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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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CHOOSING AMONG ALTERNATIVE
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BY

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CHAPTER ONE

CAUSAL ANALYSIS

I. Causation

This chapter involves a causal analysis of the backgrounds and decisions of state supreme court judges. More specifically, the analysis points to whether or not a judge's political party affiliation causes him to vote in a particular way.

Analysis of causation requires a great deal of care and foresight, if one is to avoid drawing hasty conclusions.

A "nearsighted" researcher might, in order to determine if a judge's party affiliation affects his judicial decisions, ask if Democratic judges vote in a certain way more than Republican judges do. If the answer is "yes," he might conclude that Democratic judges do, indeed, vote similarly and he might not inquire any further.

An "enlightened" researcher would not draw such a hasty conclusion. He would be alert for a third, intervening variable that he believes might explain the relation between the original two variables.
The data in this analysis include three pieces of information on each of sixty-two judges:

1. his party affiliation (X);
2. his decisional propensity (Y); and
3. his off-the-bench liberal attitude (Z).

The party affiliation of the judges can be found in the *Directory of American Judges* for the year 1988. The decisional propensities can be calculated from the various state court reports and the off-the-bench attitudes were based on questionnaire responses of the judges.¹

III. Party Affiliation and Judicial Decisions

Computer cross-tabulation of the data shows that

being a Democrat correlates positively with voting pro-

employee in a suit for compensation for a personal injury

of a worker while on the job.

The cross-tabulation permits the graphing of an
equation which equates X (party) with Y (decisional propensity). The regression equation is of the form:

\[ Y = a + b(X) \]

where "a" is the "y" (or vertical) intercept and "b" is the
slope of the curve on the graph.

If one assumes that \( X = 0 \) when the judge is a Republi-
can and \( X = 1 \) when the judge is a Democrat, then the equa-
tion:
\[ Y = 41.2 + 19.5(X), \]

allows one to predict how often a judge will vote pro-employee. The calculation of the predictions is as follows:

\[
\begin{align*}
X = 0 & \quad Y = 41.2 + 19.5(0) = 41.2 \\
X = 1 & \quad Y = 41.2 + 19.5(1) = 60.7.
\end{align*}
\]

Thus, one can predict that a judge will vote pro-employee 41.2 percent of the time if he is a Republican and 60.7 percent of the time if he is a Democrat.

Graph 1-1 shows the graphing of this equation.

The "enlightened" researcher would proceed with at least two tests to determine the validity of the intervening (S) variable. The first of these tests can be called the "positive test." The S variable, off-the-beach liberal attitude, should bear a positive relationship to both the X (party) and the Y (decisional propensity) variables if S is, indeed, the real cause of the apparent relation between X and Y.

IV. Party Affiliation and Judicial Attitude

The cross-tabulation of X (party) and S (off-the-beach liberal attitude) results in a regression coefficient of + 41.7. The resulting equation is:

\[ X = 25 + 41.7(S) \]

where \( S = 0 \) when the judge is conservative and \( S = 1 \) when the judge is liberal.
Party Affiliation and Percentage Progress

Graph 1-1

Republican

Democratic
The graphing of this equation can be found on graph 1-2.

Using this equation, one can predict a judge's party affiliation if one knows his off-the-bench attitude. The calculation of the predictions is as follows:

\[ S = 0 \quad X = 25.0 + 41.7(0) = 25.0 \]
\[ S = 1 \quad X = 25.0 + 41.7(1) = 66.7. \]

Thus, one can predict that judges who score as conservatives on an attitude test will be Democrats 25.0 percent of the time and judges who score as liberals on the test will be Democrats 66.7 percent of the time.

V. Party Affiliation and Judicial Attitude

The cross-tabulation of \( Y \) (decisional propensity) and the intervening, \( S \), variable (attitude) results in a regression coefficient of \( +45.2 \). The equation which relates \( Y \) and \( S \) is:

\[ Y = 28.1 + 45.2(S). \]

This equation allows one to predict how often a judge will vote pro-employee given the judge's attitude score. If one assumes, again, that \( S = 0 \) for conservative judges, and \( S = 1 \) for liberal judges, the results are:

\[ S = 0 \quad Y = 28.1 + 45.2(0) = 28.1 \]
\[ S = 1 \quad Y = 28.1 + 45.2(1) = 73.3 \]
Party Affiliation and Judicial Attitude

Graph 1+2

Observation

Democratic

Conservative

Liberal

Graph 1+2
The graphing of this equation can be found on graph 1-3.

Using the equation, one can predict that a judge will vote pro-employee 28.1 percent of the time if he scores as a conservative on the attitude test and 73.3 percent of the time if he scores as a liberal on the test.

VI. **The Negative Test**

The second test, called the "negative test," says that if I is the real cause of the apparent relation between X and Y, then when it is held constant for, the relation of X and Y should approach zero. It would not be expected to go to perfect zero, though, because liberalism probably does not account for all of the relation between party affiliation and decisional propensity. Another I variable, such as urbanism, could account for some of the relation between X and Y since living in an urban area may have a positive relation with being a Democrat.

Another reason that the regression coefficient is not exactly zero is that the negative test entails cutting the sample size drastically. This reduction in sample size raises the chance of sampling error (i.e., the probability that any results are due solely to chance), which is an important factor in any statistical study.
VII. The Partial Correlation Coefficient

Another way of testing the relationship between X and Y, while holding constant the effect of Z, is the partial correlation coefficient \( r_{XY.z} \) which is calculated as follows, by using the separate correlation coefficients \( (r_1, r_2, r'_3) \):

\[
\frac{r_1 - r_2 \cdot r'_3}{\sqrt{(1 - r^2_2) \cdot (1 - r^2_3)}}
\]

In this case, \( r_{XY.z} \) is determined as follows:

\[
\frac{.195 - .188}{\sqrt{(1 - .174) \cdot (1 - .204)}}
\]

\[= .0086 \approx \text{is approximately equal to zero.}\]

The fact that \( r_{XY.z} \) is close to zero shows that the relation of X and Y virtually disappears when Z is held constant for.

VIII. Conclusion

Thus, it has been shown that political party affiliation does not cause a judge to vote in a particular way. Rather, a judge's decisions are affected by his off-the-bench attitudes.

The obvious conclusion is that legislation regarding judges should be viewed in light of the fact that judicial
decisions are ultimately affected by the attitudes of the judges.

The most important concept one must keep in mind in a causal analysis is that one must always watch for an intervening, I, variable that may explain an apparent relation.

IX. Causal Analysis Concerning Crime Statistics

Another example of such a causal analysis involves certain crime statistics and the time of year in which they occur.

Statistics show that the crimes of rape and child molesting hit their peaks during the summer months. Additionally, the crimes of theft and house-breaking peak in the winter time.²

At first glance, it may seem that summer causes more rapes and child molestings and that winter causes more thefts and house-breakings.

One might assume (incorrectly) that potential rapists become more aggressive and sexually frustrated during the summer and that potential thieves have stronger urges to steal when it is winter.

But, the true relations can be explained by an intervening variable, namely: increased opportunities for crime committing. That is, during the warm, summer months there are more potential victims outdoors and thus more opportunities for potential perpetrators to attack them.
In addition, during the winter there is an increase in the number of dark hours per day and thus more opportunities for potential thieves to carry out their illegal activities without being detected.

The conclusion to be drawn from this analysis is that increased opportunities for crime committing, and not different seasons, can cause increased crime rates.

The incorrect assumption that criminals feel more like committing crimes when the weather is different is shown to be erroneous by the fact that the crime of forgery does not peak in any particular season.

The following figures show the relations between the variables. A plus indicates a positive relation and a zero indicates no relation.

1) **summer** $\rightarrow$ incidence of rape and child molesting
2) **winter** $\rightarrow$ incidence of theft and housebreaking
3) **summer** $\rightarrow$ (indirect)
   $\rightarrow$ warm weather
   $\rightarrow$ women and children outside
   $\rightarrow$ opportunities for rapists
   $\rightarrow$ incidence of rape
4) **winter** $\rightarrow$ (indirect)
   $\rightarrow$ long nights
   $\rightarrow$ opportunities for thieves
   $\rightarrow$ incidence of theft
5) summer
d→ incidence of forgery
c→ winter
FOOTNOTES

1The three pieces of information on each judge was provided to this author by Professor Stuart S. Nagel, who did the original research and who created the questionnaire.

CHAPTER TWO

OPTIMUM CHOICE WITHOUT PROBABILITIES

I. The Exclusionary Rule

In 1961, in Napp vs. Ohio, the Supreme Court of the United States declared that all states must exclude illegally seized evidence in all criminal proceedings (a declaration which was already in force in the federal courts). Prior to this case, twenty-three states already had the exclusionary rule; twenty-four states did not have the rule; and the three remaining states had an exclusionary rule which did not apply to all types of criminal cases (and for this reason these three states are ignored in this study).¹

In this analysis, differences between the "formerly exclusionary states" and the "newly exclusionary states" are used to determine an optimum choice. That is, the choice (between adopting the exclusionary rule, on one hand; and subjecting police officials to some legal action, on the other) which maximizes the net benefits (and likewise minimizes the costs) according to various goals.

II. The Data

The data in this analysis consists of questionnaire responses from American Civil Liberties Union officials, defense attorneys, judges, prosecuting attorneys, and police chiefs who represent 113 communities in the United States.
In this study, regressions are calculated and used to determine how certain policy choices can affect various goals. Four different regressions are calculated, each with a different combination of one policy and one goal.

The policies in question are:

1. adopting the exclusionary rule; and
2. subjecting law enforcement officials to civil or criminal proceedings for committing illegal searches.

The goals that are used to evaluate these policies are:

1. adherence of police officials to the requirements for legal searches; and
2. morale or enthusiasm of police officials with respect to making searches.

In each of the four regression analyses, a standardized regression coefficient ($r$) is determined. These four coefficients indicate the marginal rates of return, on police adherence and on police morale, of adopting the exclusionary rule and also of adopting increased civil or criminal action.

III. The First Regression

The first regression uses police adherence as the goal variable and, as the policy variable: whether the states were newly adopting or they had the exclusionary rule all along.
The hypothesis of this relation is that police adherence will increase more in newly adopting states than in those which had the rule all along.

The policy (or X) variable is set equal to 1, when the states are newly adopting and X = 2 when the states had the rule all along.

The goal (or Y) variable is equal to 1, when police adherence has decreased substantially, Y = 2 when adherence has decreased a little, Y = 3 when it has stayed the same, Y = 4 when it has increased a little, and Y = 5 when police adherence has increased substantially.

The resulting equation is:

\[ Y = 4.53 - .56(X) \]

Thus when \( X = 1 \) (newly adopting):

\[
Y = 4.53 - .56(1) \\
= 3.97
\]

and, when \( X = 2 \) (had all along):

\[
Y = 4.53 - .56(2) \\
= 3.41
\]

This is similar to saying that in "had all along" states police adherence remained the same (i.e., \( Y = 3 \)) and in "newly adopting" states police adherence increased a little (i.e., \( Y = 4 \)).
The coefficient of correlation, $r$, is $+.26$ for this relation. It is far enough above zero to consider the relationship as significant, provided the sample size is large enough.

IV. The Second Regression

The second regression uses police enthusiasm or morale as the goal variable and, as the policy variable: whether the states were newly adopting or they had the rule all along.

The hypothesis of this relation is that police enthusiasm for making searches will decrease more in states which are newly adopting than those which had the exclusionary rule all along.

The resulting equation is:

$$ Y = 1.38 + .45(X) $$

where $X = 1$ when the states are newly adopting and $X = 2$ when the states had the rule all along; and where:

$Y = 1$ when police enthusiasm has decreased substantially,

$Y = 2$ when it has decreased a little,

$Y = 3$ when it has stayed the same,

$Y = 4$ when it has increased a little, and

$Y = 5$ when police enthusiasm for making searches has increased substantially.

Thus, when $X = 1$ (newly adopting):

$$ Y = 1.38 + .45(1) $$

$$ = 1.83 $$
and, when $X = 2$ (had all along):

$$Y = 1.38 + .45(2)$$
$$= 2.28$$

This is similar to saying the enthusiasm of police in "newly adopting" states did, indeed, decrease more than the enthusiasm of police in "had all along" states, as was previously hypothesized.

The coefficient of correlation, $r$, is +.19 for this relation (the use of the coefficients for all four of the relations will be discussed later in this chapter).

V. **The Third Regression**

The third regression uses police adherence to the legal requirements of the search and seizure procedure as the goal ($Y$) variable and as the policy ($X$) variable: whether police were subjected to civil or criminal proceedings for committing illegal searches.

This relation is hypothesized to show that police adherence will increase more in states in which officials could be subjected to legal action than those in which they could not be subjected to such action.

The resulting equation is:

$$Y = 3.6 + .02(X)$$

where:
$X = 1$ when there is no legal action, and $X = 2$ when there is partial legal action, and $Y = 1$ to 5 for changes in adherence as determined in the first regression in this chapter.

When $X = 1$ (no legal action):

$$Y = 3.6 + .02(1)$$
$$= 3.62$$

and when $X = 2$ (some legal action):

$$Y = 3.6 - .02(2)$$
$$= 3.64$$

In other words, police adherence increased a little in both types of states.

The coefficient of correlation, $r$, is $+.01$ for this relation. This "$r$" is close enough to zero to determine that the relation is not statistically significant (again, the correlation coefficients will be used later).

VI. The Last Regression

The fourth regression uses police enthusiasm as the goal ($Y$) variable and legal action as the policy ($X$) variable.

This relation is hypothesized to show that police enthusiasm to conduct searches will decrease more in states in which officials could be subjected to such action.

The resulting equation is:

$$Y = 1.68 + .15(X)$$
where:

\( X = 1 \) when there is **no legal action**, and

\( X = 2 \) when there is **some legal action**, and

\( Y = 1 \) to 3 as defined in the second regression.

Thus, when \( X = 1 \) (no legal action):

\[
Y = 1.88 + .16(1)
\]

\[
= 2.04
\]

and when \( X = 2 \) (some legal action):

\[
Y = 1.88 - .16(2)
\]

\[
= 2.2
\]

In other words, the enthusiasm of police for making searches has decreased a little in both types of states.

The coefficient of correlation, \( r \), for the fourth relation is \(+.06\) which shows this relation to be statistically insignificant.

VII. **The Benefit-Cost Analysis**

The next step in this analysis is to analyse the policies in question from a benefit-cost perspective.

The benefit-cost analysis involves the aforementioned coefficients of correlation (or standardized regression coefficients) to determine the marginal rates of return (i.e., how many "units" of goal is achieved by one additional "unit" of policy) for the policies that are being discussed here.
First, let us assume that our society values police adherence twice as much as police enthusiasm and morale. The net benefits of each policy:

1. adoption of the exclusionary rule, and
2. legal action,

for both of the goals:

1. adherence, and
2. enthusiasm,

can be determined as follows:

Adopt: \[ ((.26) \times (2)) - ((.19) \times (1)) = +.33 \]
Action: \[ ((.01) \times (2)) + ((.06) \times (1)) = +.08 \]

\[ +.33 > +.08 \]

The net benefits of these two policies show that adoption of the exclusionary rule is the optimum choice for our assumed society.

Now let us assume that our society values police adherence three times as much as police enthusiasm. The weighted benefits minus costs can be determined as follows:

Adopt: \[ ((.26) \times (3)) - ((.19) \times (1)) = +.39 \]
Action: \[ ((.01) \times (3)) + ((.06) \times (1)) = +.09 \]

\[ +.39 > +.09 \]

Thus, under both assumptions, faced with alternative policies, the social scientist would choose that policy which has the higher weighted net benefits (assuming both policies
cannot be chosen), namely the adoption of the exclusionary rule.

As another example, let us consider a more economically oriented policy choice. It discusses the possible benefits and costs and goals of a state government's choice between building embankments or digging a reservoir for flood control in an area where there would otherwise be severe land and property damage every year.²

Assume the goals of the state are:

1. maximizing inexpensiveness of the plan, and
2. reducing damage due to floods.

The policies, as stated before, are:

1. building embankments,
or
2. digging a reservoir.

The first step is to compare the two policies on goal one (maximizing inexpensiveness of the plan). Building embankments is less costly than constructing a reservoir. Assume building costs of $3,000 for the embankments and $10,000 for the reservoir.

The next step is to compare the two policies on goal two (reducing flood damage). Assume that embankments will reduce damage by 6,000 and a reservoir will reduce damage by $25,000.

Now, it is logical to compare the costs and benefits of the two plans. However, unless the two goals are equally
desirable, it is not sufficient to simply subtract the costs from the benefits and choose the policy with the higher net benefits. Just as in the exclusionary rule example, the goals here, must be weighted according to the desires and values of society.

If society values the two goals equally, the benefit-cost analysis is as follows:

\[
\begin{align*}
\text{Embarkments} & \quad [-3,000] + [+6,000] = +3,000 \\
\text{Reservoir} & \quad [-18,000] + [25,000] = +7,000 \\
& \quad 7,000 > 3,000
\end{align*}
\]

So, choose the reservoir policy.

If society, though, is very conservation-minded, it may prefer to preserve the land more than it prefers to limit state spending. Under this assumption, the goal of reducing damage must be weighted more heavily than maximizing inexpensiveness before the net benefits are calculated. The analysis proceeds as follows:

\[
\begin{align*}
\text{Embarkments:} & \quad [-3,000] + [(2)(6,000)] = +9,000 \\
\text{Reservoir:} & \quad [-18,000] + [(2)(25,000)] = +32,000
\end{align*}
\]

So, once again, choose the reservoir policy.

Conversely, if society is very inflation-minded, for example, it may be relatively more important to limit state spending than to reduce damage to land. In this case, the goal of inexpensiveness must be weighted more heavily than
the goal of saving land, before the net benefits are calculated. Assuming that the first goal is one-and-a-half times as desirable as the second goal, the net-benefits are calculated as follows:

**Embankments:** \([1.5 \times (-3,000)] + [6,000] = +1,500\)

**Reservoir:** \([1.5 \times (-10,000)] + [25,000] = -2,000\)

So, in this case, the social scientist would choose the embankment policy to better represent the desires of society.
FOOTNOTES

1 The questionnaire data was provided to this author by Professor Stuart S. Nagel, who created the questionnaire and originated the research.

CHAPTER THREE

OPTIMUM CHOICE WITH PROBABILITIES

Optimum choice with probabilities, also referred to as decision making under risk, involves three main elements: acts, situations, and outcomes. A decision-maker's possible choices are his acts. The conditions under which he may find himself after he chooses are referred to as his situations, while the outcome for any particular chosen act is dependent upon which situation occurs.

For example, suppose a man must decide whether or not to carry an umbrella throughout the day. His possible choices are:

1. carry an umbrella; or
2. do not carry an umbrella.

The situations under which he may find himself are:

1. it will rain; or
2. it will not rain.

The four possible outcomes are:

1. he may carry an umbrella and it will rain;
2. he may carry an umbrella and it will not rain;
3. he may not carry an umbrella and it will rain; and
4. he may not carry an umbrella and it will not rain.

The decision maker wishes to choose the act which yields the most satisfying outcome. Before such a choice can
be determined, he must consider the relative desirability of the possible outcomes, as well as the probabilities that each of the various situations will arise.

To the extent that the man in the umbrella example believes the report of his local weatherman, the reported probability of precipitation is the value that he assigns to the possible situations: rain and no rain. He must look at the desirability of the possible outcomes in light of these probabilities.

It seems obvious that the man would be most satisfied if he was burden-free and dry, that is, he carries no umbrella and it does not rain. Likewise, it seems just as obvious that he would be satisfied if he carries an umbrella and it rains (in fact, it is conceivable that he may be even more satisfied than if he was burden-free and dry, because he feels he has conquered "Mother Nature").

The remaining two outcomes: carrying an umbrella when it does not rain; and not carrying an umbrella when it does rain, will both bring about some level of dissatisfaction. Getting wet would probably be more dissatisfying than being unnecessarily burdened, although one could understand a situation in which a school child would be more dissatisfied if his friends saw him carrying an umbrella on a sunny day than if he got caught in the rain without any protection.

Similarly, a juror in a criminal trial has two choices of action:
1. voting to acquit the defendant, and
2. voting to convict the defendant.

The possible situations that he may encounter are:
1. the defendant is truly innocent, and
2. the defendant is truly guilty.

As in the umbrella example, there are four possible outcomes when the two acts and the two situations are combined:

1. voting to acquit a defendant who is truly innocent,
2. voting to acquit a defendant who is truly guilty,
3. voting to convict a defendant who is truly innocent,
4. voting to convict a defendant who is truly guilty.

By proposing these four possible outcomes to prospective jurors and asking them to rank the outcomes in order of how much satisfaction or dissatisfaction they provide, it is possible to calculate the threshold probability (called $P^*$) for each juror. The threshold probability of a juror is the probability of guilt, of a defendant, above which the juror will vote to convict and below which he will vote to acquit.

In this study, questionnaires were given to twenty prospective jurors. The questionnaires were not all the same: of the twenty questionnaires, ten said to assume the case in question was a rape case, and ten said to assume it was an embezzlement case. In addition, the questionnaires were different with respect to the instructions given to the respondents: ten instructed the jurors not to vote to convict
unless they felt the defendant was guilty beyond a reasonable doubt; and ten questionnaires gave no instructions at all.

Likewise, the respondents were not all the same. Six of the respondents were female and fourteen were male. In addition, five of the respondents were business people or students with business majors. Five more were attorneys or law students. The remaining ten respondents had other occupations.

The questionnaire was also designed to determine whether the respondents were liberal or conservative but, the results were inconclusive so this variable was not considered in any conclusions (it is my contention that the smallness and non-randomness of the sample was the cause of the inconclusiveness of this attitude variable).

The analysis of the data involves comparing the average threshold probabilities of different groups within the sample. For example, males were compared with females; males who received beyond a reasonable doubt instructions were compared with males without instructions; lawyers in rape cases with instructions were compared with lawyers in rape cases without instructions, and so on.

Of all the possible breakdowns of respondents, some were hypothesized to be significantly different. To test these hypotheses for their relative importance, a statistical test, called the t-test, was used. Due to the smallness of the sample, traditional t-test conclusions, namely total
rejection or total acceptance of the hypotheses, cannot be
drawn. Therefore, the level of significance was set at .25
(a 25 percent chance that the t-test result was due solely
to chance) and conclusions were drawn only of the relative
significance of the hypothesized comparisons. The hypotheses
and the results of nine interesting comparisons will be dis-
cussed in the following paragraphs.

1. Rape vs. Embarrassment: Rape cases should have a
lower average threshold probability ($P^*$), which means it is
more easy to convict, than embarrassment cases, since rape is
a less socially accepted crime. The results showed that rape
cases did not have lower $P^*$ than embarrassment cases, with
very little statistical significance. This result could arise
as a consequence of respondents not heeding the instructions
as to what type of case it was.

2. Instructions vs. No Instructions: Since reasonable
doubt instructions are designed to make the juror more sensi-
tive to the situation of the defendant, the presence of such
instructions should raise $P^*$. The results, though, did not
support the hypothesis. It is possible, again that the
respondents ignored the instructions and simply moved on to
the part of the questionnaire to which they were required to
write a response.

3. Lawyers vs. Non-Lawyers: Lawyers (and law students)
should have higher $P^*$ than people with other occupations be-
because they should be more sensitive to the ill effects of
convicting innocent people; or because they are so familiar with the subject matter they are more able to "fudge" their answers. By virtue of their legal educations, many lawyers would be familiar with the teachings of Sir William Blackstone, the British jurist, who contended that it is ten times worse to convict an innocent defendant than to acquit a guilty one. This is translated into a threshold probability of .91. When asked: "What is your threshold probability?" four out of five lawyers and law students replied: .90.

When lawyers and businessmen were compared, and when lawyers and those of "other" occupations were compared, the results upheld the hypothesis and proved to be statistically significant as well.

4. Business-people with Embarrassment Cases vs. Business-people with Rape Cases: Business-people should find it easier to empathize with defendants in embarrassment cases than with defendants in rape cases. Therefore, those with embarrassment cases should have higher $P^e$ than those with rape cases.

The results of this comparison upheld the hypothesis but, statistically, the relationship was not very strong. It should be noted, though, that since all of the business-people interviewed were men, the $P^e$ in rape cases may be inflated. That is, females should have lower $P^e$ in rape cases since they may empathize more with the victims in rape cases.
5. **Females with Rape Cases vs. Females with Embarrassment Cases**: Once again, since females can most easily picture themselves as victims in rape cases than in embarrassment cases, they should have lower $P^*$ in rape cases.

The results show that females in rape cases did not have lower $P^*$ than in embarrassment cases. This result seems unexplainable, unless the respondents, again, ignored the instructions on the questionnaire.

6. **Females with Rape Cases vs. Males with Rape Cases**: Females should have lower $P^*$ than males in rape cases, since females tend to be the most common victims of rape.

The results did not uphold the hypothesis. This could be a consequence of the fact that the overall average $P^*$ for women was higher than the overall average $P^*$ for men.

7. **Lawyers in Rape Cases vs. Lawyers in Embarrassment Cases**: Lawyers should have identical $P^*$ in rape and embarrassment cases since they are looking at the situation from a legal viewpoint rather than a social viewpoint.

The results upheld this relation: the difference between the $P^*$ for these two groups is .0096.

8. **Business-people with Instructions in Embarrassment Cases vs. Business-people with Instructions in Rape Cases**: Business people with instructions in embarrassment cases should have higher $P^*$ than those with instructions in rape cases, since picturing themselves as defendants in embarrassment cases may cause them to heed reasonable doubt instructions more strictly. This hypothesis was upheld by the t-test result.
9. **Lawyers in Rape Cases with Instructions vs. Lawyers in Rape Cases without Instructions:** Lawyers in rape cases with instructions should have the same $P^*$ as those without instructions, since reasonable doubt instructions should be "built-in" to lawyers, via their legal educations.

The results of this relation do not uphold the hypothesis. To the contrary, they show that lawyers with instructions had higher $P^*$ than those without instructions, that is the lawyers did, indeed, heed the instructions when instructions were present.

The $P^*$ calculated in the above comparisons is a reflection of how the respondents feel about the possible errors they may make. The potentially dissatisfying choices on the questionnaire: convicting an innocent defendant and acquitting a guilty defendant, can be referred to as type one and type two errors, respectively.

Consider the situation in which a motorcycle rider finds himself. He must choose between wearing a helmet and not wearing a helmet while riding the motorcycle. His possible errors are: not wearing a helmet and having a collision, a type one error; and: wearing a helmet and not having a collision, a type two error. In this case, the cost of a type one error (a cracked skull) seems very high, yet the uncertainty of incurring this cost convinces many motorcycle riders to ride bare-headed.
<table>
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B = Business  
O = Other  
L = Lawyer  
E = Embarrassment  
Y = Yes  
N = No  
R = Rape  
M = Male  
F = Female
### Comparisons by Group

<table>
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<th>Hypothesis</th>
<th>1</th>
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<th>N₁</th>
<th>N₂</th>
<th>M₁</th>
<th>M₂</th>
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<td>.5695</td>
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</table>
Sample T-Tests

1. R vs. E

\[ M_R = .9684 \quad s^2 = .0025 \quad n = 10 \]
\[ M_E = .5707 \quad s^2 = .005 \quad n = 10 \]

\[ \frac{-.9684 - .5707}{\sqrt{.0025 + .005}} = .035 = t \]

2. I vs. N1

\[ M_I = .5969 \quad s^2 = .003 \quad n = 10 \]
\[ M_{NI} = .5833 \quad s^2 = .003 \quad n = 10 \]

\[ \frac{.5833 - .5969}{\sqrt{.003 + .003}} = .438 = L \]

3. RE vs. BR

\[ s^2 = .006 \quad n = 3 \]
\[ M_{RE} = .5633 \quad s^2 = .001 \quad n = 2 \]

\[ \frac{.5633 - .5279}{\sqrt{.006}} = .3849 = t \]

4. LRI vs. LBM

\[ M_{LRI} = .666 \quad s^2 = .013 \quad n = 2 \]
\[ M_{LBM} = .5830 \quad s^2 = 0 \quad n = 1 \]

\[ \frac{.6666 - .5830}{.026} = .9159 = t \]
QUESTIONNAIRE

This study is being conducted for a graduate seminar at the University of Illinois, entitled: Law, Policy, and Social Science. The subject of the study is the decisions of jurors regarding conviction or acquittal. The questionnaire has no identifying marks and you are guaranteed total anonymity. Thank you for your cooperation.

Below are some statements that represent some different opinions on various social questions. After each statement, please record your personal opinion regarding each statement, using the following system of marking:

1) + YOU AGREE WITH THE STATEMENT
2) 0 YOU CANNOT DECIDE OR YOU CANNOT RESPOND TO THE STATEMENT AS IT IS WRITTEN
3) - YOU DISAGREE WITH THE STATEMENT

Present laws favor the rich over the poor.

War is inherent in human nature.

People should be allowed to vote only after they have taken a test to establish their intelligence and education.

Divorce laws should be altered to make divorce easier.

Unrestricted freedom of discussion on every topic is desirable in the press, in literature, and on the stage.

Women are not the equals of men in intelligence and organizing ability.

Our treatment of criminals is too harsh; we should try to cure, not to punish them.

Differences in pay between men and women doing the same work should be abolished.

Birth control, except when medically indicated, should be made illegal.

Marriages between white and black people should be greatly discouraged.
For the following questions assume you are a juror in a rape case. You should not vote to convict unless you feel the defendant is guilty beyond a reasonable doubt.

There are four possible outcomes:

A) YOU VOTE TO CONVICT A GUILTY DEFENDANT.

B) YOU VOTE TO CONVICT AN INNOCENT DEFENDANT.

C) YOU VOTE TO ACQUIET A GUILTY DEFENDANT.

D) YOU VOTE TO ACQUIET AN INNOCENT DEFENDANT.

1. Which two of the four possibilities would give you some dissatisfaction?

2. Of those most dissatisfying occurrences, which one is the most dissatisfying? (Let's score this one -100 to have a low anchor point.)

3. Where would you score the next to most dissatisfying alternative, on a scale from 0 to -100. (Zero means neither satisfying nor dissatisfying and -100 means most dissatisfying).

4. Are you sure you want your next to the worst choice to be as close or as far away from your worst choice or that far away from the neutral position as you initially put it? If not, please revise that evaluation accordingly.

5. Which two of the original four possibilities would give you some satisfaction if they were to occur?

6. Of those two satisfying occurrences, which one is the most satisfying? (Let's score this one +100 for an upper limit.

7. If the most satisfying alternative is score +100 on a 0 to +100 scale, where would you score the next to the most satisfying alternative? (Zero means neutral and +100 means most satisfying.)

8. Are you sure you want your next to the best choice to be that close or that far away from the neutral position? If not please revise your answer accordingly.
Please state your occupation. (If you are a student please state your major or field of study.)

Please circle your sex.

What is your threshold probability? (That is: the probability of guilt above which you will vote to convict and below which you will vote to acquit.)
CHAPTER FOUR

OPTIMUM MIX ANALYSIS

Almost every consumer, at one time or another, faces a decision of how to spend his available resources (usually dollars). That is, he must decide what mix of commodities he should buy to maximize his net benefits. In addition, producers face similar decisions when determining the mix of alternative goods to sell.

In optimum mix analysis, as compared to optimum choice analysis, one assumes that the decision maker can choose both of his alternatives, albeit in differing amounts.

Consider the situation of the production manager of a firm which produces two products: carved wood chairs and carved wood tables. The following data should be assumed: the firm has 16 hours of production time and 24 board/feet of wood available each week.

Each chair takes nine hours of production time and requires three board/feet of wood, while each table requires six hours and six board/feet.

For various reasons, managerial accountants recommend that such decisions be based upon maximizing the total "contribution margin." The contribution margin is the gap between sales price and variable cost. In other words, fixed
costs—those which do not fluctuate with changes in production level—are not taken into account in the decision process.

We shall further assume that the contribution margin per table is $8.00 and per chair: $10.00. Due to economic conditions, the market will only accept three chairs per week.

Since the objective is to maximize the total contribution margin (F), the so-called objective function in this linear programming analysis is:

\[ F = 8(T) + 10(C), \text{ where} \]

\( T = \text{table and} \ C = \text{chair.} \)

The constraints under which the firm must operate should now be expressed in algebraic terms. Since one table requires six hours and one chair requires nine hours of production time, the resultant constraint equation, involving the 36 hour production capacity, is:

\[ 6(T) + 9(C) \leq 36. \]

Furthermore, since one table requires six board/feet and one chair requires three board/feet of wood, the constraint equation, involving the total of 24 board/feet of wood available, is:

\[ 6(T) + 3(C) \leq 24 \]}
The third constraint, dealing with the market acceptance of chairs, results in the equation:

\[ C \leq 3 \]

Figure 4-1 shows the graphing of the aforementioned equations.

The next step is to find the optimum mix of tables and chairs, within the feasible (shaded) region of the graph, and according to the objective function:

\[ F = 8(T) + 10(C) \]

By calculating the total contribution margin \( F \) for points within the feasible region, it can be determined that a maximum total contribution margin of $44.00 can be earned by a mix of three tables and two chairs per week. Consequently, this is the optimum mix of tables and chairs for this firm.

The next example involves using the same type of analysis to determine an optimum mix among alternative legal policies, namely: how the Office of Economic Opportunity Legal Services Program should allocate its resources between routine case handling and law reform activities.

I. The Data

The variables of interest come from a study by the Kettelle management consulting firm. The variables are:

1. the total number of project participants \( (P) \)
Table and Chair Production

Graph 4.1
2. the total cost of the project, in dollars (TTC);
3. the project's overall satisfaction rating (S), on a scale from one to twelve, with one meaning the project has critical deficiencies and twelve meaning the project operates efficiently;
4. the average percentage of attorney time spent on law reform activities (%L); and
5. the average percentage of attorney time spent on routine case handling activities (1-%L or %C).

For this study, three of the five variables must be transformed to be stated in terms of dollars per participant. Thus, the variable TTC becomes TC, %L becomes $L and %C becomes $C.

Before determining the equations needed for the analysis, it is necessary to test for any deviant cases which would render the statistical results invalid, or at least slightly incorrect. By obtaining statistics on each of the variables, one can determine if any of the cases' averages are too many standard deviations away from the grand mean. If so, the deviant case should be removed from the sample.

To determine the equations that are necessary to find an optimum mix, one must enter the variables into two regression relations (with the assistance of a computer).
II. The First Regression

The first regression has, as its independent variables: $L$ and $C$, and as its dependent variable: $TC$. Using unstandardized coefficients, the equation is:

$$TC = 0 + L + C.$$  

When one wishes to compare $L$ and $C$, standardization of the coefficients becomes necessary. The resultant equation is:

$$TC = 0 + .30(L) + .74(C).$$

The coefficient of determination ($R^2$) is 1.00, which means that all of the variation in total cost ($TC$) is due to variations in $L$ and $C$. This is consistent with the tautological equivalence of $TC$ with $L$ and $C$. The average $TC$ for each case is $47.49.$

III. The Second Regression

The second regression has as its independent variables: $L$ and $C$ (once again), and as its dependent variable: the satisfaction score ($S$). The resultant equation, using unstandardised coefficients, is:

$$S = 7.16 + .42(L) - .06(C).$$

The interpretation of this equation is that a $1.00$ increased in $L$ will raise the satisfaction score by .42 and, a $1.00$
increase in $C$ will decrease the satisfaction score by .06. The coefficient of determination is .44 which shows that 44% of the variation in satisfaction is due to variations in law reform dollars and case handling dollars. The minimum allowable satisfaction level is 7.0 and the average satisfaction level is 8.2.

To determine an optimum mix, one must, once again, consider both the objective functions and the environmental constraints.

The objective functions are:
1. to minimize total costs, and
2. to maximize satisfaction.

The constraints are:
1. the minimum that must be spent on law reform is 10% of total cost or $4.74 (MIN $L$)
2. the maximum that can be spent on law reform is 40% of total cost or $18.96 (MAX $L$)
3. the minimum that must be spent on routine case handling is 60% of total cost or $28.50 (MIN $C$)
4. the maximum that can be spent on routine case handling is 90% of total cost or $42.75 (MAX $C$)
5. the minimum allowable satisfaction score is 7.00 (MIN $S$)
6. the maximum satisfaction score is 12.00 (MAX $S$)
7. the minimum total cost is 70% of the total budget or $33.25 (MIN TC)
8. the maximum total cost is 100% of the budget or $47.49 (MAX TC).

The graphing of the constraints and the objective functions can be located on graph 4-2.

The point labelled "A" on graph 4-2 is where total cost is minimized within the constraints.

The point labelled "B" on graph 4-2 is where satisfaction is maximized within the environmental constraints.

The equations in the linear results are not necessarily the statistically best fitting equations for this data. To determine if a non-linear graph is more accurate, non-linear regressions should be calculated and then the coefficients of determination should be compared with those obtained in the linear analysis.

For this part of the analysis, the four variables used in the linear regressions are transformed into logarithms, so when the computer emits what it "thinks" are linear regression results, the coefficients can be used in the formula:

\[ Y = a \cdot X_1^{b_1} \cdot X_2^{b_2} \quad \text{instead of:} \]

\[ Y = a + b_1X_1 + b_2X_2. \]

The resultant equations are:

(1) \[ S = 13 \cdot (\$L)^{.52} \cdot (\$C)^{- .405} \quad \text{and} \]

(2) \[ TC = 1.65 \cdot (\$L)^{.12} \cdot (\$C)^{.84} \quad \text{although} \]

it is still tautologically correct that:
TC = $L + $C.

The $R^2$ for the first, non-linear regression is .78 which is larger than the .44 found in the linear regression using the same variables. Thus, the non-linear curve is the better fitting curve.

The $R^2$ for the second, non-linear regression is .99 which is lower than the 1.00 found in the linear regression using the same variables. Therefore, the best fitting pair of equations is:

$$TC = $L + $C \quad R^2 = 1.00$$

and

$$S = 13 \cdot ($L)^{.52} \cdot ($C)^{-0.405} \quad R^2 = .78.$$  

The graphing of these equations and the aforementioned constraints is found on graph 4-3.

The point labelled "A" on graph 403 is the mix of $L$ and $C$ which brings about the minimum total cost, while the point labelled "B" is the mix which brings about the maximum satisfaction score.
NON-LINEAR VERSION
FOOTNOTES

Chapter 5  OPTIMUM LEVEL ANALYSIS

I) Optimum Level Analysis

Finding an optimum policy level involves determining how stringent or lenient a policy should be, when doing too little or too much is undesirable.

This particular analysis is concerned with finding an optimum level of defendants to hold in jail prior to trial. Obviously, it would be quite unacceptable to hold all defendants prior to trial since many of them would be truly innocent and the Constitution provides that defendants must be considered innocent until they are proved guilty. Alternatively, by releasing all defendants prior to trial, the criminal justice system would be responsible for releasing some truly dangerous and violent people into society.

II) The Data

The data consists of questionnaire responses from legal experts of twenty-three different cities. The questionnaire data was then used to compile a set of variables for each city. The variables are:

1) Jail Costs (JC). Dollar costs per jailed defendant per day.
2) Jail Time (JT). The average length of time defendants remained in jail prior to trial.
3) Number of Defendants (D). The number of defendants who faced a judge to determine whether they should be released or
held in jail prior to trial.

4) Percent of Defendants Held (%H). The percentage of defendants who were held in jail prior to trial.

5) Percent Failed to Appear (%F). The percentage of defendants who were released and subsequently failed to appear at trial.

6) Percent Crime Committing (%C). The percentage of defendants who were arrested for another crime while released.

7) Percent Held Guilty (%G).

8) Population of the City (P).

From these variables, various costs are derived:

Total jail costs = (%H) x (JT) x (JC) x (30)

Total lost national income = (%H) x (JT) x (360), assuming an average monthly wage of $360.

Total bitterness cost = (%H) x (JT) x (1 - %G) x (300), figured at $300 per month of incarceration for each defendant subsequently found innocent.

Total rearrest cost = (1 - %H) x (%F) x (200), assuming a rearrest cost of $200 for each defendant who fails to appear in court.

Total recidivism cost = (1 - %H) x (%C) x (1,000) figured at an average cost of $1,000 for each defendant who was arrested for another crime while released and awaiting trial.

Now, these costs are combined to arrive a meaningful costs which can be used to determine an optimum level of defendants to
hold prior to trial. These costs are determined as follows:

1) Total Holding Cost (THC) = Total Jail Costs + Total Lost National Income + Total Bitterness Cost.

2) Total Releasing Cost (TRC) = Total Recidivism Cost + Total Rearrest Cost.

3) Total Cost = Total Releasing Cost + Total Holding Cost.

The next step is to find linear relations between:

a) \%H and THC, and

b) \%H and TRC.

III. The First Regression

The regression results emitted by the computer shows the first relation to be:

\[ THC = 55.02 + 1171 \ (\%H) \]

This means that a one unit increase in \%H will bring about an increased in THC of 1171 units.

The coefficient of correlation \( R^2 \) is \(.13\). This shows that 13% of the variations in THC is due to fluctuations in percent held.

IV. The Second Regression

The next regression shows the relation between TRC and \%H to be:

\[ TRC = 167.94 - 156.49 \ (\%H) \]

This means that TRC and \%H have a negative relation, but, the \( R^2 \) is \(.08\) which means that only 8% of the variation in Total Releasing Cost is due to fluctuations in percent held.
V. **Non-Linear Regressions**

The linear relations may not yield the best fitting curves for this data. Therefore it is necessary to calculate non-linear regressions. This is done by feeding the computer the logarithms of the variables, and thus fooling the computer into generating non-linear coefficients when it "believes" it is calculating linear coefficients. The results are then plugged into an equation of the form:

\[ y = ax^b \]

instead of the linear equation form:

\[ y = a + b(x) \].

The resultant equations are:

\[ THC = 1161 \times (\%H)^{1.299} \quad ; \quad R^2 = .41, \text{ and} \]

\[ TRC = 79.5 \times (\%H)^{-1.15} \quad ; \quad R^2 = .02. \]

The $R^2$ values show a fairly strong relationship between THC and $\%H$, and a very weak statistical relationship between TRC and $\%H$.

Total Cost (TC) is computed by simply summing these two equations:

\[ TC = (1161 \times (\%H)^{1.299} + 79.5 \times (\%H)^{-1.15}). \]

The graphing of the three non-linear equations can be found on Figure 5-1.
Figure 5-1 shows that the optimum level of defendants to hold prior to trial is 3%. The average actual percentage of defendants that is held in the cities in this study is 27%. The discrepancy between the optimum percent to hold and the average actual scores is due to the discrepancy between the costs that were used in this analysis and the costs that judges' consider in making hold versus release decisions. In this study, societal costs were those used to determine the effects of different levels of defendant holding. On the other hand, the costs which judges try to avoid are the personal embarrassment costs he incurs when a released defendant fails to appear at trial.

VI. **Causal Analysis**

To analyse the causal relations among THC, TRC, TC, and $N$, it is necessary to compute the "Pearson's R" statistics, and use them in causal models. The causal models can be found on Figure 5-2. These causal models can then be compared to the observed or empirical correlations among the variables. These empirical relations are located on Figure 5-3.

VII. **City Size**

It is now necessary to determine if city size is distorting the overall picture of optimum pretrial release. If, in large cities, the relations between the variables are substantially
different than the relations found in smaller cities, then separate optimum levels must be computed for each.

The non-linear regressions for cities of above average populations results in the following equations:

\[ THC = 2630 \, \%H^{1.19}, \text{ and} \]
\[ TRC = 109 \, \%H^{-0.20}. \]

The optimum percent to hold can be determined by the equation:

\[ \%H^* = \frac{1}{(b_2 - b_1)} \left( -\frac{a_1 b_1}{a_2 b_2} \right) \]

So, in this relation, the optimum percent to hold is:

\[ \left( -(2630)(1.19)/(109)(-.20) \right)^{1/(-.2 - 1.19)} = 3\% \]

Using the same procedure for smaller than average cities, we have:

\[ THC = 617 \, \%H^{1.12} \]
\[ TRC = 62 \, \%H^{-0.21} \]
\[ \%H^* = \left( -\frac{(617)(1.12)}{(62)(-.21)} \right)^{1/(-.21 - 1.12)} = 5\% \]

Thus, it has been shown that the optimum percent to hold is insensitive to city size. It appears that larger cities have higher holding costs and higher releasing costs. Therefore there is little change in the optimum percent to hold in different cities.
VIII. Another Example

The nature of this type of study allows application to many diverse fields. In essence, this study helps to understand how lenient or severe a policy should be in order to bring about optimal results.

When faced with such a problem, one can view the situation in light of the way in which the costs are related. It is often helpful to think in terms of a graph similar to the one found in Figure 5-1. Such a generalized graph can be found on Figure 5-4.

For example, consider a law concerning how strict a physician should be in notifying the health department of a possible plague victim.

There are at least four symptoms that victims of plague may exhibit:

1) enlarged lymph nodes
2) darkened blood
3) subcutaneous bleeding
4) dusky appearance.

If doctors are required to report all possible victims, no matter how remote the possibility, then we incur costs such as overburdening the clerical sector of the health department with reports of patients who have enlarged nodes due, for example, to strep throat.

Alternatively, if doctors are required to report only those
victims who exhibit all four symptoms, then we incur high
damage costs with regard to spreading contagious, deadly plague.
These two types of errors are often referred to as "Type I"
and "Type II" errors, respectively. The error costs in this
plague example can be visualized in Figure 5-4.
Footnotes

1) The data was provided to this author by Professor Stuart S. Nagel of the Political Science Department at the University of Illinois.
BIBLIOGRAPHY


