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## **Compulsory versus Voluntary Insurance: An Online Experiment**

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# Compulsory versus Voluntary Insurance: An Online Experiment\*

## Abstract

Insurance can be classified into two broad categories: Compulsory (government/public) and Voluntary (market/private). In practice, the vast majority of compulsory insurance is partially compulsory, where compulsory insurance provides only partial coverage, and it allows for supplemental voluntary purchases (mixed insurance). In this paper, we use the Balloon Analogue Risk Task (BART) as both the assessment of risk-taking and insurance context to conduct an online experiment. The main objective is to compare purely compulsory, voluntary and mixed insurance in terms of adverse selection, moral hazard and social welfare simultaneously. We find adverse selection in purely voluntary insurance, but not in mixed insurance. Moral hazard exists in all three types of insurance, but it is smaller in mixed insurance. Finally, our results suggest that the combined effects of significant moral hazard and “no adverse selection” in purely compulsory insurance make it the insurance type with the lowest social welfare. Overall there is no crowd-out effect of the compulsory part on residual voluntary purchases in mixed insurance.

**Keywords:** BART, Behavioral Insurance, Risk

**JEL Codes:** G22, C90, D81

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# I Introduction

Insurance plays an important role in society and in public policy. Insurance can be classified into two broad categories: Compulsory (government/public) and Voluntary (market/private). People can freely choose to purchase voluntary insurance or not, but they are unable to refuse compulsory insurance. For example, in many countries, national medical insurance and national health care insurance are compulsory. Compulsory insurance is usually provided and required by the government in order to guarantee benefits or to help solve the private insurance market failure problem.<sup>1</sup> The other category —voluntary insurance— is normally provided by private insurance companies. Many kinds of insurance, such as life insurance, house insurance and fire insurance, belong to this category. In practice, the vast majority of compulsory insurance is partially compulsory. In this case, compulsory and voluntary insurance coexist in the market. This means that public insurance provides only partial coverage, and it allows for supplemental voluntary purchases. For example, the U.S. Medicare program covers only half of all health expenditures for Americans aged 65 and older, and younger people with some disabilities; but it still leaves them exposed to substantial health expenditure risk. In this case, people can freely choose to buy additional insurance from the private market to increase their coverage. In our paper, we refer to this type of insurance as mixed insurance.

Not surprisingly, the question of what type of insurance has the highest social welfare has received a great deal of attention in theoretical and empirical studies. However, a general consensus is far from being reached. In order to investigate this question, adverse selection and moral hazard are two main issues that need to be jointly addressed.

Adverse selection is a well-known phenomenon in the insurance market, which describes a situation where an individual's demand for insurance is positively correlated with the individual's risk of loss. Due to asymmetric information, insurers are not able to distinguish high-risk individuals from low-risk individuals. Chiappori and Salanie (2000), Cardon and Hendel (2001), Cohen et al. (2005), Kolstad and Kowalski (2016) use empirical evidence to test the adverse selection model, and find adverse selection in the private insurance market. In contrast, in the case of compulsory insurance, there is no adverse selection, as it forces all individuals, including high-risk and low-risk

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<sup>1</sup>A kind of market failure identified by Kenneth Arrow is the absence of markets to provide insurance against some uncertain events.

individuals, into the consumer pool. This is why Arrow (1963) and Akerlof (1970) strongly suggest that the government should provide insurance in situations where the market, for whatever reason, has failed to emerge. Moral hazard is another factor that influences the welfare of insurance. Moral hazard arises when an individual engages in riskier behavior after purchasing insurance because the insurance company bears the cost of the risks. Previous literature has shown that moral hazard is present in different insurance markets. Pauly (1968) and Sapelli and Vial (2003) evaluate moral hazard in health insurance by studying medical care expenses and health care services utilization. Horowitz and Lichtenberg (1993) show moral hazard in agricultural crop insurance by studying chemical use.

Previous studies of social welfare comparisons between insurance schemes, theoretical or empirical, consider adverse selection and moral hazard separately (Dionne and Doherty, 1992; Hansen and Keiding, 2002). This is due to the models having to be extended from one-period to a multi-period context to study moral hazard; from an empirical perspective, it is challenging to obtain all the data needed to study adverse selection and moral hazard together. However, in real life, adverse selection and moral hazard usually come together. In our experiment, we use the Balloon Analogue Risk Task (BART) as both the assessment of risk-taking and economic context which has insurance options to protect participants from zero earnings due to explosions of balloons. By setting different balloons with or without insurance options respectively, our experimental design allows for testing adverse selection and moral hazard simultaneously. As a result, the comparison between different insurance schemes in our paper is more comprehensive. Our results suggest that under the combined effects of “no adverse selection” and significant moral hazard, purely compulsory insurance has the lowest social welfare. Social welfare in our experiment consists of three parts: the government, the insurer, and the consumer, and it is indicated by wealth (earnings).

Since the majority of compulsory insurance is partial, investigating the effects of compulsory insurance on the residual voluntary part and conducting social welfare analysis under such interaction are also important to the insurance literature (Briys et al., 1988; Petretto, 1999; Hindriks, 2001; Chetty and Saez, 2010). According to Ehrlich and Becker (1972), compulsory and voluntary insurance are substitutes when they coexist. This means that there is a crowd-out effect of compulsory insurance on the residual private market. Crowd-out effect indicates that increased government involvement in insurance markets substantially reduce demand for private insurance.

Finkelstein (2004) studied the U.S. Medicare program and found that Medicare does not have substantial effects on the coverage of the residual private insurance market. Brown and Finkelstein (2008) reviewed the U.S. Medicaid program and showed that incomplete public insurance crowds out private insurance demand. Sakai et al. (2012) find that crowd-out depends on the coverage rate of government insurance. Given the mixed results in the literature, one of our treatments is “Mixed Insurance”. In the “Mixed Insurance” treatment, subjects are first required to buy partially compulsory insurance, and then they are allowed to voluntarily purchase additional private insurance. We find that when compulsory and voluntary insurance coexist, for low-risk individuals, they are complements, but for high-risk individuals, they are substitutes. Overall there is no crowd-out effect of the compulsory part on the residual voluntary part. Since for high-risk individuals, they are substitutes, the other effect of the compulsory part is that it eliminates adverse selection in the residual voluntary part.

Our objective in this paper is to use one simple experiment to address adverse selection and moral hazard simultaneously, and to analyze their combined effects on the social welfare of purely compulsory, purely voluntary, and mixed insurance. There has been considerable experimental work on insurance including both laboratory and field experiments. Lab insurance experiments focus more on the designs of insurance, such as testing prospect theory (Schoemaker and Kunreuther, 1979), and studying insurance purchase decisions and decision strategy (Schram and Sonnemans, 2011). Some lab experiments use hypothetical situations. For example, Kunreuther and Pauly (2014) asked participants to imagine that they owned a house that was worth US \$ 100,000, and then asked them to make insurance purchasing decisions. In this sense, field insurance experiments (Newhouse et al., 1981; Giné and Yang, 2009; Norton et al., 2014; Carter et al., 2015) are more related to our paper. Cai et al. (2015) studied the effects of microinsurance on farmers’ sow production by conducting a randomized field experiment in China. Karlan et al. (2011) studied crop price insurance in a pilot experiment in rural Ghana. There are also field experiments that focus on moral hazard. For example, Hill and Viceisza (2012) simulated a fertilizer purchase situation to study moral hazard in weather-index insurance. Unlike these field experiments focusing on one specific insurance market such as health insurance, crop insurance and livestock insurance, our study compares the three broad insurance categories, to our knowledge, there are no previous experimental studies doing such comparison. Additionally, there are no lab or field experiments

studying adverse selection and moral hazard simultaneously.

In our experiment, by using the Balloon Analogue Risk Task (BART) as both the assessment of risk-taking and insurance context, our design has two important advantages. First, the setting is not hypothetical (unrealistic), but a real insurance context using a familiar task (pumping the balloon), which may have accidents (explosions). Second, since BART has been proved to be a valid measure to assess risky behavior in the real world (Lejuez et al., 2002), we can use performance with and without insurance to test for adverse selection and moral hazard simultaneously. It is not easy to study moral hazard and adverse selection of insurance jointly in a lab experiment. To avoid limiting subject pool to only students, we conduct our BART insurance experiment on Amazon Mturk. We are aware that using Mturk comes at a cost. Yet, pumping a balloon is a simple task demanding low cognitive effort. It sets up a context that is familiar and easy to grasp for participants (Charness et al., 2013); and in addition, Buhrmester et al. (2011) find that the data obtained from Mturk are at least as reliable as those obtained via traditional methods.

Our findings contribute to three main branches of the insurance literature: testing for adverse selection and moral hazard; a social welfare comparison between different insurance schemes; and the effect of compulsory insurance on the remainder voluntary insurance in mixed insurance. Our results suggest that there is adverse selection in voluntary insurance, but not in mixed insurance in that the compulsory part eliminates adverse selection in the residual voluntary part. All three insurance types have moral hazard, but mixed insurance has the lowest degree of moral hazard. Purely compulsory insurance has the lowest social welfare. There is no crowd-out effect of partially compulsory insurance on the remainder voluntary purchases.

Another contribution of this paper is developing a new method for insurance experiments using BART. To prevent potential negative outcomes associated with risk-taking behavior, researchers have devoted a great deal of attention to the development of reliable and accurate approaches to measure riskiness (Crosetto and Filippin, 2013, 2016). Lejuez et al. (2002) show that BART can successfully predict naturalistic risk-taking behavior in everyday life. BART is a widely used behavioral measure of risk-taking in clinical and psychological settings, but it has not yet been widely used in experimental economics.

The rest of paper is organized as follows. Section II introduces the Balloon Analogue Risk Task. In section III, we present our experimental design and procedures. The analysis and results

are presented in section IV. Section V shows a robustness check to test the validity of BART; and section VI concludes.

## II The Balloon Analogue Risk Task (BART)

BART is a computerized measure of risk-taking behavior. In this task, participants are presented with a balloon and they receive a monetary reward for each successful pump of the balloon. However, if the balloon explodes, they receive nothing. A higher number of pumps yields higher potential earnings, but it also represents a higher risk of explosion. Therefore, risk-taking is measured by the selected number of pumps, with more pumps indicating more risk-taking. The participants only know the balloon may explode at some point, but they do not know the actual probability function. The probability of explosion of a balloon is arranged by constructing an array of  $N$  numbers. In our experiment, the array of each balloon is 1-128.<sup>2</sup> Thus, the probability that a balloon will explode at the first pump is  $1/128$ . The probability of explosion at the second pump is  $1/127$  if the balloon did not explode after the first pump,  $1/126$  at the third pump, and so on up until the 128th pump, at which the probability of an explosion is 1. According to this arrangement, the expected earnings for each balloon are a bow-shaped function with a maximum at the 64th pump which is also the expected explosion point.

The Participants' decisions can be formalized as the choice of the lotteries

$$L = \begin{cases} 0 & k/128 = 1 - (128 - k)/128 \\ \gamma k & (128 - k)/128 = (127/128 * 126/127 * \dots * (128 - k)/(129 - k)) \end{cases}$$

where  $k$  is the number of pumps which in our experiment  $\in [0, 128]$ , while  $\gamma > 0$  is a scale factor. The expected value of these lotteries is equal to  $\gamma(128k - k^2)/128$ . Assuming a constant relative risk aversion (CRRA) utility function  $u(x) = x^r$ , the BART allows for the estimation of the coefficient of risk aversion. The implied levels of  $r$  for every possible choice  $k$  are shown in Appendix Table A2. The table implies a *risk-neutral* individual would choose  $k^* = 64$ . A *risk-loving* participant whose utility function is convex would choose more than 64 pumps; a *risk-*

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<sup>2</sup>In the original paper, the association of the BART with self-reported risk behavior in the real world occurred only with data from the balloon with a maximum number of 128 pumps (Lejuez et al., 2002). For this reason, we choose a range of  $[0, 128]$  pumps in our experiment.



*averse* participant with a concave utility function would choose less than 64 pumps. The insurance premium and coverage in our experiment are designed based on this algorithm of BART (explained in detail in the experimental design section).

Pleskac et al. (2008) developed the Automatic BART version, in which participants input their desired number of pumps into a box for each balloon and the balloon is pumped automatically. If a balloon explodes before the indicated number of pumps is reached, participants lose all their earnings for that balloon. Pleskac et al. (2008) show that this version does not change the validity of BART as an assessment of risk-taking. In order to observe risk-taking of successful pumps and explosions, we use the Automatic Version of BART.<sup>3</sup> Risk-taking is quantified by the selected number of pumps. Ferrey and Mishra (2014) find different compensation methods have significant influence on participants’ risk-taking propensity as measured by the BART. Our objective is to compare different insurance schemes, so we just use the same compensation method used in Lejuez et al. (2002) for all the three treatments. Thus far, we can conclude that we use BART as our basic insurance context because it is an economic environment with accidents (explosions), and it is also a valid assessment of risk-taking. Furthermore, BART is relatively simple; it sets up a context that is familiar and easy to grasp for participants (Charness et al., 2013).

### III Experimental Design

The experiment was conducted using Amazon Mechanical Turk. We use a between subject design with three treatments. The treatments are the three types of insurance: purely voluntary, purely compulsory, and mixed insurance. Subjects signed a consent form and then proceeded to the BART task. In the BART section, subjects played with **30** sequential balloons which have a maximum of 128 pumps each; the reward for each pump is €1. Subjects were asked to indicate the number of pumps they want to select for each balloon. At the end of the experiment, three randomly selected balloons determine their final payments.

**Treatment 1: Purely Voluntary Insurance.** For the **first** and **last** balloon, subjects were allowed to voluntarily buy insurance at a premium of €40 before pumping those two balloons. Subjects did not know this information until they played with that particular balloon. For the

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<sup>3</sup>In the original BART version, risk-taking can only be observed for balloons that did not explode.

other **28** balloons, they played BART normally without the insurance option. The insurance in this case is voluntary. If the insured balloon explodes, participants receive €64. If the insured balloon does not explode, participants receive nothing from the insurance, and the cost is not refunded. In order to ensure understanding of the procedure and the insurance scheme, subjects had to correctly answer a quiz before proceeding to pump the balloons.

In our experiment, the maximum number of pumps for a balloon is 128, which implies the balloon will surely explode at the 128th pump. According to the BART algorithm, the optimal number of pumps in terms of expected rewards is 64. Thus, we set the insurance coverage equal to the actual earnings at the optimal pump, which is €64. The probability of a balloon exploding at the 64th pump is  $1 - (127/128 * 126/127 * \dots * 64/65) = 1/2$ , and hence, the expected insurance benefits are  $64 * 1/2 = 32$ . If we set the insurance as actuarially fair, the premium should be €32. However, in real life, insurance is rarely actuarially fair, since insurance companies make profits, and also due to transaction costs, administration fees, moral hazard, adverse selection and risk premium.<sup>4</sup> Therefore, the premium is usually higher than the expected benefits from insurance. Thus, in our paper, for simplicity, we set the premium at €40.

Recall in the BART, each pump corresponds to a level of  $r$ ; if we assume a CRRA utility function (Appendix A2), it implies a *risk-neutral* individual would choose  $k^* = 64$ ; a *risk-loving* participant would choose more than 64 pumps; a *risk-averse* participant would choose less than 64 pumps. Therefore, people with different average number of pumps (i.e., different risk preferences) have different corresponding actuarially fair premiums with the fixed insurance coverage of €64. For example, for a risk-averse individual who chooses less than 64 pumps, his explosion probability is less than  $1/2$ , and hence the actuarially fair premium should be less than €32 if the coverage is €64. Since in this paper, *our objective is to compare different insurance types under the same coverage and premium instead of the effects of different premiums and coverage*, it is reasonable for us to calculate the premium above based on a risk-neutral individual for simplicity.

In our experiment, we only set the insurance option for the first and last balloon. We view participants' insurance purchasing decisions in the first balloon as a reflection of homegrown risk-taking before learning, and a signal of previous experience in insurance purchases; the performance in the last balloon can be viewed as risk-taking after learning. All the other balloons serve as com-

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<sup>4</sup>Risk premium is the maximum amount a person will pay above actuarially fair premiums.

parison without insurance allocation, i.e., the measurement of risk-taking by BART. By doing this, we can study moral hazard and adverse selection simultaneously, and then compare the insurance schemes more comprehensively.

**Treatment 2: Purely Compulsory Insurance.** This treatment is the same as the first treatment, except that the insurance is compulsory, which means subjects were required to buy the insurance at a cost of ¢40 for the first and last balloon.

**Treatment 3: Mixed Insurance.** This treatment is the same as the second treatment, except that the insurance is partially compulsory. This means the compulsory insurance only pays ¢32 to the subject if the insured balloon explodes, and the subject is allowed to buy additional voluntary insurance to obtain full coverage. The premium for the compulsory part is ¢20. The premium and coverage for the voluntary part are also ¢20 and ¢32 cents respectively. The calculations of the premium and coverage are the same as in treatment 1, and we just split the premium and coverage into two equal parts.

Table 1: Insurance Features for each Treatment.

Treatments	First & Last balloon	Ins coverage (if explodes)	Ins premium	2-29th balloon	No. Subjects
Purely Voluntary	Vol insurance	¢64	¢40	Normal BART	97
Purely Compulsory	Com insurance	¢64	¢40	Normal BART	103
Mixed	Vol+Com	¢32+¢32	¢20+¢20	Normal BART	99

At the end of the BART task, all participants are asked to respond to the DOSPERT questionnaire (Blais and Weber, 2006),<sup>5</sup> a Sensation Seeking Scale questionnaire (Zuckerman et al., 1964), a gamble-choice task (Eckel and Grossman, 2008) and a demographic survey. The DOSPERT and Sensation Seeking Scale are used to check whether participants in different treatments have different original risk preferences; they are also used as robustness checks to evaluate whether the riskiness in BART is associated with psychological measures of risk-taking and self-reported risk behavior. The gamble choice, as one of the most widely used methods of eliciting risk preferences in laboratory experiments, serves the same purpose.

The experiment was computerized in Inquisit (Inquisit, 2016). In total there were 305 subjects, with about 100 participants per treatment. After deleting subjects with incomplete information,

<sup>5</sup>The Domain-Specific Risk-Taking Scale is designed to elicit the domain-specific nature of risk preferences.

the final sample consists of 299 subjects. Table 1 summarizes the Insurance features for each treatment. The instructions, screenshots, questionnaires and demographic survey questions are available in the Appendix.

## IV Results

In this experiment, we are interested in comparing the three insurance schemes. Since we set an insurance option for the first and last balloon, we use the performance of these two balloons for the analysis of social welfare and the effects of the compulsory part on the residual voluntary part in mixed insurance; the other 28 balloons —without insurance options— are used for the analysis of adverse selection and moral hazard.

### IV.1 Analysis of Crowd-out and Learning Effects

**Result 1** *1a.* When compulsory and voluntary insurance coexist, there is no crowd-out effect of the compulsory part on the residual voluntary purchases.

*1b.* People use their experience from previous insurance purchases as an important element when considering purchasing insurance. If they obtain insurance benefits from a previous experience, they are more likely to buy insurance.

Table 2 summarizes the proportion of subjects choosing to buy (additional) insurance in the first and last balloon in purely voluntary and mixed insurance. The last row shows the  $p$ -values from two-sided Fisher’s exact tests, which suggests there are no significant differences in the number of subjects choosing to buy insurance between purely voluntary and mixed insurance in either the first or last balloon. Since there are no significant differences across treatments by education, gender composition, the number of people in the household, income and self-reported risk-taking<sup>6</sup> (see Appendix Table A1), the only difference between the two treatments is the compulsory part of mixed insurance based on the experimental design. However, the compulsory part has no crowd-out effect on the residual voluntary purchases, which is also shown in our estimation results (Table 3). Although, in aggregate, adding a compulsory part does not change the purchasing rate, it has

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<sup>6</sup>One exception is that participants in the purely voluntary insurance treatment are older than participants in the mixed insurance treatment, but in our following estimations, we don’t find significant effects of age on insurance purchases.

opposite effects on people with different risk preferences, with these effects offsetting each other. (This is further explained in the analysis of adverse selection.)

Table 2: Number of subjects choosing to buy insurance.

Insurance	First balloon	Last balloon	P-value
Purely Voluntary	39.2%	60.8%	0.001
Mixed	43.4%	60.6%	0.002
P-value	0.565	1.000	

*Notes:* In purely compulsory insurance, the insurance is mandatory.

The last column are the  $p$ -values from Wilcoxon signed-rank tests, rejecting the null hypothesis that the difference in the number of participants choosing to buy (additional) insurance between the first and last balloon equals zero for both purely voluntary insurance and mixed insurance. In particular, there are significantly more people choosing to buy insurance in the last balloon than in the first balloon. We analyze this effect by estimating a probit model for choosing to buy insurance in the last balloon. Following Kunreuther (1976)'s field survey which examines the factors that induce individuals to purchase insurance voluntarily,<sup>7</sup> the five independent variables of interest in our regression include the decision in the first balloon (First = 1 if insurance was purchased in the first balloon), explosion in the first balloon (Explosionfirst = 1 if the first balloon explodes), earnings in the 1-29th balloons, number of explosions in the 2-29th balloons, the interaction - First \* Explosionfirst, and a dummy variable for mixed insurance (Addition = 1 if buying additional insurance, i.e., mixed insurance). In addition to these independent variables, we controlled for average number of pumps in the 2-29th balloon (Avgpump2-29), age (AGE), gender (MALE = 1 if male), education<sup>8</sup> (EDU), income<sup>9</sup> (INC), and number of people in the household (Household). We also present the results without these controls.

The hypotheses are that subjects are more likely to buy insurance in the last balloon if a) insurance was purchased in the first balloon (people's risk preference is consistent), b) total earnings in the 1-29th balloons are higher (people with higher wealth can afford more insurance), c) the

<sup>7</sup>In Kunreuther's field survey, they consider: awareness of the hazard; knowledge about the availability; costs and coverage of insurance; and previous experience with both the hazard and insurance.

<sup>8</sup>Education levels were coded as follows: EDU = 1 if Some High School or less, EDU = 2 if High School Diploma, EDU = 3 if Some College, EDU = 4 if 2 year/Associates Degree, EDU = 5 if 4 year/Bachelor's Degree, EDU = 6 if Some Graduate School, EDU = 7 if Graduate Degree.

<sup>9</sup>Income levels were coded as follows: INC = 1-10 corresponds to Less than \$30,000, \$30,000 - \$39,999, \$40,000 - \$49,999, \$50,000 - \$59,999, \$60,000 - \$69,999, \$70,000 - \$79,999, \$80,000 - \$89,999, \$90,000 - \$99,999, \$100,000 - \$149,999, \$150,000 or more respectively.

subject experiences more explosions in the 2-29th balloons, d) the subject buys insurance in the first balloon, and the balloon explodes. Since both insurance types have such learning effects, we pool all subjects.

Table 3: Determinants of the Learning Effect.

	Purchase Decision in the last balloon	
	with controls	without controls
First	0.497*(0.287)	0.554**(0.274)
Explosionfirst	-1.791*** (0.494)	-1.824*** (0.486)
Earning1-29	-0.072(0.089)	-0.012(0.058)
Explosion2-29	-0.060(0.061)	-0.008(0.029)
First * Explosionfirst	3.287*** (0.580)	3.109*** (0.552)
Addition	0.130(0.241)	0.098(0.229)
Constant	-0.211(0.865)	0.095(0.566)

*Notes:* The dependent variable of the probit model is the dummy variable for choosing to buy insurance in the last balloon. Standard errors are in parentheses. \* $p < 10\%$ , \*\* $p < 5\%$ , \*\*\* $p < 1\%$

Table 3 shows the estimation results of our probit model. Only factors related to the first balloon (First), Explosionfirst and the interaction effect of First \* Explosionfirst (i.e., buying insurance in the first balloon and the balloon explodes) are significant. In particular, the magnitude of First \* Explosionfirst is large, which means that experience from previous insurance purchases plays an important role when people make subsequent insurance purchase decisions in our experiment. This result is in line with Kunreuther (1976)’s findings. The sign of First \* Explosionfirst is positive, which means people are more likely to buy insurance if they obtain insurance benefits from a previous experience, and it explains why there are more participants choosing to buy insurance in the last balloon in our experiment. The lack of significance of the “Addition” coefficient is in line with our conclusion above that the existing compulsory part has no crowd-out effects on the residual voluntary part in mixed insurance.

## IV.2 Analysis of Adverse Selection

**Result 2** *2a.* There is adverse selection in purely voluntary insurance, but not in mixed insurance in that the compulsory part eliminates adverse selection in the residual voluntary part.

*2b.* The elimination of adverse selection in mixed insurance is mainly contributed by the most risk-seeking subgroup.

Based on the premium and coverage of insurance in our experiment, and the arrangement of

the explosion probability for each pump in BART, the expect utility of buying insurance is:

$$EU(\text{buy (additional) insurance}) = U(24)k/128 + U(k - 40)(128 - k)/128 \quad (1)$$

and the expected utility function of not buying insurance in purely voluntary insurance normalizing  $U(0) = 0$  is:

$$EU(\text{not buy insurance}) = U(k)(128 - k)/128 \quad (2)$$

and the expected utility function of not buying additional insurance in mixed insurance is:

$$EU(\text{not buy additional insurance}) = U(12)k/128 + U(k - 20)(128 - k)/128 \quad (3)$$

Recall that by assuming a CRRA utility function, we get the levels of  $r$  for every possible choice of pumps (Appendix A2). Using table A2, we can calculate the following equation for each pump and its corresponding  $r$ :

$$EU(\text{buy insurance}) - EU(\text{not buy insurance}) : U(24)k/128 + U(k - 40)(128 - k)/128 - U(k)(128 - k)/128 \quad (4)$$

$$EU(\text{buy additional insurance}) - EU(\text{not buy additional insurance}) : [U(24)k/128 + U(k - 40)(128 - k)/128] - [U(12)k/128 + U(k - 20)(128 - k)/128] \quad (5)$$

The result shows that the 20 (24) pumps is a threshold: for those whose desired number of pumps is greater than 20 (24),  $EU(\text{buy (additional) insurance}) < EU(\text{not buy additional insurance})$ ; for those whose desired number of pumps is less than or equal to 20 (24),  $EU(\text{buy insurance}) > EU(\text{not buy insurance})$ . Appendix Table A3 shows that the results for  $k = 1 - 20$  in purely voluntary insurance, and the results for  $k = 1 - 24$  in mixed insurance are similar.

The theoretical predictions for those who choose to buy insurance, i.e., those having less than or equal to 20 (24) pumps, show that participants with higher desired number of pumps are more likely to buy insurance with the €64 coverage and €40 premium:

$$40 - 64 * k/128 > 40 - 64 * (k + 1)/128, \quad k \in [0, 20] \quad \text{or} \quad k \in [0, 24] \quad (6)$$

In addition, Appendix Table A3 shows the value of  $EU(\text{buy insurance}) - EU(\text{not buy insurance})$  is non-monotonic with the number of pumps. Thus, we hypothesize that adverse selection exists in both purely voluntary and mixed insurance. However, Figure 1 shows that adverse selection is only found in purely voluntary, but not in mixed insurance.<sup>10</sup>

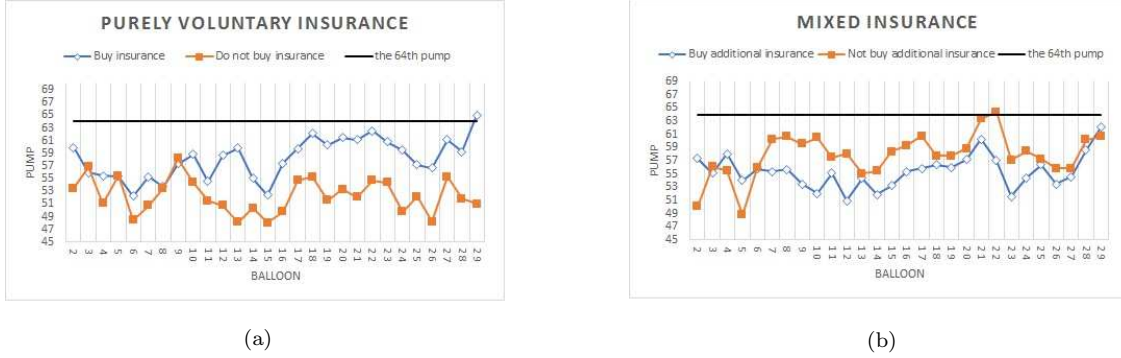


Figure 1: Adverse selection: Average number of pumps in the 2-29th balloons by insurance purchasing decision. *Note:* The black line represents the 64th pump which theoretically maximizes the expected earnings. In our experiment, except for the first and last balloon, the average number of pumps per balloon per subject is 56 for purely voluntary and mixed insurance, and 57 for purely compulsory insurance. This result is similar to Pleskac et al. (2008) who report an average of 61 pumps.

Since there is no insurance option in the 2-29th balloons, and BART is an assessment of risk-taking, we can analyze adverse selection by comparing the average number of pumps in the 2-29th balloons for those who chose to buy insurance in the first or last balloon and those who did not purchase insurance at all. In purely voluntary insurance (Figure 1a), the line of participants who purchased insurance lies above the line of those who did not purchase insurance. Using a two-tailed Mann-Whitney  $U$ -Test with 28 observations for each subgroup, we find the average number of pumps in the 2-29th balloons for those who “buy insurance” is significantly higher than those who “do not buy insurance” ( $p < 0.001$ ). Additionally, the difference between the two lines expands in the 11-29th balloons. For the initial 2-10th balloons, it is possible that subjects are still affected by the insurance option in the first balloon, or some subjects misunderstand that they are still under insurance, so the 11-29th balloons may better reflect subjects’ risk-taking behavior without insurance. Thus, the figure indicates the presence of adverse selection in purely voluntary insurance, since insurance is more attractive to high-risk individuals. The result is consistent whether we consider the first or last balloon separately.

In mixed insurance (Figure 1b), the result, however, is opposite: the average number of pumps

<sup>10</sup>Since most participants are risk averse in our experiment, adverse selection exists when the insurance is more attractive to people with a higher average number of pumps.



in the 2-29 balloons for those who chose to buy additional insurance in the first or last balloon is significantly lower than for those who did not choose to buy additional insurance at all (Mann-Whitney  $U$ -Test,  $p < 0.001$ .) In Figure 1b, the diamond and square lines swap positions. Table 4 summarizes the average number of pumps in the 2-29th balloon by insurance purchasing decision for both treatments.

Table 4: Average number of pumps in the 2-29th balloons by insurance decisions.

	Purely Voluntary	Mixed
Buy (additional)	58	55
Not buy (additional)	52	58

We further find that there is no difference in the average number of pumps in the 2-29th balloons between those who chose NOT to buy insurance in purely voluntary (52) and those who chose to buy insurance in mixed insurance (55) (Mann-Whitney  $U$ -Test,  $p=0.399$ ). There is no difference between those who choose to buy insurance in purely voluntary insurance (58) and those who chose NOT to buy insurance in mixed insurance (58) (Mann-Whitney  $U$ -Test,  $p=0.982$ ). This means that the compulsory part leads individuals with lower-risk to buy additional voluntary insurance; but individuals with higher-risk do not buy additional voluntary insurance. To some extent, this also explains why in Result 1 there is no overall crowd-out effect of the compulsory part on the residual voluntary part.

The adverse selection results are consistent whether we consider the first or last balloon separately. We now explore the potential causes of the effects of partially compulsory insurance on residual voluntary insurance. Since the first balloon is used as a proxy for the subjects' homegrown risk preferences, and no information is available before their choice in the first balloon, we use the last balloon to analyze the insurance purchase decision.

Table 5 shows the average number of pumps in the 2-29th balloons by gender. In purely voluntary insurance, adverse selection exists in both genders. However, in mixed insurance, adverse selection is not present neither in males nor in females: for females, there is no difference in the number of pumps in the 2-29th balloon between women who buy and women who do not buy additional insurance. For males, our result suggests that men who buy additional insurance selected significantly less pumps in the 2-29th balloon than men who do not buy additional insurance. Males who choose not to buy additional insurance in mixed insurance are the most risk-seeking

participants in these two treatments in terms of average number of pumps in the 2-29th balloons (63) (figures are shown in Appendix A4).

Table 5: Gender differences in adverse selection by treatment.

	Purely Voluntary			Mixed		
	Buy	Not buy	P-value	Buy	Not buy	P-value
Male	61	52	< 0.001	58	63	0.002
Female	55	51	< 0.001	52	51	0.376

Notes: P-values are from two-sided Mann-Whitney  $U$ -Tests.

We first use “64 pumps” as the threshold to estimate a linear probability model (LPM) for subjects with different risk preferences. Although mixed insurance (“Addition”) has no significant effects on insurance purchases of either risk-averse (< 64 pumps) or risk-seeking (> 64 pumps) participants, as shown in columns 2-3 of Table 6<sup>11</sup>, the sign of “Addition” is opposite for these two subgroups: positive for risk-averse subjects, and negative for risk-seeking subjects. This result is in line with the notion that the partially compulsory part leads risk-averse participants to buy additional voluntary insurance, but makes risk-seeking subjects less likely to buy additional voluntary insurance. We further estimate the LPM by gender. The results for males, shown in the last two columns of Table 6, are similar to the results in columns 2-3: the sign of “Addition” is positive for risk-averse males, but negative for risk-seeking males. However, we do not find opposite signs for females, as shown in columns 4-5. In addition, males are more risk seeking than females in terms of the number of pumps in the 2-29th balloon (Mann-Whitney  $U$ -Test,  $p=0.020$ ) in our experiment.

Table 6: Adverse selection.

	< 64 pumps	> 64 pumps	Female (< 64 pumps)	Female (> 64 pumps)	Male (< 64 pumps)	Male (> 64 pumps)
First	0.134(0.093)	0.153(0.140)	0.241(0.145)	0.108(0.338)	0.029(0.136)	0.024(0.239)
Explosionfirst	-0.481*** (0.120)	-0.475** (0.217)	-0.606*** (0.174)	-0.607(0.513)	-0.455** (0.204)	-0.474(0.297)
Earning1-29	-0.018(0.039)	-0.001(0.043)	0.015(0.044)	0.010(0.115)	-0.150* (0.083)	-0.054(0.058)
Explosion2-29	-0.017(0.025)	-0.006(0.025)	-0.001(0.030)	-0.036(0.063)	-0.089(0.056)	-0.023(0.034)
First * Explosionfirst	0.800*** (0.133)	0.835*** (0.242)	0.839*** (0.235)	0.836(0.565)	0.878*** (0.460)	1.124*** (0.346)
Addition	0.080(0.079)	-0.046(0.122)	0.056(0.111)	0.150(0.300)	0.104(0.121)	-0.243(0.186)
Constant	0.440* (0.261)	0.280(0.712)	0.584* (0.341)	-1.514(2.377)	0.802(0.519)	1.103(1.122)

Notes: The dependent variable is the dummy variable for choosing to buy insurance in the last balloon. Standard errors are in parentheses.  $*p < 10\%$ ,  $**p < 5\%$ ,  $***p < 1\%$ .

Thus far, we conclude that the elimination of adverse selection in mixed insurance might be mainly contributed by males (i.e., the most risk-seeking subgroup in our experiment). Although according to theoretical predictions, risk-seeking subjects are less likely to buy insurance, sometimes they may still want some coverage instead of no coverage at all, especially for individuals who are

<sup>11</sup>Since the coefficients of all covariant are not significant, we only show the estimated coefficients for the independent variables in Table 6.

not that risk-seeking. Thus, in purely voluntary insurance, risk-seeking participants may still buy insurance, but when adding a compulsory part, they do not buy additional insurance.

### IV.3 Analysis of Moral Hazard

**Result 3** There exists moral hazard in all three insurance types; but comparatively, mixed insurance reduces moral hazard through the partially-insured individuals who do not buy additional voluntary insurance.

We set the insurance coverage equal to the actual earnings at the optimal number of 64 pumps. Now suppose the insurance premium is  $Y$  cents and the subject chooses  $K$  pumps after buying the insurance. His expected earnings will be  $(64-Y)*K/128+(K-Y)*(128-K)/128$ , which is the sum of the expected earnings for explosion and not explosion. Taking the first order condition results in  $X=96$ . Adding an insurance option changes the optimal number of pumps from 64 to 96. Therefore, moral hazard is theoretically expected in our experiment.

To consider moral hazard we compare the average number of pumps with and without insurance for each participant. We find that participants have a significantly higher average number of pumps when buying insurance in the first or last balloon compared to their average number of pumps with no insurance in the 2-29th balloons. For those who did not buy insurance in voluntary or mixed insurance, we do not find a significant difference. This result suggests that the effect is not due to the insurance itself, but to the endogenous decision of choosing to buy insurance.

Figure 2 depicts the average number of pumps in purely voluntary insurance. First we take the average number of pumps over all the insured subjects. Figure 2a shows that the average number of pumps in the 2-29th balloons is significantly lower than in the first and last balloon (Mann-Whitney  $U$ -tests,  $p < 0.001$ ;  $p < 0.001$ ). The difference between the first and last balloon is not statistically significant (Mann-Whitney  $U$ -Test,  $p=0.203$ ). Figure 2b shows moral hazard in purely voluntary insurance more clearly. Figure 2b shows that for nearly all insured subjects, the average number of pumps in the first or last balloon are higher than the average number of pumps in the 2-29th balloons. In order to show the figure clearly, we add the line, and the average number of pumps in the first and last balloon combined instead of showing them separately as in Figure 2a.<sup>12</sup> The

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<sup>12</sup>For those who buy insurance only in one of the two balloons, we directly keep the number of pumps in that balloon; for those who buy insurance in both the first and last balloon, we take the average of the number of pumps for the first and last balloons.

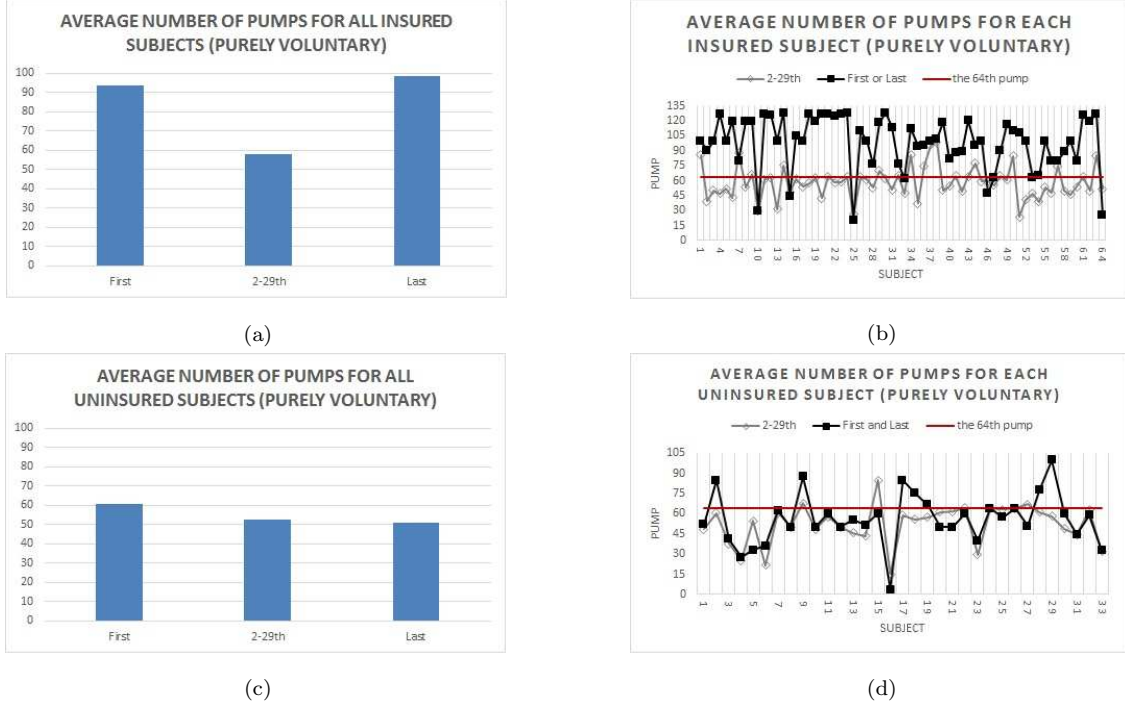
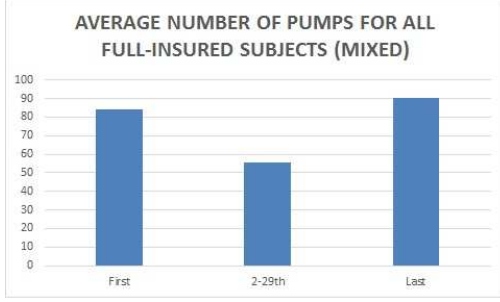


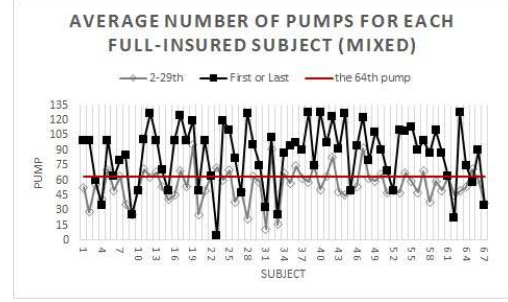
Figure 2: Moral Hazard: Comparison of the average number of pumps between the 2-29th balloon and first & last balloon in purely voluntary insurance. *Note:* After buying insurance, most participants' average number of pumps exceeds the line of the 64th pump.

results are consistent when using the average number of pumps in the first and last balloons jointly or separately.

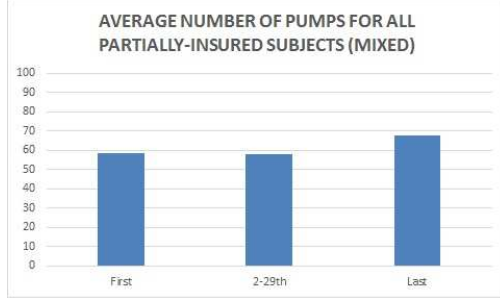
Figure 2c and Figure 2d show that there is no statistically significant difference in the average number of pumps between the 2-29th balloons and the first and last balloons for subjects who did not buy insurance at all (Mann-Whitney  $U$ -Test,  $p=0.635$ ). Figure 3 shows the results for mixed insurance. In mixed insurance, all subjects are insured (full or partially), however, we find different results between subjects who buy and those who do not buy *additional* voluntary insurance. Using Mann-Whitney  $U$ -Tests we find a significant higher number of pumps in the first or last balloon compared to the 2-29th balloons ( $p < 0.001$ ) for subjects who buy additional voluntary insurance (i.e., full-insured). There is no difference for subjects ( $p=0.768$ ) who do not buy additional insurance (i.e., partially-insured). Figure 4 shows the results for purely compulsory insurance. The only difference from the other two treatments is the statistically significant difference in the average number of pumps between the first and last balloon (Mann-Whitney  $U$ -tests,  $p < 0.001$ ). One possible explanation is that some subjects ignore compulsory insurance as they do not need to make any decisions in purely compulsory insurance, especially in the first balloon. This result does



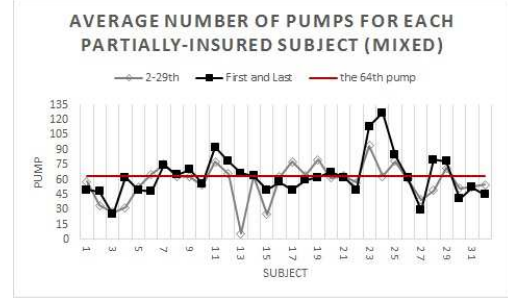
(a)



(b)



(c)



(d)

Figure 3: Moral Hazard: Comparison of the average number of pumps between the 2-29th balloon and first & last balloon in mixed insurance.

not affect our results of moral hazard. We find that the average number of pumps in the first or last balloon is significantly higher than the average number of pumps in the 2-29th balloons in purely compulsory insurance (Mann-Whitney  $U$ -tests,  $p=0.001$  for the first balloon;  $p < 0.001$  for the last balloon). Since every participant in the purely compulsory insurance treatment is required to buy full insurance, there are no uninsured or partially-insured subjects in this treatment.

We further compare the degree of moral hazard for the three insurance schemes. The degree of moral hazard is quantified as the difference in the average number of pumps for insured subjects between the “first and last balloons” and the “2-29th balloons”. Table 7 shows the average degree of moral hazard per insured subject for each treatment. We find that in the first balloon, the degree of moral hazard in purely voluntary insurance (33.7) is the highest. We find no overall difference between mixed (15.2) and purely compulsory insurance (15.4), but individuals who do not buy additional insurance in mixed insurance (2.9) have the lowest degree of moral hazard. In the last balloon, the degree of moral hazard in mixed insurance (24.9) is the lowest, which is mainly contributed by individuals who do not buy additional voluntary insurance. There is no difference in the moral hazard level between purely voluntary (40.8) and compulsory insurance (39.8) in the

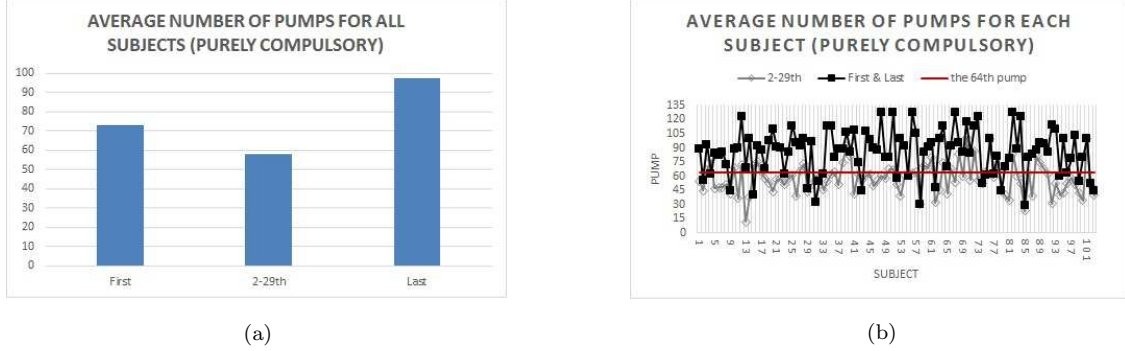


Figure 4: Moral Hazard: Comparison of the average number of pumps between the 2-29th balloon and first & last balloon in purely compulsory insurance.

last balloon.<sup>13</sup>

Table 7: Average degree of moral hazard per insured subject in the first or last balloon.

	Voluntary (Buy)	Mixed (Buy addition)	Mixed (Not buy addition)	Mixed	Compulsory
First	33.7	23.2	2.9	15.2	15.4
Last	40.8	35.2	16.9	24.9	39.8

*Notes:* In mixed and purely compulsory insurance, all people are required to buy (partially) insurance, so all the subjects in these two treatments are insured subjects. In mixed insurance, we also show the moral hazard level for individuals who buy and do not buy additional voluntary insurance separately.

We estimate an OLS regression on the level of moral hazard in the first and last balloon. The independent variables are “Addition” and “Compulsory” (Compulsory=0 if purely voluntary, Compulsory=0.5 if mixed, Compulsory=1 if purely compulsory). We also control for age, education, gender, income, race and household size, but the coefficients for all these covariants are not significant. We show the estimated coefficients for the independent variables in Table 8. In mixed insurance, all the subjects are insured, but we estimate three regressions for first and last balloons. The three regression differ in the inclusion of subjects in mixed insurance: all the subjects in mixed insurance; only the subjects who buy additional voluntary insurance; only the subjects who do not buy additional insurance. The other insured subjects in the three regressions are the same: all the subjects in purely compulsory insurance and the subjects who buy insurance in purely voluntary insurance.

Table 8 shows that in the first balloon, making insurance compulsory reduces moral hazard. When we only consider insured subjects who do not buy additional insurance, mixed insurance

<sup>13</sup>P-values from Mann-Whitney *U*-Tests: V(Buy) vs M(Buy): 0.078(F), 0.193(L); V(Buy) vs M(Not buy): < 0.001(F), < 0.001(L); V(Buy) vs M: 0.001(F), < 0.001(L); V(Buy) vs C: 0.002(F), 0.825(L); M(Buy) vs C: 0.085(F), 0.303(L); M(Not buy) vs C: 0.029(F), < 0.001(L); M vs C: 0.954(F), < 0.001(L).

Table 8: Level of moral hazard.

	First Balloon: all subjects in M	First Balloon: only M (Buy)	First Balloon: only M (Not buy)	Last Balloon: all subjects in M	Last Balloon: only M (Buy)	Last Balloon: only M (Not buy)
Addition	-0.208 (4.352)	8.260 (5.061)	-14.085** (5.564)	-14.676*** (4.410)	-5.546 (5.595)	-21.658*** (5.195)
Compulsory	-17.652*** (5.881)	-17.226*** (5.937)	-16.836*** (5.616)	-2.736 (5.122)	-2.727 (5.048)	-2.502 (5.094)
Constant	34.849*** (11.565)	36.497*** (12.239)	39.915*** (12.017)	31.970*** (10.987)	33.846*** (11.726)	28.001** (11.527)

*Notes:* The dependent variable is the degree of moral hazard. Standard errors are in parentheses. \* $p < 10\%$ , \*\* $p < 5\%$ , \*\*\* $p < 1\%$ .

also reduces moral hazard. In the last balloon, the compulsory part has no effect, and making the insurance mixed, reduces moral hazard. The reduction in moral hazard is contributed mainly by insured subjects who do not buy additional insurance in mixed insurance, as shown in the last two columns of Table 8. Recall that in purely compulsory insurance there is a significant difference in the number of pumps between the first and last balloon. Since in real life there are very few situations in which people do not realize that they are insured when they have insurance, even when insurance is compulsory, we mainly focus on the result of moral hazard in the last balloon. Mixed insurance reduces moral hazard through the partially-insured individuals who do not buy additional insurance. One reasonable explanation could be that partially-insured individuals in mixed insurance may treat themselves as “uninsured” because they choose not to buy (additional) insurance. In purely compulsory insurance, although insurance is also compulsory, individuals do not need to make a decision to purchase insurance, and hence, this will not “remind” them they were “uninsured”.

#### IV.4 Social Welfare Analysis

**Result 4** Purely compulsory insurance has the lowest social welfare.

The efficiency of each insurance type is determined by social welfare. Social welfare in our experiment, indicated by wealth (earnings), consists of three parts: the government, the insurer, and the consumer.<sup>14</sup> Table 9 shows the overall average social welfare, the average net earnings from each subject for the insurer and government (henceforth, earnings of the insurer, government), and also the average net earnings from insurance per consumer (henceforth, earnings of the consumer).

<sup>14</sup>Some compulsory insurance in real life are paid by employers or by the insurer; for simplicity, we assume in our analysis that compulsory insurance is paid by the government.

Table 9: Average social welfare (dollar).

	First balloon				Last balloon			
	Society	Insurer	Consumer	Government	Society	Insurer	Consumer	Government
Purely Voluntary	0.24	-0.04	0.28	-	0.21	-0.05	0.26	-
Purely Compulsory	0.27	-	0.21	0.05	0.13	-	0.24	-0.11
Mixed	0.19	-0.03	0.22	-0.02	0.20	-0.01	0.22	-0.01

In the first balloon, there is no difference in overall social welfare, earnings of the insurer, government and consumer between any insurance scheme. In the last balloon, purely compulsory insurance has the lowest social welfare (Mann-Whitney  $U$ -tests,  $p=0.013$  (C vs V);  $p=0.034$  (C vs M)), while we find no difference between purely voluntary and mixed insurance (Mann-Whitney  $U$ -Test,  $p=0.725$ ). The last balloon represents the risk-taking behavior of participants after learning. Also given the significant difference in risk-taking between the first and last balloon in purely compulsory insurance, we concentrate on social welfare in the last balloon. We further find that the lower social welfare in purely compulsory insurance is due to the loss of earnings of the government (Mann-Whitney  $U$ -Test,  $p < 0.001$  for C vs M). Earnings of the consumer in purely compulsory insurance are even higher than in mixed insurance (Mann-Whitney  $U$ -Test,  $p=0.004$ ).

We estimate an OLS regression on the overall social welfare in the last balloon. The independent variables are moral hazard level in the last balloon (MHL), and a dummy variable for adverse selection ( $AS = 1$  if purely voluntary insurance,  $AS = 0$  if mixed or purely compulsory insurance). We also control for Earning1-29, Explosion1-29, age, education, gender, income, race and household size; but the coefficients of all demographics are not significant. The results shown in column 2 of Table 10 suggest that moral hazard has significantly negative effects on overall social welfare, but the coefficient of adverse selection is not significant. We further estimate the regressions on earnings of the consumer, the insurer and government. We combine the insurer and government into a broader “insurer” category. The results in columns 3-4 of Table 10 show that moral hazard reduces the earnings of the insurer (the government in purely compulsory insurance), but increases the earnings of consumers to a smaller degree. <sup>15</sup> *Why does purely compulsory and voluntary insurance has different overall social welfare given their degree of moral hazard are not different from each other as shown in Result 3?*<sup>16</sup> Table 10 shows that adverse selection has a marginal

<sup>15</sup>This explains why in Table 9, earnings of the consumer in purely compulsory insurance are higher than it in mixed insurance. Mixed insurance has the lowest degree of moral hazard as shown in Result 3.

<sup>16</sup>There are no differences in either Earning1-29 or Explosion1-29 between purely compulsory and voluntary insurance.



positive effect on earnings of the consumer. Since purely compulsory insurance has no adverse selection, its overall social welfare does not have the positive effects from adverse selection on the consumers part.

Table 10: (Social) Welfare from Insurance (dollar).

	Society	Consumer	Insurer & Government
MHL	-0.001** (0.000)	0.001*** (0.001)	-0.002*** (0.000)
AS	0.033(0.039)	0.035* (0.021)	-0.002(0.029)
Earning1-29	-0.000(0.010)	0.018*** (0.005)	-0.018** (0.007)
Explosion1-29	-0.013** (0.005)	0.005* (0.003)	-0.018*** (0.004)
Constant	0.184(0.131)	-0.088(0.069)	0.272*** (0.098)

Notes: \* $p < 10\%$ , \*\* $p < 5\%$ , \*\*\* $p < 1\%$ .

As mentioned in the introduction, the efficiency of purely compulsory insurance has no exact answer from economists. Our results show that the combined effects of significant moral hazard and “no adverse selection” makes purely compulsory insurance less efficient than purely voluntary and mixed insurance.

## V Testing the Validity of BART as an Assessment of Risk-taking

We test the validity of BART as an assessment of risk-taking in our experiment by comparing it with other measures of risk-taking. In particular, we use the Sensation Seeking Scale (SSS), DOSPERT<sup>17</sup> and a gamble-choice task.<sup>18</sup> We consider Spearman rank correlations among risk-taking in BART and the other three risk measures.<sup>19</sup> Table 11 shows the Spearman’s  $\rho$  in all the treatments. The results suggest that risk-taking behavior in BART is highly correlated with DOSPERT-investing and SSS-experience measures. Risky behavior collected by the SSS-total scores and SSS-bor are positively correlated with BART at the 10% level. The correlation between risk-taking in BART and

<sup>17</sup>The SSS yields one total score and primary scales for: Disinhibition (SSS-DIS)-This scale represents the desire for social and sexual disinhibition as expressed in social drinking, partying, and a variety of sexual partners; Boredom Susceptibility (SSS-BOR)-This scale represents an aversion to repetition, routine, and dull people, and restlessness when things are unchanging; Thrill and Adventure Seeking (SSS-THR)-This scale contains items expressing a desire to engage in sports or other activities involving speed or danger; Experience Seeking (SSS-EXP)-This scale represents the seeking of experiences through the mind and senses, travel, and a nonconforming life-style. DOSPERT assesses risk taking in five content domains: financial decisions (separately for investing versus gambling), health/safety, recreational, ethical, and social decisions.

<sup>18</sup>In the incentivized gamble-choice task, participants were asked to choose one out of six lottery options with option 1 representing extreme risk aversion, and option 6 risk-loving. We code option 1 to 6 as 1, 2, 3, 4, 5, 6.

<sup>19</sup>We only use the average number of pumps in the 2-29th balloon as risk-taking in BART when testing for the correlations with other measures, as the pumps in the first and last balloon were affected by the insurance options.

the gamble-choice is not statistically significant. We conclude that risk-taking behavior collected in our experiment has some predictive power of self-reported risk-taking behavior in real life, and this further confirms the validity of our analysis about adverse selection and moral hazard using the average number of pumps in BART for quantifying risk-taking behavior.

Table 11: Spearman’s  $\rho$  of the correlations among risk-taking in BART and the other three measures

	SSS-all	SSS-bor	SSS-dis	SSS-exp	SSS-thr		
Average number of pumps in 2-29th	.100*	.096*	.029	.158***	.057		
	Do-all	Do-ethics	Do-gamble	Do-invest	Do-health	Do-recreational	Do-social
Average number of pumps in 2-29th	.078	.039	.029	.156***	.027	.052	.0923
	GC						
Average number of pumps in 2-29th	.027						

Notes: \* $p < 10\%$ , \*\* $p < 5\%$ , \*\*\* $p < 1\%$ .

## VI Concluding Remarks

We use a simple experiment to address several main issues in insurance markets: adverse selection and moral hazard, social welfare and the effects of compulsory insurance on residual voluntary purchases in mixed insurance. By setting different balloons with or without insurance options respectively, we take advantage of the validity of BART as an assessment of real risk-taking behavior to study adverse selection and moral hazard simultaneously. First, by comparing risk-taking behaviors in normal balloons (i.e., with no insurance options) for people who buy and people who do not buy insurance, we find adverse selection in purely voluntary insurance but not in mixed insurance. Specifically, our results suggest that mixed insurance is more attractive to low-risk individuals, in that the compulsory part leads lower-risk individuals to buy additional voluntary insurance, but higher-risk individuals to not buy additional voluntary insurance. We further find that the elimination of adverse selection is mainly contributed by males (the most risk-seeking subgroup in our experiment). These two effects offset each other, and hence, overall, there is no crowd-out effect of compulsory insurance on the residual voluntary insurance market when they coexist.

Our results shed light on the combined effects of adverse selection and moral hazard on compulsory insurance. Purely compulsory insurance avoids adverse selection but it increases moral hazard

(Sepehri et al., 2006). *But what is the combined effect?* Most previous studies have focused on the single effect of compulsory insurance on individuals and society. The comprehensive effects are not well understood, which makes the overall efficiency of purely compulsory insurance ambiguous. The results from our experiment suggest that moral hazard reduces the earnings of insurers (insurance companies and/or the government), but it increases the earnings of consumers from insurance to a smaller degree. Thus, overall moral hazard has negative effects on social welfare. Adverse selection increases earnings the consumer, but we do not find significant effects of adverse selection on overall social welfare. Since purely compulsory insurance has a higher degree of moral hazard compared to mixed insurance, and it has no adverse selection compared to purely voluntary insurance, the combined effects make it the least efficient insurance scheme in terms of social welfare. For simplicity, we do not set any control methods of moral hazard in our experimental design emulating insurance providers in real life. Private insurance companies usually try to control moral hazard by making insurance premiums dependent on the risk of the insured. The government, as insurer, seldom controls moral hazard such as in the case of universal health insurance. Thus, moral hazard in purely compulsory insurance in our experiment represents a lower bound, and social welfare the upper bound compared to the other two insurance schemes.

These results imply that mixed insurance is the preferred insurance scheme in that it has the lowest degree of moral hazard, and its social welfare is higher than purely compulsory insurance (although we do not find differences with purely voluntary insurance in terms of social welfare). The results of our experiment provide valuable insights to developing countries where the insurance industry is not yet well developed and very few schemes of insurance exist that implement some kinds of mixed insurance.

Our paper is the first to use BART to study insurance mechanisms. As mentioned in the introduction, we recognize that further work is needed to validate BART as an instrument to study insurance markets. Future studies can focus on whether the insurance purchase decision and performance with insurance in the BART context correlate with insurance decisions in real life. Varying the premium, coverage, and subject pool, may also provide meaningful insights. Our paper also provides a possible method to study insurance subsidies and the changes in people's attitudes toward insurance by allowing them to make their choices sequentially.

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# Appendix.

## A1. Background characteristics and measures of risk-taking

Table A1: Background characteristics and measures of risk-taking across treatments.

	Purely Voluntary	Mixed	Purely Compulsory	Purely Voluntary v. Mixed	Purely Voluntary v. Compulsory	Purely Compulsory v. Mixed
Gamble Choice(mean)	3.5	3.3	3.5	0.551	0.984	0.498
Pumps in 2-29th(mean)	56.20	56.20	57.66	0.624	0.628	0.864
SSS-all(mean)	15.12	17.23	16.99	0.045	0.087	0.90
DOSPERT-all(mean)	91.08	91.13	94.46	0.658	0.224	0.350
Age (mean)	38	35	37	0.012	0.345	0.178
Gender	51.5% (F) 48.5% (M)	51.5% (F) 48.5% (M)	44.7% (F) 55.3% (M)	0.669	0.331	0.587
Household(mean)	2.6	2.7	2.8	0.448	0.163	0.564
Education(median)	2 year/ Associates Degree	2 year/ Associates Degree	2 year/ Associates Degree	0.048	0.432	0.284
Income(mean)	40,000-49,999	40,000-49,999	40,000-49,999	0.433	0.139	0.515

*Notes:* The last three columns show the p-values from two-sided Mann-Whitney  $U$ -Tests.



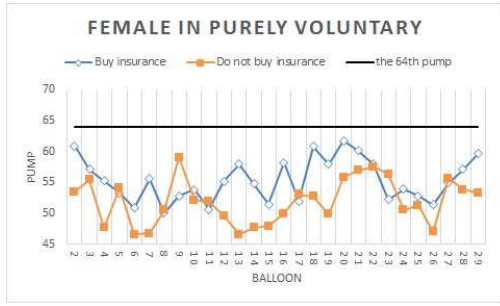
Table A2: Estimates of  $r$  for the BART, assuming CRRA  $u(k) = k^r$ 

<b>K</b>	$r$	<b>K</b>	$r$	<b>K</b>	$r$
<b>1</b>	$0 \leq r \leq 0.011$	<b>44</b>	$0.515 \leq r \leq 0.532$	<b>87</b>	$2.085 \leq r \leq 2.161$
<b>2</b>	$0.012 \leq r \leq 0.019$	<b>45</b>	$0.533 \leq r \leq 0.551$	<b>88</b>	$2.162 \leq r \leq 2.240$
<b>3</b>	$0.020 \leq r \leq 0.027$	<b>46</b>	$0.552 \leq r \leq 0.570$	<b>89</b>	$2.241 \leq r \leq 2.324$
<b>4</b>	$0.028 \leq r \leq 0.036$	<b>47</b>	$0.571 \leq r \leq 0.590$	<b>90</b>	$2.325 \leq r \leq 2.413$
<b>5</b>	$0.037 \leq r \leq 0.044$	<b>48</b>	$0.591 \leq r \leq 0.610$	<b>91</b>	$2.414 \leq r \leq 2.506$
<b>6</b>	$0.045 \leq r \leq 0.053$	<b>49</b>	$0.611 \leq r \leq 0.630$	<b>92</b>	$2.507 \leq r \leq 2.605$
<b>7</b>	$0.054 \leq r \leq 0.062$	<b>50</b>	$0.631 \leq r \leq 0.651$	<b>93</b>	$2.606 \leq r \leq 2.710$
<b>8</b>	$0.063 \leq r \leq 0.071$	<b>51</b>	$0.652 \leq r \leq 0.673$	<b>94</b>	$2.711 \leq r \leq 2.821$
<b>9</b>	$0.072 \leq r \leq 0.080$	<b>52</b>	$0.674 \leq r \leq 0.695$	<b>95</b>	$2.822 \leq r \leq 2.938$
<b>10</b>	$0.081 \leq r \leq 0.089$	<b>53</b>	$0.696 \leq r \leq 0.718$	<b>96</b>	$2.939 \leq r \leq 3.063$
<b>11</b>	$0.090 \leq r \leq 0.098$	<b>54</b>	$0.719 \leq r \leq 0.741$	<b>97</b>	$3.064 \leq r \leq 3.196$
<b>12</b>	$0.099 \leq r \leq 0.108$	<b>55</b>	$0.742 \leq r \leq 0.765$	<b>98</b>	$3.197 \leq r \leq 3.339$
<b>13</b>	$0.109 \leq r \leq 0.117$	<b>56</b>	$0.766 \leq r \leq 0.790$	<b>99</b>	$3.340 \leq r \leq 3.491$
<b>14</b>	$0.118 \leq r \leq 0.127$	<b>57</b>	$0.791 \leq r \leq 0.815$	<b>100</b>	$3.492 \leq r \leq 3.654$
<b>15</b>	$0.128 \leq r \leq 0.137$	<b>58</b>	$0.816 \leq r \leq 0.841$	<b>101</b>	$3.655 \leq r \leq 3.830$
<b>16</b>	$0.138 \leq r \leq 0.147$	<b>59</b>	$0.842 \leq r \leq 0.868$	<b>102</b>	$3.831 \leq r \leq 4.02$
<b>17</b>	$0.148 \leq r \leq 0.158$	<b>60</b>	$0.869 \leq r \leq 0.896$	<b>103</b>	$4.021 \leq r \leq 4.225$
<b>18</b>	$0.159 \leq r \leq 0.168$	<b>61</b>	$0.897 \leq r \leq 0.924$	<b>104</b>	$4.226 \leq r \leq 4.447$
<b>19</b>	$0.169 \leq r \leq 0.179$	<b>62</b>	$0.925 \leq r \leq 0.954$	<b>105</b>	$4.448 \leq r \leq 4.689$
<b>20</b>	$0.180 \leq r \leq 0.190$	<b>63</b>	$0.955 \leq r \leq 0.984$	<b>106</b>	$4.690 \leq r \leq 4.954$
<b>21</b>	$0.191 \leq r \leq 0.201$	<b>64</b>	$0.985 \leq r \leq 1.015$	<b>107</b>	$4.955 \leq r \leq 5.224$
<b>22</b>	$0.202 \leq r \leq 0.213$	<b>65</b>	$1.016 \leq r \leq 1.048$	<b>108</b>	$5.225 \leq r \leq 5.565$
<b>23</b>	$0.214 \leq r \leq 0.224$	<b>66</b>	$1.049 \leq r \leq 1.081$	<b>109</b>	$5.566 \leq r \leq 5.920$
<b>24</b>	$0.225 \leq r \leq 0.236$	<b>67</b>	$1.082 \leq r \leq 1.115$	<b>110</b>	$5.921 \leq r \leq 6.315$
<b>25</b>	$0.237 \leq r \leq 0.248$	<b>68</b>	$1.116 \leq r \leq 1.151$	<b>111</b>	$6.316 \leq r \leq 6.759$
<b>26</b>	$0.249 \leq r \leq 0.261$	<b>69</b>	$1.152 \leq r \leq 1.188$	<b>112</b>	$6.760 \leq r \leq 7.260$
<b>27</b>	$0.262 \leq r \leq 0.273$	<b>70</b>	$1.189 \leq r \leq 1.226$	<b>113</b>	$7.261 \leq r \leq 7.830$
<b>28</b>	$0.274 \leq r \leq 0.286$	<b>71</b>	$1.227 \leq r \leq 1.265$	<b>114</b>	$7.831 \leq r \leq 8.485$
<b>29</b>	$0.287 \leq r \leq 0.299$	<b>72</b>	$1.266 \leq r \leq 1.306$	<b>115</b>	$8.486 \leq r \leq 9.244$
<b>30</b>	$0.300 \leq r \leq 0.312$	<b>73</b>	$1.307 \leq r \leq 1.348$	<b>116</b>	$9.245 \leq r \leq 10.136$
<b>31</b>	$0.313 \leq r \leq 0.326$	<b>74</b>	$1.349 \leq r \leq 1.392$	<b>117</b>	$10.137 \leq r \leq 11.198$
<b>32</b>	$0.327 \leq r \leq 0.340$	<b>75</b>	$1.393 \leq r \leq 1.438$	<b>118</b>	$11.199 \leq r \leq 12.485$
<b>33</b>	$0.341 \leq r \leq 0.354$	<b>76</b>	$1.439 \leq r \leq 1.485$	<b>119</b>	$12.486 \leq r \leq 14.074$
<b>34</b>	$0.355 \leq r \leq 0.368$	<b>77</b>	$1.486 \leq r \leq 1.534$	<b>120</b>	$14.075 \leq r \leq 16.090$
<b>35</b>	$0.369 \leq r \leq 0.383$	<b>78</b>	$1.535 \leq r \leq 1.585$	<b>121</b>	$16.091 \leq r \leq 18.729$
<b>36</b>	$0.384 \leq r \leq 0.398$	<b>79</b>	$1.586 \leq r \leq 1.639$	<b>122</b>	$18.730 \leq r \leq 22.334$
<b>37</b>	$0.399 \leq r \leq 0.414$	<b>80</b>	$1.640 \leq r \leq 1.694$	<b>123</b>	$23.335 \leq r \leq 27.558$
<b>38</b>	$0.415 \leq r \leq 0.430$	<b>81</b>	$1.695 \leq r \leq 1.752$	<b>124</b>	$27.559 \leq r \leq 35.816$
<b>39</b>	$0.431 \leq r \leq 0.446$	<b>82</b>	$1.753 \leq r \leq 1.813$	<b>125</b>	$35.817 \leq r \leq 50.885$
<b>40</b>	$0.447 \leq r \leq 0.462$	<b>83</b>	$1.814 \leq r \leq 1.876$	<b>126</b>	$50.886 \leq r \leq 87.682$
<b>41</b>	$0.463 \leq r \leq 0.479$	<b>84</b>	$1.877 \leq r \leq 1.942$	<b>127</b>	$87.683 \leq r \leq 146.285$
<b>42</b>	$0.480 \leq r \leq 0.497$	<b>85</b>	$1.943 \leq r \leq 2.011$	<b>128</b>	$r \geq 146.286$
<b>43</b>	$0.498 \leq r \leq 0.514$	<b>86</b>	$2.012 \leq r \leq 2.084$		

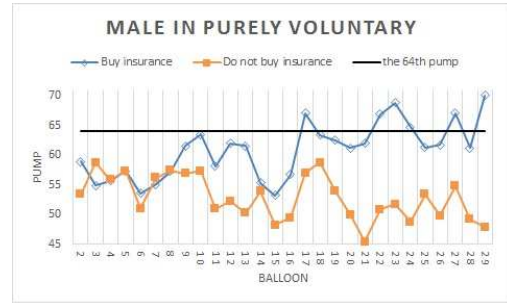
Table A3: **Value of  $EU(buyinsurance) - EU(notbuyinsurance)$  for corresponding  $k$  and  $r$ .**

<b>K</b>	$r$	$EU(buyinsurance) - EU(notbuyinsurance)$
<b>1</b>	$0 \leq r \leq 0.011$	$0.081 + 0.067i$
<b>2</b>	$0.012 \leq r \leq 0.019$	$0.075 + 0.066i$
<b>3</b>	$0.020 \leq r \leq 0.027$	$0.099 + 0.102i$
<b>4</b>	$0.028 \leq r \leq 0.036$	$0.120 + 0.140i$
<b>5</b>	$0.037 \leq r \leq 0.044$	$0.138 + 0.179i$
<b>6</b>	$0.045 \leq r \leq 0.053$	$0.152 + 0.220i$
<b>7</b>	$0.054 \leq r \leq 0.062$	$0.163 + 0.263i$
<b>8</b>	$0.063 \leq r \leq 0.071$	$0.171 + 0.307i$
<b>9</b>	$0.072 \leq r \leq 0.080$	$0.176 + 0.353i$
<b>10</b>	$0.081 \leq r \leq 0.089$	$0.172 + 0.349i$
<b>11</b>	$0.090 \leq r \leq 0.098$	$0.173 + 0.395i$
<b>12</b>	$0.099 \leq r \leq 0.108$	$0.172 + 0.442i$
<b>13</b>	$0.109 \leq r \leq 0.117$	$0.167 + 0.491i$
<b>14</b>	$0.118 \leq r \leq 0.127$	$0.158 + 0.540i$
<b>15</b>	$0.128 \leq r \leq 0.137$	$0.146 + 0.589i$
<b>16</b>	$0.138 \leq r \leq 0.147$	$0.130 + 0.639i$
<b>17</b>	$0.148 \leq r \leq 0.158$	$0.111 + 0.689i$
<b>18</b>	$0.159 \leq r \leq 0.168$	$0.087 + 0.739i$
<b>19</b>	$0.169 \leq r \leq 0.179$	$0.060 + 0.789i$
<b>20</b>	$0.180 \leq r \leq 0.190$	$0.001 + 0.902i$

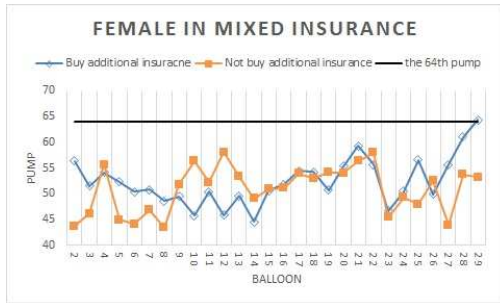
#### A4. Gender differences in adverse selection.



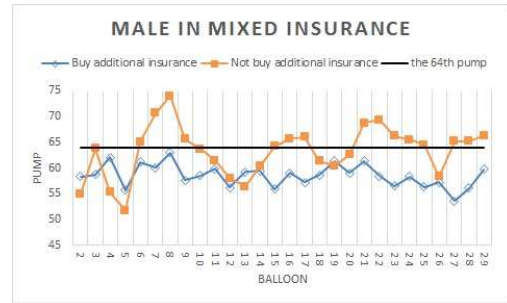
(a)



(b)



(c)



(d)

Figure A1: Gender differences in adverse selection by treatment.

## **A5. Experimental Instructions**

### (1). General Instructions

Now you will be presented with 30 balloons in the computer screen.

You have to decide how many times you want to pump each balloon. For every successful pump you will earn money. However, the explosion point for each balloon is random. The maximum possible number of pumps for each balloon is 128. The explosion point is random and it can be anywhere in the range from the first (1st) to the last (128th) pump.

For each balloon, you will be asked to select how many times you want to pump it up. You get a MONETARY reward of \$0.01 for every successful pump. HOWEVER, if a balloon explodes before it reaches the number of pumps you indicated, you earn \$0.00 for that balloon.

After each trial, a new balloon will appear.

For SOME balloons, you have an opportunity to buy an Insurance to protect yourself against the risk of an explosion for that particular balloon. Please make your decisions carefully. (if Purely Voluntary or Mixed Treatment)

For SOME balloons, you are required to buy an Insurance to protect yourself against the risk of an explosion for that particular balloon. (if Purely Compulsory Treatment)

At the end of the experiment, 3 balloons will be RANDOMLY SELECTED, and you will be paid the amount of money earned for these three balloons.

(2). Summary

- \* You write the number of times you want to pump up each balloon in a provided textbox.
- \* Remember: each balloon can be pumped up to 128 times (it will surely pop at 128th pump).
- \* Each balloon is then pumped up until a) that number is reached or b) it pops. Whatever occurs first.

- \* If it does not explode, you make \$0.01 for each pump.

- \* If it does explode, you will not make any money on that balloon.

- \* There are a total of 30 balloons.

- \* Only some balloons have the opportunity to purchase insurance. (if Purely Voluntary or Mixed Treatment)

For some balloons, you are REQUIRED to buy an Insurance. (if Purely Compulsory Treatment)

- \* At the end, you will be paid the exact amount you earned on THREE randomly selected balloons.

Continue when you are ready to start.

(3a).Insurance (Purely Voluntary)

On the following balloon, you have an opportunity to buy an insurance to protect yourself against the risk of explosion. The price of the insurance is \$0.40.

If the balloon does explode, the insurance will pay you \$0.64; if the balloon does not explode, the insurance will pay you nothing, and the cost is not refunded. However, you will keep the earnings you make in that balloon if it is selected at the end of the experiment.

Remember: each balloon can be pumped up to 128 times;

The insurance is only valid for this balloon.

Before proceeding to make your choices, you have to correctly answer the following three questions.

(1). If you choose to buy the insurance, and you pump 128 times, then how much would you earn for this balloon?

A. \$0 B. \$64 C. \$24 D. \$40

(2). If you choose NOT to buy the insurance, and you pump 64 times, and the balloon does not explode, then how much would you earn for this balloon?

A. \$64 B. \$24 C. \$0 D. \$40

(3). If you choose to buy the insurance, and you pump 70 times, and the balloon does not explode, then how much would you earn for this balloon?

A. \$70 B. \$30 C. \$0 D. \$40

(3b).Insurance (Mixed)

On the following balloon, you are REQUIRED to buy an insurance to protect yourself against the risk of explosion. The price of the insurance is \$0.20, and it is compulsory.

If the balloon does explode, the insurance will pay you \$0.32; if the balloon does not explode, the insurance will pay you nothing, and the cost is not refunded. However, you will keep the earnings you make in that balloon if it is selected at the end of the experiment.

Besides the compulsory insurance, you have an opportunity to buy another insurance VOLUNTARILY. The price of this insurance is also \$0.20, and it is voluntary.

If the balloon does explode, the insurance will also pay you \$0.32; if the balloon does not explode, the insurance will pay you nothing, and the cost is not refunded. However, you will keep the earnings you make in that balloon if it is selected at the end of the experiment.

Remember: each balloon can be pumped up to 128 times (it will surely pop at 128th pump);  
if the balloon does not explode, you make \$0.01 for each pump;  
the insurance is only valid for this balloon.

Before proceeding to make your choices, you have to correctly answer the following three questions.

(1).If you choose NOT to buy the voluntary insurance, and you pump 128 times, then how much would you earn for this balloon?

A. \$0.0 B. \$0.64 C. \$0.24 D. \$0.12

(2). If you choose NOT to buy the voluntary insurance, and you pump 64 times, and the balloon does not explode, then how much would you earn for this balloon?

A. \$0.64 B. \$0.24 C. \$0.0 D. \$0.44

(3). If you choose to BUY the voluntary insurance, and you pump 70 times, and the balloon explodes, then how much would you earn for this balloon?

A. \$0.12 B. \$0.24 C. \$0.58 D. \$0.30

(3c).Insurance (Purely Compulsory)

On the following balloon, you are REQUIRED to buy an insurance to protect yourself against the risk of explosion. The price of the insurance is \$0.40, and it is compulsory.

If the balloon does explode, the insurance will pay you \$0.64; if the balloon does not explode, the insurance will pay you nothing, and the cost is not refunded. However, you will keep the earnings you make in that balloon if it is selected at the end of the experiment.

Remember: each balloon can be pumped up to 128 times (it will surely pop at 128th pump);  
if the balloon does not explode, you make \$0.01 for each pump;  
the insurance is only valid for this balloon.

Before proceeding to pump the balloon, you have to correctly answer the following two questions.

(1).After you buy the insurance, you pump 128 times, and then how much would you earn for this balloon?

A. \$0.0 B. \$0.64 C. \$0.24 D. \$0.40

(2).After you buy the insurance, you pump 70 times, and the balloon does not explode. How much would you earn for this balloon?

A. \$0.70 B. \$0.30 C. \$0.0 D. \$0.40

(4a). Insurance choice (Purely voluntary)

Now please indicate your decision by Clicking the options below.

Yes, I buy the insurance at a cost of \$0.40.

No, I do not buy the insurance.

(4b). Insurance choice (Mixed)

Now please indicate your decision by Clicking the options below.

Yes, I buy the additional insurance at a cost of \$0.20.

No, I do not buy the additional insurance.

(5). BART

**Enter how many times you want to pump up this balloon**

Remember: anything higher than 127 and the balloon SURELY pops

Continue



Number of wanted pumps: 0

Potential earnings: \$0.00

Balloon number: 1 of 30

Number of current pumps: 0

Total Winnings: \$0.00

Figure A2: Screenshot of BART.

(6). Earnings in BART

Congratulations!

Your earnings on 1-30 balloons are(),(),()...respectively, by randomly selecting three of them, your payment of this part is \$().

The balloon task is now complete. Please Click continue to go to the next part.



(7). DOSPERT (Figure A3)

For each of the following statements, please indicate the likelihood that you would engage in the described activity or behavior if you were to find yourself in that situation. Provide a rating from Extremely Unlikely to Extremely Likely.

- (1). Admitting that your tastes are different from those of a friend.
- (2). Going camping in the wilderness.
- (3). Betting a day's income at the horse races.
- (4). Investing 10% of your annual income in a moderate growth mutual fund.
- (5). Drinking heavily at a social function.
- (6). Taking some questionable deductions on your income tax return.
- (7). Disagreeing with an authority figure on a major issue.
- (8). Betting a day's income at a high-stake poker game.
- (9). Having an affair with a married man/woman.
- (10). Passing off somebody else's work as your own.
- (11). Going down a ski run that is beyond your ability.
- (12). Investing 5% of your annual income in a very speculative stock.
- (13). Going whitewater rafting at high water in the spring.
- (14). Betting a day's income on the outcome of a sporting event.
- (15). Engaging in unprotected sex.
- (16). Revealing a friend's secret to someone else.
- (17). Driving a car without wearing a seat belt.
- (18). Investing 10% of your annual income in a new business venture.
- (19). Taking a skydiving class.
- (20). Riding a motorcycle without a helmet.
- (21). Choosing a career that you truly enjoy over a more prestigious one.
- (22). Speaking your mind about an unpopular issue in a meeting at work.
- (23). Sunbathing without sunscreen.
- (24). Bungee jumping off a tall bridge.
- (25). Piloting a small plane.
- (26). Walking home alone at night in an unsafe area of town.

- (27). Moving to a city far away from your extended family.
- (28). Starting a new career in your mid-thirties.
- (29). Leaving your young children alone at home while running an errand.
- (30). Not returning a wallet you found that contains \$200.

(8). Sensation Seeking Scale (Figure A4)

Each of the items below contains two choices, A and B. Please click the letter of the choice which most describes your likes or the way you feel. In some cases you may find items in which both choices describe your likes or feelings. Please choose the one which better describes your likes or feelings. In some cases you may find items in which you do not like either choice. In these cases mark the choice you dislike least. Do not leave any items blank.

In this part, there are not right or wrong answers. Be frank and give your honest appraisal of yourself.

- (1) A. I like “wild” uninhibited parties  
B. I prefer quiet parties with good conversation
- (2) A. There are some movies I enjoy seeing a second or even a third time  
B. I can’t stand watching a movie that I’ve seen before
- (3) A. I often wish I could be a mountain climber  
B. I can’t understand people who risk their necks climbing mountains
- (4) A. I dislike all body odors  
B. I like some for the earthly body smells
- (5) A. I get bored seeing the same old faces  
B. I like to comfortable familiarity of everyday friends
- (6) A. I like to explore a strange city or section of town by myself, even if it means getting lost  
B. I prefer a guide when I am in a place I don’t know well
- (7) A. I dislike people who do or say things just to shock or upset others  
B. When you can predict almost everything a person will do and say he or she must be a bore
- (8) A. I usually don’t enjoy a movie or play where I can predict what will happen in advance  
B. I don’t mind watching a movie or a play where I can predict what will happen in advance
- (9) A. I have tried marijuana or would like to  
B. I would never smoke marijuana

- (10) A. I would not like to try any drug which might produce strange and dangerous effects on me
- B. I would like to try some of the new drugs that produce hallucinations
- (11) A. A sensible person avoids activities that are dangerous
- B. I sometimes like to do things that are a little frightening
- (12) A. I dislike “swingers” (people who are uninhibited and free about sex)
- B. I enjoy the company of real “swingers”
- (13) A. I find that stimulants make me uncomfortable
- B. I often like to get high (drinking liquor or smoking marijuana)
- (14) A. I like to try new foods that I have never tasted before
- B. I order the dishes with which I am familiar, so as to avoid disappointment and unpleasantness
- (15) A. I enjoy looking at home movies or travel slides
- B. Looking at someone’s home movies or travel slides bores me tremendously
- (16) A. I would like to take up the sport of water skiing
- B. I would not like to take up water skiing
- (17) A. I would like to try surf boarding
- B. I would not like to try surf boarding
- (18) A. I would like to take off on a trip with no preplanned or definite routes, or timetable
- B. When I go on a trip I like to plan my route and timetable fairly carefully
- (19) A. I prefer the “down to earth” kinds of people as friends
- B. I would like to make friends in some of the “far out” groups like artists or “punks”
- (20) A. I would not like to learn to fly an airplane
- B. I would like to learn to fly an airplane
- (21) A. I prefer the surface of the water to the depths
- B. I would like to go scuba diving
- (22) A. I would like to meet some persons who are homosexual (men or women)
- B. I stay away from anyone I suspect of being “gay or lesbian”
- (23) A. I would like to try parachute jumping
- B. I would never want to try jumping out of a plane with or without a parachute
- (24) A. I prefer friends who are excitingly unpredictable

B. I prefer friends who are reliable and predictable

(25) A. I am not interested in experience for its own sake

B. I like to have new and exciting experiences and sensations even if they are a little frightening, unconventional, or illegal

(26) A. The essence of good art is in its clarity, symmetry of form and harmony of colors

B. I often find beauty in the “clashing” colors and irregular forms of modern paintings

(27) A. I enjoy spending time in the familiar surroundings of home

B. I get very restless if I have to stay around home for any length of time

(28) A. I like to dive off the high board

B. I don't like the feeling I get standing on the high board (or I don't go near it at all)

(29) A. I like to date members of the opposite sex who are physically exciting

B. I like to date members of the opposite sex who share my values

(30) A. Heavy drinking usually ruins a party because some people get loud and boisterous

B. Keeping the drinks full is the key to a good party

(31) A. The worst social sin is to be rude

B. The worst social sin is to be a bore

(32) A. A person should have considerable sexual experience before marriage

B. It's better if two married persons begin their sexual experience with each other

(33) A. Even if I had the money I would not care to associate with flight rich persons like those in the “jet set”

B. I could conceive of myself seeking pleasures around the world with the “jet set”

(34) A. I like people who are sharp and witty even if they do sometimes insult others

B. I dislike people who have their fun at the expense of hurting the feelings of others

(35) A. There is altogether too much portrayal of sex in movies

B. I enjoy watching many of the “sexy” scenes in movies

(36) A. I feel best after taking a couple of drinks

B. Something is wrong with people who need liquor to feel good

(37) A. People should dress according to some standard of taste, neatness, and style

B. People should dress in individual ways even if the effects are sometimes strange

(38) A. Sailing long distances in small sailing crafts is foolhardy

B. I would like to sail a long distance in a small but seaworthy sailing craft

(39) A. I have no patience with dull or boring persons

B. I find something interesting in almost every person I talk to

(40) A. Skiing down a high mountain slope is a good way to end up on crutches

B. I think I would enjoy the sensations of skiing very fast down a high mountain slope

(9). Gamble Choice

See Figure A5: screenshot of gamble-choice task.

(10). Demographic survey

Please answer the following survey questions.

(1) Please enter your age in years.

(2) Please indicate the HIGHEST level of education you have completed.

Some High School or less

High School Diploma

Some College

2 year/Associates Degree

4 year/Bachelor's Degree

Some Graduate School

Graduate Degree

(3) Including yourself, how many people live in your household?

(4) Please indicate your gender.

Male

Female

(5) Please indicate your race.

Asian/ Pacific Islander

African American

Caucasian/ White

Native American/ Indigenous

Hispanic

Other (Please list below)

(6) Please indicate your household yearly income for 2016. (Include all forms of income, including salary, interest and dividend payments, tips, scholarship support, student loans, parental support, and allowance)

Less than \$30,000

\$30,000 - \$39,999

\$40,000 - \$49,999

\$50,000 - \$59,999

\$60,000 - \$69,999

\$70,000 - \$79,999

\$80,000 - \$89,999

\$90,000 - \$99,999

\$100,000 - \$149,999

\$150,000 or more

(7) Do you think the Insurance Option in the balloon task is clear?

Yes.

No.

Please answer the following questions. You will earn 10 cents for completing the two parts of the questionnaire. All answers will be completely anonymous and unrelated to your payoffs.

Your honest answers will be greatly appreciated as real responses will help to improve our research. Thank you!

Continue

(a)

PART 1: For each of the following statements, please indicate the likelihood that you would engage in the described activity or behavior if you were to find yourself in that situation. Provide a rating from Extremely Unlikely to Extremely Likely.

1. Admitting that your tastes are different from those of a friend.

☐ Extremely Unlikely ☐ Moderately Unlikely ☐ Somewhat Unlikely ☐ Not Sure ☐ Somewhat Likely ☐ Moderately Likely ☐ Extremely Likely

2. Going camping in the wilderness.

☐ Extremely Unlikely ☐ Moderately Unlikely ☐ Somewhat Unlikely ☐ Not Sure ☐ Somewhat Likely ☐ Moderately Likely ☐ Extremely Likely

3. Betting a day's income at the horse races.

☐ Extremely Unlikely ☐ Moderately Unlikely ☐ Somewhat Unlikely ☐ Not Sure ☐ Somewhat Likely ☐ Moderately Likely ☐ Extremely Likely

4. Investing 10% of your annual income in a moderate growth diversified fund.

☐ Extremely Unlikely ☐ Moderately Unlikely ☐ Somewhat Unlikely ☐ Not Sure ☐ Somewhat Likely ☐ Moderately Likely ☐ Extremely Likely

Back

Continue

(b)

Figure A3: Screenshot of DOSPERT



**PART 2:** Each of the items below contains two choices, A and B. Please click the letter of the choice which most describes your likes or the way you feel. In some cases you may find items in which both choices describe your likes or feelings. Please choose the one which better describes your likes or feelings. In some cases you may find items in which you do not like either choice. In these cases mark the choice you dislike least. Do not leave any items blank.

In this part, there are not right or wrong answers. Be frank and give your honest appraisal of yourself.

1.
  - ☐ A. I like “wild” uninhibited parties.
  - ☐ B. I prefer quiet parties with good conversation.
2.
  - ☐ A. There are some movies I enjoy seeing a second or even a third time.
  - ☐ B. I can't stand watching a movie I've seen before.
3.
  - ☐ A. I often wish I could be a mountain climber.
  - ☐ B. I can't understand people who risk their necks climbing mountains.
4.
  - ☐ A. I dislike all body odors.
  - ☐ B. I like some of the earthy body smells.

Continue

Figure A4: Screenshot of SSS.

In this part, please make a choice among the following six gamble choices. Each choice has two events A and B, and each event's chance of occurring is 50%. After you make your choice, the system will randomly choose an event and depending on your choice, you will get the corresponding payoff for that event. If you select a gamble with a negative payoff for outcome B, negative payoffs will be deducted from your payment in previous parts of the experiment.

Gamble choice	The event	Probability	Payoff (cents)
<input type="radio"/> 1.	A	50%	10
	B	50%	10
<input type="radio"/> 2.	A	50%	18
	B	50%	6
<input type="radio"/> 3.	A	50%	26
	B	50%	2
<input type="radio"/> 4.	A	50%	34
	B	50%	-2
<input type="radio"/> 5.	A	50%	42
	B	50%	-6
<input type="radio"/> 6.	A	50%	44
	B	50%	-8

Continue

Figure A5: Screenshot of gamble-choice task.