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Theft Insurance in Berkeley

Introduction:

In the following study, we will investigate property losses resulting from criminal activities around UC Berkeley. After living here for three-and-half years, we have become relatively knowledgeable and aware of the risky environment where our university is located. We wonder if students' willingness-to-pay (WTP) that arises from safety/property-loss concerns can generate profit opportunities for insurers.

To contextualize the idea of a property insurance plan in Berkeley, we propose a hypothetical insurance plan that will cover losses from theft. However, the coverage does not extend to automobiles. To keep variance under control, we propose to exclude any valuable belongings exceeding $10,000. Also, the insurance plan applies strictly to properties and does not compensate for injuries resulting from criminal activities. We will price such an insurance product based on historical data of property theft in Berkeley and willingness-to-pay of students.

We collected publicly available data from UC Police Department (UCPD) on numbers of thefts as well as values of property lost. In addition to exploring Berkeley's criminal records, our goal is to examine its impact on the students as well as an insurance market for properties stolen in Berkeley. We will evaluate the annual premium for a hypothetical insurance plan from two approaches: one based on the crime statistics obtained from websites and UCPD, and the other based on the WTP of students. We will also discuss some fundamentals of the insurance market as well as our methodologies in the premium evaluations.

Why an insurance market exists:

The market for insurance arises from the fact that most people are risk-averse. Unpredictable losses are very unwelcomed among us. Often times, we would rather take a small loss for certain to avoid uncertainties of such large and unpredictable losses. Thus, we begin with the assumption that most students have a concave utility function that reflects one's risk-aversion.

Then theoretically, an insurer is able to charge a premium of Π and cover a possible loss of X from an individual's current wealth w that satisfy the following equality:

- $\boldsymbol{U(w-\Pi) = E\,(\,U(w-X)\,)}$

The intuition is that an individual's utility of paying a premium for sure should equal to the expected utility of one's uncertain loss of X taken probability into account.

Using Jensen's Inequality for concave functions: $\varphi(E[X]) \leq E[\varphi(X)]$ where $\varphi(X)$ is concave, we can derive that one is willing to pay a premium greater than the expected loss, a.k.a.

- $\boldsymbol{\Pi \geq E(X)}$.

As a result, when a third-party insurer pools risks, his expected loss is E(X) with a diminishing variance as more individuals enroll in the insurance plan.

Pricing Annual Premium – Historical Data Approach:

After doing research on insurance-pricing methodologies, we realize that pricing any insurance plan is a complicated process that often involves advanced modeling using existing data as well as judgment calls. However, Andreas Kull's paper "A Unifying Approach to Pricing Insurance and Financial Risk" mentions an equivalence principle that can represent the premium symbolically:

- $\boldsymbol{premium} = \frac{\mathbf{1}}{\mathbf{1+r}}\boldsymbol{E[X]} + \boldsymbol{S[X]}$ *

*slightly simplified from the original paper.

In words, it states the equality between premium and the expected loss discounted by the time value of money plus a risk premium. Since this equation is relatively straight-forward and makes intuitive sense, we decide to use it as a starting point in calculating our preliminary price.

In order to find the expected value of annual loss, we need historical value of property stolen. The only accessible data set that includes stolen property value is from the year 2008, as shown below:

# Larceny - Theft	Stolen Property Value*	Recovered Property	Percent Recovered
804	$257,841	$22,765	8.83%

*Excluding: motor vehicles and university properties.

Figure 1. Value of Stolen and Recovered Property 2008
Source: http://annualreport.ucpd.ucla.edu/2008/berkeley/value_of_stolen_property.html

Since most professors and other staff have more private office spaces where they work, we make the assumption that all the private properties stolen belong to students. The student population in 2008 is 35,409. Our calculation for the expected loss is thus:

- $E[X] = \frac{\$257,841 - \$22,765}{35,409} = \$6.64$

Since recently interest rate is very low and can hardly change this number, we keep the $6.64 as the minimum charge for such an insurance plan. We leave the risk premium S[X] uncalculated for now since it involves too much judgment call.

However, based on the knowledge that the loss ratio for a Property & Casualty insurance plan generally ranges from 40% to 60%, we can expect the risk premium to fall within the complement of that, namely 40% to 60%. Using those percentages, we get a range for our overall premium: $11.07 to $16.6.

Risks and Limitations:

- Only 2008**:** 2008 is the only available year in which we find practical data set for calculation purposes. Often times an insurance company utilizes many years of data in pricing. This limited data source limits our calculation's reliability. Although we find other data sources to show fluctuating but similar numbers of larceny in following years, we cannot guarantee similar property loss values in the years to come, nor do we have a measure of such variability.

- Every-student-enroll Assumption: We used the whole school's student population as the denominator in calculating loss. However, in reality, we may not be able to get such a comprehensive risk pool. In addition, we predict that those who have more valuable belongings will choose to enroll. They are also the ones who are more likely to be targets of theft offenses.
- Every-theft-is-reported Assumption: In the calculations, we are assuming that the data collected and shown by the UCPD is a comprehensive record of thefts. In reality, not every student reports lost items to the police. In fact, it's highly likely that a greater proportion chooses not to, believing what's lost cannot be recovered. If an insurance plan covers the loss a student suffers from theft, we can expect the student to report the case to the insurer with a much higher probability.
- Inconsistent statistics**:** We found slightly differing numbers from another data source that suggest different numbers of theft cases in 2008. One possible explanation is that the reporting area may be defined differently in the two places. However, we cannot rule out the possibility that there is potential inaccuracy with the historical data we are using.

Pricing Annual Premium – Willingness-to-Pay Approach:

**The study is based double bounded contingent valuation (DBCV) method.

Data Source:

The data used for this study come from 100-people-scale individual survey in UC Berkeley community. We distributed surveys through networks including phone calls, face-to-face interviews, emails, facebook, twitter etc. The survey includes sections on housing situation in Berkeley, part-time job, assets in households/apartments and consumption expenditures on food and non-food items.

We targeted on students in UC Berkeley who have lived in the Berkeley community for over one semester since they have gained knowledge of their own financial standing as well as their surroundings. Demographic boundaries are in accordance with UCPD's reporting area map. Surveys are randomly distributed to both undergraduate and graduate students with all majors and backgrounds to get a representative sample of our student population.

Format:

The sample was designed as a stratified two-stage probability sample. Values from respondents are derived from bidding games and dichotomous formats. To begin with, a contingent valuation survey presents an overview of the situation for which the individual would hypothetically pay. In this survey, the interviewees are presented with description of an imaginary insurance product that we designed.

Double bounded contingent valuation (DBCV) method is used in the choice elicitation process where interviewees will be asked binary discrete choice questions.

- First, interviewee is asked if s/he is willing to purchase such insurance product based on his/her evaluation of cost and benefits.

- If yes, then this respondent is asked if s/he is willing to pay for the first bid which comes from our preliminary research of the estimated annual premium.
  We set the starting point at 18 dollars to reflect estimated annual premium based on our preliminary calculation with a 60% risk premium and profit incentives for the insurer.
- If the respondent says 'yes' again, a second higher bid will be given and her/his willingness to pay is asked. If s/he says no to the initial bid, a second lower bid will be provided. If s/he says 'no' to both the first and the second bids then s/he will be asked to mention the maximum that s/he is willing to pay.
- Under this elicitation procedure, we have two discrete responses from every individual.

Methodology:
We use CV method (Contingent valuation) to evaluate the willingness to pay for theft insurance plan in order to study the potential market in Berkeley community. The CV method is used to study the demand for new property-loss insurance products which we believe will give us adequate set of information for the potential market.

Key:
y .....allowances per month
$q1$ .....level of utility associated with property-loss insurance.
$q0$ .....level of utility associated without property-loss insurance.
WTP .....a student's willing to pay as a premium
X .....vector of factors including gender(1=M, 0=F), age, edu(undergraduate=0, graduate=1), part-time job(have=1, don't have=0), monthly consumption expenditures etc. that may affect a student's preferences
π ..... perceived probability of being stolen
ε ..... errors/unobservable factors

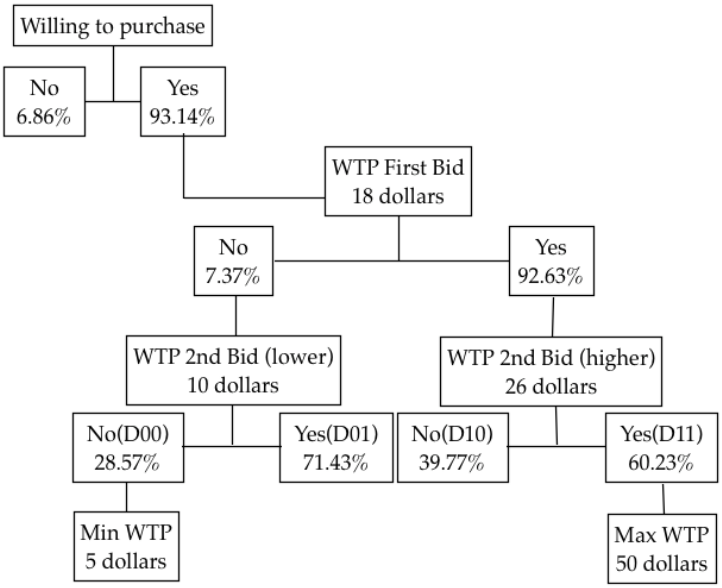
Then, the WTP that equates the two indirect utility functions with and without insurance can be written as:

- $v[(q_1, y-WTP, X, \pi)+\varepsilon] = v[(q_0, y, X, \pi)+\varepsilon]$

Therefore, $WTP=\varphi(q1,q0,y,X,\pi,\varepsilon)$ is the maximum value students are willing to forgo to avoid monetary loss associated with theft. When $v[(q1,y-WTP,X,\pi)+\varepsilon] > v[(q0,y,X,\pi)+\varepsilon]$, insurance plan will be purchased; otherwise, it will not be. This is based on the assumption that each interviewee will compare his/her utility from the proposed theft insurance plan with his/her current situation and decide whether to accept or reject the offered bid levels.

The true willingness to pay is hard to be observed by dichotomous choices because for each individual we only know whether that individual's WTP is greater than or less than the stated amount. One estimate of WTP from referendum CVM data is the *Turnbull estimator* which provides an estimate of average WTP for the sample with few restrictive assumptions about preferences. *Turnbull estimator* takes lower-bound on average WTP for each binary discrete choice question. Figure below provides the descriptive analysis of the statistics for 102 students' willingness to pay on our hypothetical analysis. As we explained earlier, we give each

individual a first bid (P_f) which is 18 US dollars and then according to his or her answer, give the second higher (P_h) or the second lower (P_l) bids. The nonparametric *Turnbull estimator*, for the second higher bid for example, is [Probability of D_{11}* (P_h)+ Probability of D_{10}* (P_f)]. After *Turnbull estimator* is calculated for each binary discrete choice question, the overall lower-bound estimate of WTP is straightforward. As a result, *Turnbull estimator* gives us a conservative estimate of average willing-to-pay for the insurance plan proposed which is 20.3 dollars.



D11= 1 if interviewee says 'yes' to the first bid and 'yes' to the 2nd higher bids;
D10= 1 if interviewee says 'yes' to the first bid and 'no' to the 2nd higher bids;
D01= 1 if interviewee says 'no' to the first bid and 'yes' to the 2nd lower bids;
D00= 1 if interviewee says 'no' to the first bid and 'no' to the 2nd lower bids;

Results

Surprisingly, the results show high rate of willingness to purchase as well as high willingness to pay. 95 out of 102 people (93.13%) are willing to purchase such plan and over 90% of people among the 95 people are willing to accept the first bid. We should note that the first bid is already considerably higher than the estimated annual premium to capture the potential risk as described in the previous section. In addition, over half of the people who are willing to pay for the first bid are also willing to pay the second higher bid, which is 26 dollars.

As can be seen from the research, on average, the WTP for proposed theft insurance is 1.8% of a student's monthly consumption expenditure.

In addition, a linear model is estimated to examine the impact of various factors that affect the willingness-to-pay for the proposed insurance scheme. We assume that the real willingness to pay can be expressed as a normal linear model:

- $WTP=X' \beta+\varepsilon i$

[where $\varepsilon i \sim NID(0,\sigma 2)$; X is a vector of explanatory variables; βs are estimated coefficients]

Regression output for regressing WTP on all five factors in the survey.

```
Coefficients:
                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                     -0.0519882  1.3147234  -0.040 0.968540
Gender                           0.0730663  0.2142035   0.341 0.733776
Age                              0.1158470  0.0610724   1.897 0.060882 .
Education                       -0.1888608  0.4323026  -0.437 0.663196
Part.time                       -0.2503341  0.2373800  -1.055 0.294296
Monthly.Consumption..includes.rent.  0.0006069  0.0001627   3.729 0.000326 ***
```

Regression output for regressing WTP on **age and monthly consumption only**

```
Coefficients:
                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                     0.6887546  0.8079496   0.852 0.396031
Age                             0.0767430  0.0370269   2.073 0.040832 *
Monthly.Consumption..includes.rent. 0.0005900  0.0001538   3.837 0.000220 ***
```

As the regression output shows, only two variables, namely age and monthly consumption have significant influence on respondents' willingness-to-pay for the proposed insurance scheme. Other variables like gender, education level and whether one has a part time job or not have little influence on the WTP in UC Berkeley community.

Limitation:

First of all, the CV method is considered to be based on 'hypothetical answers to hypothetical questions'. This creates a psychological barrier to relying on such results. Methodological issues ranging from designing and administrating the questionnaire to the estimation techniques. Some researchers suggested that CV model is more likely to be affected by measurement errors and therefore its validity and reliability were hurt.

Second, our insurance program suffers inherent risk of moral hazard. The sustainability of our insurance program partly depends on the honesty and trustworthiness of an insured individual. The actual commission of theft may have occurred only in the mind of the claimant, and the extent of the loss and the value of the property claimed to have been stolen rely largely on the moral character including honesty.

Conclusion:

As our survey and research indicate, property insurance against theft is a product appreciated and welcomed by a large population in UC Berkeley. Although our project has inherent limitations being based on a hypothetical insurance plan, our data reflect students' high WTP for insurance against theft well beyond what it may cost an insurer. Furthermore, the $20.3 estimated by the Turnbull estimator captures a lower-bound value and is on the conservative side.

However, we realize that this profit opportunity is left alone not without reasons. A reliable way to monitor and mitigate moral hazard or fraudulent reports is yet to be found. In addition, our estimate of this insurance's cost may be underestimated due to amount of unreported or unrecorded theft incidences that take place. The incomprehensiveness of police reports leave a great magnitude of uncertainty for a potential insurer's cost.