0.87	0
G15	0	5	10	15	0	0.25	0.5	0.25	0	0.13	0.87	0
G16	0	5	10	15	0.38	0	0.62	0	0.25	0.75	0	0
G17	0	5	10	15	0.13	0.74	0	0.13	0	1	0	0
G18	0	5	10	15	0.62	0.38	0	0	0.87	0	0	0.13
G19	0	5	10	15	0.13	0.62	0.25	0	0.25	0.25	0.5	0
G20	0	5	10	15	0	0.13	0.49	0.38	0	0.25	0	0.75
G21	0	5	10	15	0.13	0.74	0.13	0	0.25	0.5	0.25	0
G22	0	5	10	15	0.13	0.49	0.38	0	0.25	0	0.75	0
G23	0	5	10	15	0.13	0	0.25	0.62	0	0	1	0
G24	0	5	10	15	0	0.62	0.38	0	0.13	0.25	0.62	0
G25	0	5	10	15	0.75	0.25	0	0	0.87	0	0	0.13
G26	0	5	10	15	0	0.37	0.26	0.37	0	0.25	0.62	0.13
G27	0	5	10	15	0	0.13	0.87	0	0	0.25	0.5	0.25
G28	0	5	10	15	0	0.62	0.13	0.25	0	0.49	0.38	0.13
G29	0	5	10	15	0.87	0	0	0.13	0.75	0.25	0	0
G30	0	5	10	15	0	1	0	0	0.13	0.38	0.49	0
G31	0	5	10	15	0	0.13	0.74	0.13	0	0.25	0.5	0.25
G32	0	5	10	15	0.13	0	0.13	0.74	0	0	0.62	0.38
G33	0	5	10	15	0.75	0	0	0.25	0.38	0.62	0	0

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Table 2.12 – continued from previous page

Pairs	Prize 1 ($)	Prize 2 ($)	Prize 3 ($)	Prize 4 ($)	Prob L1	Prob L2	Prob L3	Prob L4	Prob R1	Prob R2	Prob R3	Prob R4
G34	0	5	10	15	0.37	0.37	0	0.26	0.13	0.87	0	0
G35	0	5	10	15	0.25	0.62	0.13	0	0.37	0.26	0.37	0
G36	0	5	10	15	0	0.13	0.62	0.25	0	0.25	0.25	0.5
G37	0	5	10	15	0	0.87	0.13	0	0.13	0.62	0.25	0
G38	0	5	10	15	0.87	0	0	0.13	0.62	0.38	0	0
G39	0	5	10	15	0.13	0.62	0.25	0	0	0.87	0.13	0
G40	0	5	10	15	0.49	0	0.13	0.38	0.38	0	0.62	0
G41	0	5	10	15	0.25	0.5	0.25	0	0.13	0.87	0	0
G42	0	5	10	15	0.25	0	0.75	0	0.13	0.49	0.38	0
G43	0	5	10	15	0.25	0	0.75	0	0.38	0	0	0.62
G44	0	5	10	15	0	0	1	0	0.13	0	0.25	0.62
G45	0	5	10	15	0.13	0.87	0	0	0.25	0.5	0.25	0
G46	0	5	10	15	0	0.62	0.38	0	0	0.74	0.13	0.13
G47	0	5	10	15	0.38	0	0	0.62	0.25	0	0.75	0
G48	0	5	10	15	0	0.25	0.5	0.25	0	0.37	0.26	0.37
G49	0	5	10	15	0.25	0.5	0.25	0	0.13	0.74	0.13	0
G50	0	5	10	15	0	0	0.62	0.38	0.13	0	0.13	0.74
G51	0	5	10	15	0.37	0.26	0.37	0	0.25	0.62	0.13	0
G52	0	5	10	15	0	0.25	0.25	0.5	0	0.13	0.62	0.25
G53	0	5	10	15	0.13	0	0.87	0	0.25	0	0.5	0.25
G54	0	5	10	15	0	0.49	0.38	0.13	0	0.62	0.13	0.25
G55	0	5	10	15	0	0.25	0.62	0.13	0	0.37	0.26	0.37
G56	0	5	10	15	0.25	0.75	0	0	0.38	0	0.62	0
G57	0	5	10	15	0.13	0.25	0.62	0	0	0.5	0.5	0
G58	0	5	10	15	0	1	0	0	0.13	0.74	0	0.13
G59	0	5	10	15	0.13	0.87	0	0	0.37	0.37	0	0.26
G60	0	5	10	15	0.25	0.25	0.5	0	0.13	0.62	0.25	0
M1	-8	-3	3	8	0.38	0.62	0	0	0.75	0	0	0.25
M2	-8	-3	3	8	0.62	0	0.38	0	0.75	0	0	0.25
M3	-8	-3	3	8	0.13	0.38	0.49	0	0	1	0	0
M4	-8	-3	3	8	0.38	0	0.62	0	0.49	0	0.13	0.38
M5	-8	-3	3	8	0	0.25	0.5	0.25	0	0.13	0.74	0.13
M6	-8	-3	3	8	0.75	0	0	0.25	0.62	0	0.38	0
M7	-8	-3	3	8	0	0.5	0.5	0	0.13	0.25	0.62	0
M8	-8	-3	3	8	0	0.25	0	0.75	0	0.12	0.49	0.38
M9	-8	-3	3	8	0	0.75	0	0.25	0	0.62	0.38	0

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Table 2.12 – continued from previous page

Pairs	Prize 1 ($)	Prize 2 ($)	Prize 3 ($)	Prize 4 ($)	Prob L1	Prob L2	Prob L3	Prob L4	Prob R1	Prob R2	Prob R3	Prob R4
M10	-8	-3	3	8	0.13	0.25	0.62	0	0	0.62	0.38	0
M11	-8	-3	3	8	0	0.74	0.13	0.13	0	0.62	0.38	0
M12	-8	-3	3	8	0	0.37	0.26	0.37	0	0.25	0.5	0.25
M13	-8	-3	3	8	0	0.62	0.38	0	0	0.75	0	0.25
M14	-8	-3	3	8	0.25	0	0.5	0.25	0.13	0	0.87	0
M15	-8	-3	3	8	0	0.25	0.5	0.25	0	0.13	0.87	0
M16	-8	-3	3	8	0.38	0	0.62	0	0.25	0.75	0	0
M17	-8	-3	3	8	0.13	0.74	0	0.13	0	1	0	0
M18	-8	-3	3	8	0.62	0.38	0	0	0.87	0	0	0.13
M19	-8	-3	3	8	0.13	0.62	0.25	0	0.25	0.25	0.5	0
M20	-8	-3	3	8	0	0.13	0.49	0.38	0	0.25	0	0.75
M21	-8	-3	3	8	0.13	0.74	0.13	0	0.25	0.5	0.25	0
M22	-8	-3	3	8	0.13	0.49	0.38	0	0.25	0	0.75	0
M23	-8	-3	3	8	0.13	0	0.25	0.62	0	0	1	0
M24	-8	-3	3	8	0	0.62	0.38	0	0.13	0.25	0.62	0
M25	-8	-3	3	8	0.75	0.25	0	0	0.87	0	0	0.13
M26	-8	-3	3	8	0	0.37	0.26	0.37	0	0.25	0.62	0.13
M27	-8	-3	3	8	0	0.13	0.87	0	0	0.25	0.5	0.25
M28	-8	-3	3	8	0	0.62	0.13	0.25	0	0.49	0.38	0.13
M29	-8	-3	3	8	0.87	0	0	0.13	0.75	0.25	0	0
M30	-8	-3	3	8	0	1	0	0	0.13	0.38	0.49	0
M31	-8	-3	3	8	0	0.13	0.74	0.13	0	0.25	0.5	0.25
M32	-8	-3	3	8	0.13	0	0.13	0.74	0	0	0.62	0.38
M33	-8	-3	3	8	0.75	0	0	0.25	0.38	0.62	0	0
M34	-8	-3	3	8	0.37	0.37	0	0.26	0.13	0.87	0	0
M35	-8	-3	3	8	0.25	0.62	0.13	0	0.37	0.26	0.37	0
M36	-8	-3	3	8	0	0.13	0.62	0.25	0	0.25	0.25	0.5
M37	-8	-3	3	8	0	0.87	0.13	0	0.13	0.62	0.25	0
M38	-8	-3	3	8	0.87	0	0	0.13	0.62	0.38	0	0
M39	-8	-3	3	8	0.13	0.62	0.25	0	0	0.87	0.13	0
M40	-8	-3	3	8	0.49	0	0.13	0.38	0.38	0	0.62	0
M41	-8	-3	3	8	0.25	0.5	0.25	0	0.13	0.87	0	0
M42	-8	-3	3	8	0.25	0	0.75	0	0.13	0.49	0.38	0
M43	-8	-3	3	8	0.25	0	0.75	0	0.38	0	0	0.62
M44	-8	-3	3	8	0	0	1	0	0.13	0	0.25	0.62
M45	-8	-3	3	8	0.13	0.87	0	0	0.25	0.5	0.25	0

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Table 2.12 – continued from previous page

Pairs	Prize 1 ($)	Prize 2 ($)	Prize 3 ($)	Prize 4 ($)	Prob L1	Prob L2	Prob L3	Prob L4	Prob R1	Prob R2	Prob R3	Prob R4
M46	-8	-3	3	8	0	0.62	0.38	0	0	0.74	0.13	0.13
M47	-8	-3	3	8	0.38	0	0	0.62	0.25	0	0.75	0
M48	-8	-3	3	8	0	0.25	0.5	0.25	0	0.37	0.26	0.37
M49	-8	-3	3	8	0.25	0.5	0.25	0	0.13	0.74	0.13	0
M50	-8	-3	3	8	0	0	0.62	0.38	0.13	0	0.13	0.74
M51	-8	-3	3	8	0.37	0.26	0.37	0	0.25	0.62	0.13	0
M52	-8	-3	3	8	0	0.25	0.25	0.5	0	0.13	0.62	0.25
M53	-8	-3	3	8	0.13	0	0.87	0	0.25	0	0.5	0.25
M54	-8	-3	3	8	0	0.49	0.38	0.13	0	0.62	0.13	0.25
M55	-8	-3	3	8	0	0.25	0.62	0.13	0	0.37	0.26	0.37
M56	-8	-3	3	8	0.25	0.75	0	0	0.38	0	0.62	0
M57	-8	-3	3	8	0.13	0.25	0.62	0	0	0.5	0.5	0
M58	-8	-3	3	8	0	1	0	0	0.13	0.74	0	0.13
M59	-8	-3	3	8	0.13	0.87	0	0	0.37	0.37	0	0.26
M60	-8	-3	3	8	0.25	0.25	0.5	0	0.13	0.62	0.25	0

Table 2.13: Sooner versus Later Payments in Experiments

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
1	1	30	0.05	30	0	30.03	7
1	1	30	0.1	30	0	30.06	7
1	1	30	0.15	30	0	30.09	7
1	1	30	0.2	30	0	30.12	7
1	1	30	0.25	30	0	30.14	7
1	1	30	0.3	30	0	30.17	7
1	1	30	0.4	30	0	30.23	7
1	1	30	0.5	30	0	30.29	7
1	1	30	0.75	30	0	30.43	7
1	1	30	1	30	0	30.58	7
1	1	30	1.25	30	0	30.72	7
1	1	30	1.5	30	0	30.87	7
1	1	30	1.75	30	0	31.01	7
1	1	30	2	30	0	31.15	7
2	1	60	0.05	60	0	60.06	7
2	1	60	0.1	60	0	60.12	7

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
2	1	60	0.15	60	0	60.17	7
2	1	60	0.2	60	0	60.23	7
2	1	60	0.25	60	0	60.29	7
2	1	60	0.3	60	0	60.35	7
2	1	60	0.4	60	0	60.46	7
2	1	60	0.5	60	0	60.58	7
2	1	60	0.75	60	0	60.87	7
2	1	60	1	60	0	61.15	7
2	1	60	1.25	60	0	61.44	7
2	1	60	1.5	60	0	61.73	7
2	1	60	1.75	60	0	62.02	7
2	1	60	2	60	0	62.31	7
3	2	30	0.05	30	0	30.06	14
3	2	30	0.1	30	0	30.12	14
3	2	30	0.15	30	0	30.17	14
3	2	30	0.2	30	0	30.23	14
3	2	30	0.25	30	0	30.29	14
3	2	30	0.3	30	0	30.35	14
3	2	30	0.4	30	0	30.46	14
3	2	30	0.5	30	0	30.58	14
3	2	30	0.75	30	0	30.87	14
3	2	30	1	30	0	31.15	14
3	2	30	1.25	30	0	31.44	14
3	2	30	1.5	30	0	31.73	14
3	2	30	1.75	30	0	32.02	14
3	2	30	2	30	0	32.31	14
4	2	60	0.05	60	0	60.12	14
4	2	60	0.1	60	0	60.23	14
4	2	60	0.15	60	0	60.35	14
4	2	60	0.2	60	0	60.46	14
4	2	60	0.25	60	0	60.58	14
4	2	60	0.3	60	0	60.69	14
4	2	60	0.4	60	0	60.92	14
4	2	60	0.5	60	0	61.15	14
4	2	60	0.75	60	0	61.73	14
4	2	60	1	60	0	62.31	14

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
4	2	60	1.25	60	0	62.88	14
4	2	60	1.5	60	0	63.46	14
4	2	60	1.75	60	0	64.04	14
4	2	60	2	60	0	64.62	14
5	3	30	0.05	30	0	30.09	21
5	3	30	0.1	30	0	30.17	21
5	3	30	0.15	30	0	30.26	21
5	3	30	0.2	30	0	30.35	21
5	3	30	0.25	30	0	30.43	21
5	3	30	0.3	30	0	30.52	21
5	3	30	0.4	30	0	30.69	21
5	3	30	0.5	30	0	30.87	21
5	3	30	0.75	30	0	31.30	21
5	3	30	1	30	0	31.73	21
5	3	30	1.25	30	0	32.16	21
5	3	30	1.5	30	0	32.60	21
5	3	30	1.75	30	0	33.03	21
5	3	30	2	30	0	33.46	21
6	3	60	0.05	60	0	60.17	21
6	3	60	0.1	60	0	60.35	21
6	3	60	0.15	60	0	60.52	21
6	3	60	0.2	60	0	60.69	21
6	3	60	0.25	60	0	60.87	21
6	3	60	0.3	60	0	61.04	21
6	3	60	0.4	60	0	61.38	21
6	3	60	0.5	60	0	61.73	21
6	3	60	0.75	60	0	62.60	21
6	3	60	1	60	0	63.46	21
6	3	60	1.25	60	0	64.33	21
6	3	60	1.5	60	0	65.19	21
6	3	60	1.75	60	0	66.06	21
6	3	60	2	60	0	66.92	21
7	4	30	0.05	30	0	30.12	28
7	4	30	0.1	30	0	30.23	28
7	4	30	0.15	30	0	30.35	28
7	4	30	0.2	30	0	30.46	28

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
7	4	30	0.25	30	0	30.58	28
7	4	30	0.3	30	0	30.69	28
7	4	30	0.4	30	0	30.92	28
7	4	30	0.5	30	0	31.15	28
7	4	30	0.75	30	0	31.73	28
7	4	30	1	30	0	32.31	28
7	4	30	1.25	30	0	32.88	28
7	4	30	1.5	30	0	33.46	28
7	4	30	1.75	30	0	34.04	28
7	4	30	2	30	0	34.62	28
8	4	60	0.05	60	0	60.23	28
8	4	60	0.1	60	0	60.46	28
8	4	60	0.15	60	0	60.69	28
8	4	60	0.2	60	0	60.92	28
8	4	60	0.25	60	0	61.15	28
8	4	60	0.3	60	0	61.38	28
8	4	60	0.4	60	0	61.85	28
8	4	60	0.5	60	0	62.31	28
8	4	60	0.75	60	0	63.46	28
8	4	60	1	60	0	64.62	28
8	4	60	1.25	60	0	65.77	28
8	4	60	1.5	60	0	66.92	28
8	4	60	1.75	60	0	68.08	28
8	4	60	2	60	0	69.23	28
9	5	30	0.05	30	0	30.14	35
9	5	30	0.1	30	0	30.29	35
9	5	30	0.15	30	0	30.43	35
9	5	30	0.2	30	0	30.58	35
9	5	30	0.25	30	0	30.72	35
9	5	30	0.3	30	0	30.87	35
9	5	30	0.4	30	0	31.15	35
9	5	30	0.5	30	0	31.44	35
9	5	30	0.75	30	0	32.16	35
9	5	30	1	30	0	32.88	35
9	5	30	1.25	30	0	33.61	35
9	5	30	1.5	30	0	34.33	35

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
9	5	30	1.75	30	0	35.05	35
9	5	30	2	30	0	35.77	35
10	5	60	0.05	60	0	60.29	35
10	5	60	0.1	60	0	60.58	35
10	5	60	0.15	60	0	60.87	35
10	5	60	0.2	60	0	61.15	35
10	5	60	0.25	60	0	61.44	35
10	5	60	0.3	60	0	61.73	35
10	5	60	0.4	60	0	62.31	35
10	5	60	0.5	60	0	62.88	35
10	5	60	0.75	60	0	64.33	35
10	5	60	1	60	0	65.77	35
10	5	60	1.25	60	0	67.21	35
10	5	60	1.5	60	0	68.65	35
10	5	60	1.75	60	0	70.10	35
10	5	60	2	60	0	71.54	35
11	6	30	0.05	30	0	30.17	42
11	6	30	0.1	30	0	30.35	42
11	6	30	0.15	30	0	30.52	42
11	6	30	0.2	30	0	30.69	42
11	6	30	0.25	30	0	30.87	42
11	6	30	0.3	30	0	31.04	42
11	6	30	0.4	30	0	31.38	42
11	6	30	0.5	30	0	31.73	42
11	6	30	0.75	30	0	32.60	42
11	6	30	1	30	0	33.46	42
11	6	30	1.25	30	0	34.33	42
11	6	30	1.5	30	0	35.19	42
11	6	30	1.75	30	0	36.06	42
11	6	30	2	30	0	36.92	42
12	6	60	0.05	60	0	60.35	42
12	6	60	0.1	60	0	60.69	42
12	6	60	0.15	60	0	61.04	42
12	6	60	0.2	60	0	61.38	42
12	6	60	0.25	60	0	61.73	42

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
12	6	60	0.3	60	0	62.08	42
12	6	60	0.4	60	0	62.77	42
12	6	60	0.5	60	0	63.46	42
12	6	60	0.75	60	0	65.19	42
12	6	60	1	60	0	66.92	42
12	6	60	1.25	60	0	68.65	42
12	6	60	1.5	60	0	70.38	42
12	6	60	1.75	60	0	72.12	42
12	6	60	2	60	0	73.85	42
13	7	30	0.05	30	0	30.20	49
13	7	30	0.1	30	0	30.40	49
13	7	30	0.15	30	0	30.61	49
13	7	30	0.2	30	0	30.81	49
13	7	30	0.25	30	0	31.01	49
13	7	30	0.3	30	0	31.21	49
13	7	30	0.4	30	0	31.62	49
13	7	30	0.5	30	0	32.02	49
13	7	30	0.75	30	0	33.03	49
13	7	30	1	30	0	34.04	49
13	7	30	1.25	30	0	35.05	49
13	7	30	1.5	30	0	36.06	49
13	7	30	1.75	30	0	37.07	49
13	7	30	2	30	0	38.08	49
14	7	60	0.05	60	0	60.40	49
14	7	60	0.1	60	0	60.81	49
14	7	60	0.15	60	0	61.21	49
14	7	60	0.2	60	0	61.62	49
14	7	60	0.25	60	0	62.02	49
14	7	60	0.3	60	0	62.42	49
14	7	60	0.4	60	0	63.23	49
14	7	60	0.5	60	0	64.04	49
14	7	60	0.75	60	0	66.06	49
14	7	60	1	60	0	68.08	49
14	7	60	1.25	60	0	70.10	49
14	7	60	1.5	60	0	72.12	49
14	7	60	1.75	60	0	74.13	49

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
14	7	60	2	60	0	76.15	49
15	8	30	0.05	30	0	30.23	56
15	8	30	0.1	30	0	30.46	56
15	8	30	0.15	30	0	30.69	56
15	8	30	0.2	30	0	30.92	56
15	8	30	0.25	30	0	31.15	56
15	8	30	0.3	30	0	31.38	56
15	8	30	0.4	30	0	31.85	56
15	8	30	0.5	30	0	32.31	56
15	8	30	0.75	30	0	33.46	56
15	8	30	1	30	0	34.62	56
15	8	30	1.25	30	0	35.77	56
15	8	30	1.5	30	0	36.92	56
15	8	30	1.75	30	0	38.08	56
15	8	30	2	30	0	39.23	56
16	8	60	0.05	60	0	60.46	56
16	8	60	0.1	60	0	60.92	56
16	8	60	0.15	60	0	61.38	56
16	8	60	0.2	60	0	61.85	56
16	8	60	0.25	60	0	62.31	56
16	8	60	0.3	60	0	62.77	56
16	8	60	0.4	60	0	63.69	56
16	8	60	0.5	60	0	64.62	56
16	8	60	0.75	60	0	66.92	56
16	8	60	1	60	0	69.23	56
16	8	60	1.25	60	0	71.54	56
16	8	60	1.5	60	0	73.85	56
16	8	60	1.75	60	0	76.15	56
16	8	60	2	60	0	78.46	56
17	9	30	0.05	30	0	30.26	63
17	9	30	0.1	30	0	30.52	63
17	9	30	0.15	30	0	30.78	63
17	9	30	0.2	30	0	31.04	63
17	9	30	0.25	30	0	31.30	63
17	9	30	0.3	30	0	31.56	63
17	9	30	0.4	30	0	32.08	63

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
17	9	30	0.5	30	0	32.60	63
17	9	30	0.75	30	0	33.89	63
17	9	30	1	30	0	35.19	63
17	9	30	1.25	30	0	36.49	63
17	9	30	1.5	30	0	37.79	63
17	9	30	1.75	30	0	39.09	63
17	9	30	2	30	0	40.38	63
18	9	60	0.05	60	0	60.52	63
18	9	60	0.1	60	0	61.04	63
18	9	60	0.15	60	0	61.56	63
18	9	60	0.2	60	0	62.08	63
18	9	60	0.25	60	0	62.60	63
18	9	60	0.3	60	0	63.12	63
18	9	60	0.4	60	0	64.15	63
18	9	60	0.5	60	0	65.19	63
18	9	60	0.75	60	0	67.79	63
18	9	60	1	60	0	70.38	63
18	9	60	1.25	60	0	72.98	63
18	9	60	1.5	60	0	75.58	63
18	9	60	1.75	60	0	78.17	63
18	9	60	2	60	0	80.77	63
19	10	30	0.05	30	0	30.29	70
19	10	30	0.1	30	0	30.58	70
19	10	30	0.15	30	0	30.87	70
19	10	30	0.2	30	0	31.15	70
19	10	30	0.25	30	0	31.44	70
19	10	30	0.3	30	0	31.73	70
19	10	30	0.4	30	0	32.31	70
19	10	30	0.5	30	0	32.88	70
19	10	30	0.75	30	0	34.33	70
19	10	30	1	30	0	35.77	70
19	10	30	1.25	30	0	37.21	70
19	10	30	1.5	30	0	38.65	70
19	10	30	1.75	30	0	40.10	70
19	10	30	2	30	0	41.54	70
20	10	60	0.05	60	0	60.58	70

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Table 2.13 – continued from previous page

Block	Horizon (Weeks)	Principal ($)	Annual Growth	Sooner Amount ($)	Sooner Horizon (Days)	Later Payment ($)	Later Horizon (Days)
20	10	60	0.1	60	0	61.15	70
20	10	60	0.15	60	0	61.73	70
20	10	60	0.2	60	0	62.31	70
20	10	60	0.25	60	0	62.88	70
20	10	60	0.3	60	0	63.46	70
20	10	60	0.4	60	0	64.62	70
20	10	60	0.5	60	0	65.77	70
20	10	60	0.75	60	0	68.65	70
20	10	60	1	60	0	71.54	70
20	10	60	1.25	60	0	74.42	70
20	10	60	1.5	60	0	77.31	70
20	10	60	1.75	60	0	80.19	70
20	10	60	2	60	0	83.08	70

Table 2.14: Insurance Purchase in Experiments

Initial Endowment ($)	Exp Loss ($)	Prob of Loss	Loss Amt ($)	Ins Load	Ins Premium ($)	Risk Type
60.00	6.00	0.1	60.00	0.5	3.00	L
60.00	6.00	0.1	60.00	1	6.00	L
60.00	6.00	0.1	60.00	1.5	9.00	L
60.00	6.00	0.2	30.00	0.5	3.00	L
60.00	6.00	0.2	30.00	1	6.00	L
60.00	6.00	0.2	30.00	1.5	9.00	L
30.00	12.00	0.4	30.00	0.5	6.00	H
30.00	12.00	0.4	30.00	1	12.00	H
30.00	12.00	0.4	30.00	1.5	18.00	H
30.00	12.00	0.6	20.00	0.5	6.00	H
30.00	12.00	0.6	20.00	1	12.00	H
30.00	12.00	0.6	20.00	1.5	18.00	H

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