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A LINEAR PROGRAMMING APPROACH TO
PROBLEMS OF CONFLICTING LEGAL VALUES
LIKE FREE PRESS VERSUS FAIR TRIAL

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I. THE PROBLEM AND THE DATA

There is a substantial literature which discusses the need for a balance between protecting freedom of the press and providing a fair trial in criminal cases involving pretrial publicity.[1] If newspapers read by potential jurors publish pretrial information concerning inadmissible or unreliable, evidence, they may thereby establish an atmosphere which may cause an innocent defendant to be convicted or a guilty one to have his case dismissed or biased in his favor depending on the nature of the distortions in the pretrial publicity. If such newspapers, however, are overly restricted from reporting pending trials, this may adversely affect the stimulating of individuals into (1) coming forward with relevant evidence, (2) taking defensive action to avoid becoming victims, (3) intelligently judging the performance of their law enforcement officials, and (4) making policy suggestions for coping with similar crimes.

Although previous writers on the subject have generally argued in favor of the need to provide some (but not unlimited) media reporting of pending trials, they have not discussed the possibility of obtaining insights into a desirable balance through the gathering of empirical data on the relation between (1) the degree of free press present in various communities and (2) the degree of satisfaction expressed by various interested types of persons within those communities. It is the specific purpose of this article to provide some data of that kind in

the context of what is known as a linear programming approach. A secondary, but broader (and possibly more important), purpose of this article than throwing light on the free press, fair trial dilemma is to illustrate a way in which linear programming can be applied to non-monetary policy problems in general especially where one must choose between two diametrically conflicting policies.

Linear programming can be defined as a geometric or algebraic procedure whereby one finds the optimum allocation of something between two or more alternatives in light of certain goals and in light of given constraints or conditions.[2] It is an approach which has been developed mainly by people in business administration, industrial engineering, economics, and mathematics as a means of determining the optimum allocation of scarce resources between alternative activities in order to maximize the difference between benefits and costs. By analogy, however, the methodology can be applied to problems in which neither the benefits nor the costs are basically economic in nature, such as the free press, fair trial problem.

In 1970, a national survey was made of newspaper editors, police chiefs, prosecuting attorneys, and defense attorneys from a sample of 166 cities across the country.[3] Of the approximately 600 questionnaire recipients, 54 percent of the newspaper editors responded, 65 percent of the police chiefs, 50 percent of the prosecuting attorneys, and 48 percent of the defense attorneys. The key questions which the questionnaire recipients were asked relevant to this study are shown in Figure 1.

FIGURE 1. RELEVANT QUESTIONS FROM THE FREE PRESS, FAIR TRIAL SURVEY

I. Degree of Pretrial Press Publicity in Your City

To the best of your knowledge, what kinds of information do the police, prosecuting attorneys, and defense attorneys make available to the press for possible publication? For each of these three sources of information, please mark on the lines indicated a "0" if the information is never available to the press; mark a "1" if it is seldom available; "2" if it is usually available; and "3" if it is always available.

	Police	Prosecution	Defense
a. Name of accused and charge	____	____	____
b. Details of arrest	____	____	____
c. Evidence seized at arrest	____	____	____
d. Identity of prospective witnesses or their testimony	____	____	____
e. Existence or contents of any statement by accused or information of a refusal to make a statement	____	____	____
f. Performance or refusal to perform tests or examinations (polygraph, ballistics, etc.)	____	____	____
g. Prior criminal record of accused	____	____	____
h. Possibility of plea of guilty to offense or to a lesser charge	____	____	____
i. Opinion on guilt or innocence of the accused or on merits of the case	____	____	____

II. Your Attitudes

Please respond to the following statements by marking "++" if you agree strongly; marking "+ if you tend to agree; "0" if you have no opinion; "-" if you disagree; and "--" if you disagree strongly.

p. The public needs to know the details of criminal proceedings. ____

g. The traditional legal remedies of change of venue, voir dire, sequestering, continuance, etc. are adequate to neutralize any effects of possibly prejudicial news coverage. ____

r. The American Bar Association's restrictions on information lawyers can release represents an infringement upon the people's right to know. ____

s. If it were to be conclusively proven that prejudicial publicity does bias some jury verdicts, we would have to legally restrain the press (if all voluntary methods had proved to be inadequate) rather than allow a few defendants to either face biased juries or be released without trial. ____

On the free press, fair trial controversy, the four groups of editors, police chiefs, prosecutors, and defense attorneys are the most knowledgeable groups available and they also have the clearest values concerning the controversy along with judges, bar association officials, and criminal defendants.[4] A sample of the general public would be quite expensive to poll and would probably reveal a high percentage of don't knows. The four groups used are also representative of the diverse ideological positions which the readers of this study and the general public are likely to hold. The readers can thus pick the occupational group with which they most nearly identify in order to determine what allocation they would make to free press and fair trial. As will be shown later, however, two or more groups may arrive at the same allocation given the legal constraints under which they must operate although the two groups may not receive the same satisfaction from the same allocation.

II. SCORING THE CITIES AND RESPONDENTS

A. ON THE OCCURRENCE OF FREE PRESS AND FAIR TRIAL

In order to give each city a free press score, the following steps were followed to establish a scale as a basis for the scoring system:

1. For each item (a through i) in part I of the questionnaire, consider a 0 or 1 response to be the same as "no, information not released." Consider a 2 or 3 response to be the same as "yes, information released."[5]
2. For each respondent on each item, if the respondent says "yes, information released" to any of the three sources of information (police, prosecution, or defense), then consider that item of information to be released by the press in the respondent's city. If the respondent says "no, information not released" to all three sources, then consider that information to be withheld by the press in the respondent's city.[6]
3. Consider each respondent to come from a separate city in view of the difficulty and lack of need of determining to what extent two or more respondents came from the same city.[7]
4. For all the respondents or cities taken together on each item, determine what percent of the cities released the information involved and what percent withheld the information.

Performing those simple calculations reveals that some items were much more frequently released to the press than others. If we arrange the items from those most frequently released down to those least frequently released, we obtain the following scale:

1. Name and charge--Only 2 percent of the cities failed to release this information. This in effect means that 98 percent of the respondents reported their cities did release this information.
2. Details of arrest--13 percent withheld this information.
3. Evidence seized at arrest--36 percent withheld.
4. Criminal record--50 percent withheld.
5. Statements by accused--64 percent withheld.
6. Witness testimony--65 percent withheld.
7. Test results--65 percent withheld.
8. Opinions on case--74 percent.
9. Guilty plea bargaining--77 percent.

This information was used to establish a free press scoring system ranging theoretically from 0 to 100 on which each city could be positioned.[8] To position a city, one determines what its release score was for each item and then observes what was the highest item on the above scale which was generally released in the city. For example, if the highest item released in a given city were statements by the accused, then that city would receive a free press score of 64. If, however, that city did not release criminal records even though releasing criminal records is lower on the above 1 to 9 scale, then that city would receive a free press score of only 36 because releasing evidence seized would be the highest item released by the city before its release pattern became inconsistent with the above scale. Thus, the free press score of a city represents the percentage withheld in the above scale of the highest item which the city releases before inconsistencies occur in its release pattern.[9] This approach minimizes inconsistencies in the positioning of cities without having to change the order of or eliminate items in the above scale.[10]

The above scale can also be used to establish a scoring system for positioning each city with regard to the fairness of its criminal trials on the issue of pretrial prejudicial press publicity. To do so, one simply determines the free press score of a city using the above free press scoring method. One then obtains the complement of that score to obtain the city's fair trial score. For example, if the above mentioned hypothetical city received a free press score of 36, then it would logically receive a fair trial score of 64.

B. ON SATISFACTION WITH FREE PRESS AND FAIR TRIAL

We have now determined the position of each city as perceived by each respondent on an empirical measure of freedom

of the press and fairness of trials vis-a-vis prejudicial pretrial publicity. Next we need to determine the degree of satisfaction expressed by each respondent with the situation in his city on those two variables. To do this, we need to determine for each respondent what his normative values are on these variables, and then try to measure the difference between what he wants for his city and what he is getting as a rough measure of his satisfaction.

The four items (p through s) in part II of the questionnaire can be used to determine each respondent's values on the free press-fair trial controversy. In order to give each respondent an attitude score, the following steps were followed:

1. For each item (p through s), convert a ++ or a + response to a 1 if the item is worded favorably toward free press, and convert a -- or a - response to a 0 if the item is worded unfavorably toward free press.[11] If a neutral response or a non-response is given, convert that to a score of ½.

2. For each respondent, sum his 1's, ½'s, and 0's, and then divide by 4 since there are four items. This will give each respondent a pro-free-press score from 0 to 100. One obtains a score of 0 if he expresses an unfavorable attitude toward free press on all four items, and he obtains a score of 100 if he consistently expresses a favorable

attitude toward free press.[12] These 0 to 100 scores can be roughly interpreted as indicating the percentage of free press the respondent would like to see in his community.

Since both the attitude or normative score and the occurrence or empirical score for each respondent are measured on 0 to 100 scales like percentages, the attitude score can be compared with the occurrence score to give a rough measure of the dissatisfaction gap between each respondent's normative and empirical status. For example, a respondent who wants 90 percent free press but is getting only 60 percent has a 30 percentage points dissatisfaction gap. Likewise a respondent who wants 50 percent free press but is getting 70 percent has a 20 percentage points dissatisfaction gap. So that we can talk about satisfaction rather than dissatisfaction, the dissatisfaction gap for each respondent can be subtracted from 100 (which is the maximum dissatisfaction possible) to give a satisfaction score. Thus, our first hypothetical respondent would in that sense be 70 percent satisfied, and our second respondent would be 80 percent satisfied.

The above measurement of the satisfaction variable would be more meaningful if part II of the portion of the questionnaire reproduced in Figure 1 had asked, "For each item (a through i) indicate whether you think the item should be released to the press." This would make the normative and empirical scoring systems more comparable. When the original

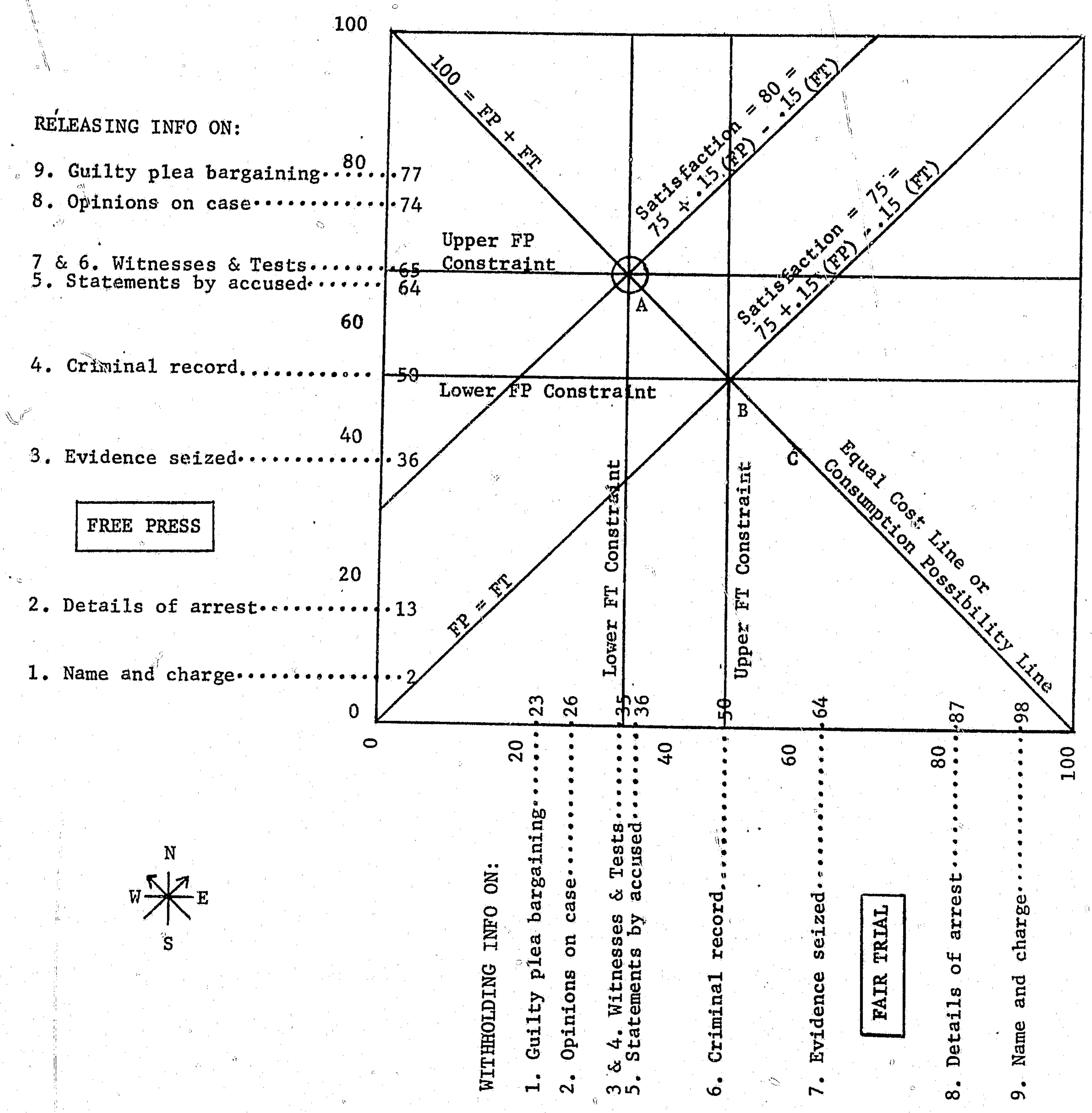
questionnaire was being prepared, however, it was not anticipated that the results would be used in a linear programming model designed to determine a free press, fair trial allocation in order to maximize satisfaction which could be measured by normative standards versus empirical actuality.[13] Nevertheless, using different normative and empirical scoring systems with a similar zero to 100 interpretation still probably produces about the same rank order on satisfaction among the respondents as using the same normative and empirical scoring systems would.[14] Only the absolute rather than the relative measure of satisfaction is affected, and the free press scale is not affected at all. For sure, the presentation of the linear programming methodology which follows is not affected, especially with regard to its ability to present the optimizing of free press, fair trial allocations as a graphical benefit-cost problem.

III. THE PROBLEM GRAPHED

A. THE AXES AND THE CONSUMPTION POSSIBLITY LINE

Figure 2 is a two-dimensional graph which describes the free press, fair trial problem. The vertical dimension shows the free press scale which we previously discussed. The horizontal dimension shows the fair trial scale which is just the complement or reverse side of the free press scale. Both scales are expressed in terms of percentage-like numbers as well as in descriptive words which refer to the informational

FIGURE 2. ALLOCATING CIVIL LIBERTIES UNITS TO FREE PRESS AND FAIR TRIAL SO AS TO MAXIMIZE SATISFACTION



Point A is where free press is maximized and fair trial is minimized within the constraints. At that point, FP = 65, FT = 35, and S = 80

Point B is where fair trial is maximized and free press is minimized within the constraints. At that point, FP = 50, FT = 50, and S = 75

Point C is where free press and fair trial are in the average city in the survey. At that point, FP = 38, FT = 62, and S = 71

items which might be released prior to a defendant's criminal trial. As one moves upward on the free press scale, one obtains more freedom of the press. As one moves outward or rightward on the fair trial scale from items 1 to 9, one obtains more fairness in trial procedure vis-a-vis prejudicial pretrial publicity.

The diagonal line running from the northwest corner of the graph to the southeast corner is referred to as an equal cost line. This is so because all points on that line involve an equal expenditure of 100 percent of the scarce civil liberties units available. Thus, a point toward the northwest may involve 80 percent free press and 20 percent fair trial ; a point toward the middle may involve 60 percent free press and 40 percent fair trial ; and a point toward the southeast on the diagonal line may involve only 30 percent free press but 70 percent fair trial. The civil liberties units to be allocated between free press and fair trial are scarce in the sense that we cannot have both 100 percent free press and 100 percent fair trial .

The equal cost line might also be referred to as a consumption possibility line. This is so because we cannot consume more than 100 percent of the civil liberties units available, and because we would not want to consume less than 100 percent of the civil liberties units available. This line is thus both a maximum and a minimum total cost line. Therefore, the optimum allocation of civil liberties units to free press and fair trial must lie somewhere along this left diagonal line.

B. THE LEGAL CONSTRAINTS

Certain points on the consumption possibility line, however, are off limits in light of the constraints imposed on the problem by the courts, bar associations, and legislatures which may have sought to place boundaries around the legally feasible allocation. One can determine that free press greater than the 65 percent level is likely to be viewed as illegal in view of the degree of the corresponding lessening of fairness in criminal procedure at that level. This 65 percent upper FP constraint means that most courts would consider a trial to be tainted such that someone might be held in contempt or reprimanded, a change of venue might be ordered, or a new trial might be granted if the press released before trial (1) information on a possible plea of guilty to the offense or to a lesser charge, or (2) editorial opinions on the guilt or innocence of the accused or on the merits of the case.

The upper legal constraint on free press was determined by the authors from an analysis of (1) relevant court cases,[15] (2) the results of a questionnaire survey directed to newspaper editors in 1968 concerning their practices and court practices in free press, fair trial situations,[16] and (3) an analysis of bar association statements and periodical articles.[17] None of the items in the questionnaire of Figure 1 were used, could be used, or should be used to determine the legal constraints of Figure 2. This is so since the questionnaire items

do not ask what is the law in the respondent's community, but instead ask (a through i) what are the practices of police, prosecutors, and defense attorneys and (p through s) what should be the law. However, once the legal constraints are determined largely by traditional legal analysis, the answers to the questions of Figure 1 can be used to indicate within the range of those constraints what those occupational groups in effect consider to be the optimum allocation of free press and fair trial in light of their normative values.

Likewise, from a similar legal analysis the lower constraint on free press was determined. The legal analysis indicated that restricting free press below the 50 percent level would be likely to be viewed as illegal in view of the undue infringements upon the first amendment which such a level represents. This means that most courts would consider unconstitutional any legislation or lower court orders designed to prohibit the release of (1) the name of the accused and the charge, (2) details of the arrest, and (3) evidence seized at the arrest. The optimum allocation of civil liberties units to free press and fair trials therefore must not exceed the upper or lower free speech constraints in Figure 2 or the complementary upper or lower fair trial constraints. In other words, the optimum point must lie somewhere on the diagonal equal cost or consumption possibility line at or between points A and B. But where?

IV. SOME SOLUTIONS TO THE PROBLEM

A. FOR ALL RESPONDING GROUPS COMBINED

The optimum point on the diagonal within the constraints should be at the point where we maximize the collective satisfaction of our total respondents or of some subgroup from among the respondents. We previously described how we measured the satisfaction of an individual respondent. What we would like to do now is determine an equation which will represent the relation between the (1) free press scores and the fair trial scores of the respondents' cities and (2) the satisfaction scores of the respondents.

We can derive such an equation by feeding into a computer or an appropriate formula the free press, fair trial, and the satisfaction scores for each city along with a regression analysis program.[18] Doing so with this data yields an equation which says:

$$\text{Satisfaction} = 75 + .15 \times (\text{Free Press Score}) - .15 \times (\text{Fair Trial Score})$$

Expressed in words, the predicted satisfaction of a respondent equals 75 plus .15 times the free press score of his city minus .15 times the fair trial score of his city.[19]

The +.15 indicates the ratio between a change in satisfaction and a change in free speech occurrence. It means that when free speech goes up 100 percent, satisfaction goes up 15 percent. Likewise, the -.15 indicates the ratio between a

change in satisfaction and a change in fair trial occurrence. It means that when fair trial goes up 100 percent, satisfaction goes down 15 percent. The 75 indicates the amount of satisfaction obtained if the percent or score of free speech occurrence equals the percent or score of fair trial occurrence.[20] One can also think of the regression equation as being the formula for calculating a net benefit. In that sense the 75 is a fixed benefit (analogous to a fixed cost) that exists even if FP and FT are both 0. The .15 FP is thus like variable income, and the .15 FT is like a variable cost.

With this key equation we can now determine the satisfaction level at any point on our consumption possibility line. For example, at point B the free press score is 50, and the fair trial score is also 50. Thus, by plugging those two scores into the above equation, we find that at point B, our combined group of respondents will achieve approximately 75 units of satisfaction. Likewise, at point A, the free press score is 65, and the fair trial score is 35. By plugging those two scores into the equation, we find that our combined group of respondents will achieve approximately 80 units of satisfaction.

The right diagonal lines in Figure 2 going from the southwest to the northeast are referred to as equal benefit lines, equal satisfaction lines, or indifference lines. They are so named because all allocation points on any one of those lines will produce an equal amount of satisfaction, and one will thus feel indifferent between any two points on the same line if the constraints are temporarily ignored. For example, any point on the equal satisfaction line going through point B will produce 75 units of satisfaction since any point on that line involves equal amounts of free press and fair trial which thereby cancel each other out and cause the satisfaction level to be equal to the constant 75 in the above equation. Likewise, any point on the equal satisfaction line going through point A will produce 80 units of satisfaction since any point on that line involves a combination of free press and fair hearing scores which when multiplied by +.15 and -.15 respectively and then added to the constant of 75 will yield a satisfaction score of 80. A similar interpretation can be given to a satisfaction line at the 90 unit level to the northwest above point A and to a satisfaction line at the 60 unit level to the southeast below point B.

Thus, as one changes allocations from southwest to northeast on any given satisfaction line, one is still obtaining equal amounts of satisfaction. As mentioned before, however, one cannot meaningfully make an allocation that is northeast above the consumption possibility line because that would involve allocating more than 100 percent of the civil liberties units available. Likewise, one would not want to make an allocation that is southwest below the consumption possibility line because that would involve allocating less than 100 percent of the civil liberties units available. Note, though, that as one

changes allocations from the southeast to the northwest (from B to A), one obtains increasing amounts of satisfaction. As mentioned before, however, one cannot make an allocation (with confidence of legal impunity) that is southeast below point B or northwest above point A given the legal constraints which the courts generally seem to have tried to impose.

Therefore, point A represents the optimum allocation of civil liberties units to free press and fair trial in order to maximize the satisfaction of our total set of respondents. At point A, 65 percent of the civil liberties units are allocated to free press and 35 percent to fair trial. This means that the press should be allowed to release information on name and charge, details of the arrest, evidence seized at arrest, criminal record, statements by accused, witness testimony, test results, and equally (or less) mild bits of information; but the press should withhold more prejudicial bits of information such as editorial opinions on the case or guilty plea bargaining.

It is relevant to note that in the average city in the sample, the respondent reported an empirical allocation of 38 percent to free speech and 62 percent to fair trial. This empirical mix is shown as point C on the consumption possibility line. It produces 71 satisfaction units given the equation for translating a free press, fair trial allocation into a satisfaction score. One also obtains an average satisfaction score of 71 if one sums the individual satisfaction scores of the respondents and divides by the number of respondents rather than use the equation which translates free press, fair trial allocations to satisfaction units. Obtaining the same S score of 71 by both methods serves as a check on the accuracy of the regression equation.

The empirical average of 71 is below the 80 satisfaction units obtainable from the optimum feasible allocation at point A. The empirical allocation of point C may be lower than the optimum allocation of point A because editors, police, prosecutors, and defense attorneys withhold more pretrial information from the newspapers and the public than they legally need to. They may over-withhold due to a misperception of the legal restrictions, and due to the fact that legal sanctions are more likely to be imposed for releasing too much information rather than too little.

B. FOR EACH GROUP SEPARATELY

The optimum allocation might be different if we derived our satisfaction equation by just using the data from one of the four groups of respondents (newspaper editors, police chiefs, prosecuting attorneys, and defense attorneys) rather than all four together. Doing so yields a satisfaction equation for newspaper editors of S = 63 + .42 (FP) - .42 (FT); for police chiefs, S = 80 + .26 (FP) - .26 (FT); for prosecutors, S = 79 + .16 (FP) - .16 (FT); for defense attorneys, S = 76 + .08 (FP) - .08 (FT).

Each of these equations will yield a set of indifference lines sloping from the southwest to the northeast because they all involve opposite signs for free press and fair trial given the positive correlation of these two variables in producing a constant level of satisfaction.[21] The indifference lines for the newspaper editors have a much flatter slope than the lines for the other groups because the editors are willing to trade a relatively lot of fair trial for a little bit more of free press.[22] The indifference lines for the defense attorneys, on the other hand, have a much steeper slope because they are willing to trade a relatively lot of free press for a little bit more of fair trial.[23] Consistent with the relative weight each group gives to free press versus fair trial is the relative order of the constants in the four equations. This is so in view of the fact that editors obtain the lowest satisfaction (only 63 units) of the four groups when the percent of free speech occurrence equals the percent of fair trial occurrence, and the other groups obtain the relatively higher satisfaction (76 to 80 units).

It is interesting to note that point A is the optimum point for all four groups because they all give more weight to free press (a positive regression weight and correlation) in the above equations than to fair trial (a negative regression weight and coorelation). As mentioned, however, newspaper editors give even more weight to free press than defense attorneys do, with police chiefs and prosecutors in the middle.

Thus for all four groups, as one moves up from southeast to northwest in Figure 2, one obtains higher levels of satisfaction so long as free press has a positive sign and fair trial a negative sign in each satisfaction equation.[24] This probably reflects the fact that all four groups along with the Supreme Court may recognize that freedom of speech and freedom of the press do have a preferred position in the Constitution in that all the other rights (including fair trial) are not so meaningful if one cannot communicate to the general public that those rights are being violated.

If the defense attorneys had given more weight to fair trial than to free press (such that fair trial would have a positive sign and free press a negative sign in their satisfaction equation), then for defense attorneys moving down from northwest to southeast in the allocation would produce greater satisfaction rather than moving up from southeast to northwest. This would mean that for defense attorneys point B rather than point A would be the optimum allocation point.

Although all four groups here had a positive correlation between free press and satisfaction (meaning a negative correlation between fair trial and satisfaction when FP and FT are in conflict), criminal defendants probably would have had a reverse correlation if they had been surveyed.[25] This is so since they have more at stake than the others in getting a fair trial (meaning a trial with less likelihood of conviction due to prejudicial press publicity) and since the educational level of

criminal defendants usually correlates low or less high with intellectual abstractions like freedom of speech. The correlations of all four groups might have also been reversed if fair trial as used here meant right to counsel, cross-examination, and an unbiased judge, and not just right to be free of prejudicial press publicity. Likewise the positive correlations would be even stronger if free press included the right of newspapers to report on political events and carry political editorials, and not just the right to report on pending criminal trials.

At point A where free press is 65 and fair trial is 35, then (given the above four equations) newspaper editors will obtain 75 units of satisfaction, police chiefs 88 units, prosecuting attorneys 83 units, and defense attorneys 78 units. This shows that relatively speaking the newspaper editors are the least satisfied of the four groups at the optimum point since they would especially like to have a more free press in order to have a higher level of satisfaction. More free press than point A provides, however, would exceed the upper FP legal constraint shown.

If the upper legal constraint of 65 on free press could be raised so as to allow for a free press score of one additional unit to 66 along with a fair trial score of one less unit to 34, then the additional satisfaction of newspaper editors would increase by .84 units (from 75.60 to 76.44); the additional satisfaction of police chiefs, by .52 units; of prosecutors, by .32 units; and the additional satisfaction of defense attorneys would increase by only .16 units.[26] The additional satisfaction of newspaper editors from raising this upper constraint is about five times greater than the additional satisfaction of defense attorneys because additional free press is more exciting to newspaper editors than it is to defense attorneys. Both groups, however, obtain some additional satisfaction from the additional free press because, as mentioned, they both value free press more highly than fair trial.[27]

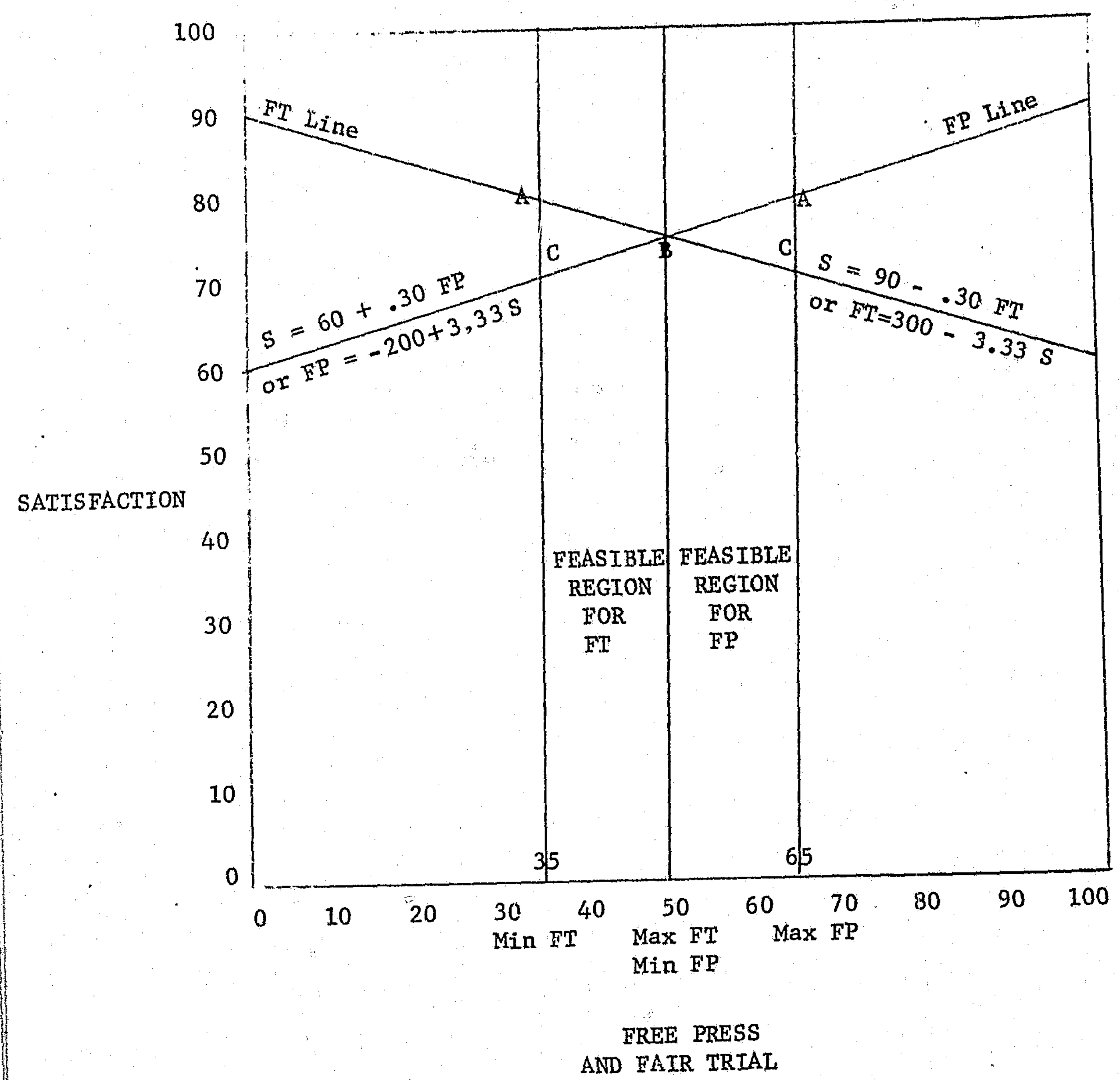
V. SOME ALTERNATIVE OR SUPPLEMENTARY PERSPECTIVES ON THE PROBLEM

A. EMPHASIZING OPTIMUM LEVEL RATHER THAN OPTIMUM MIX

Instead of plotting free press on the vertical axis against fair trial on the horizontal axis as we did in Figure 2, we could plot satisfaction (scored 0 to 100)on the vertical axis and both free press and fair trial (scored 0 to 100) on the horizontal axis as is done in Figure 3. The vertical line rising from the 35 score on the horizontal scale shows the minimum fair trial constraint; the one at the 65 score shows the maximum free press constraint; and the one at the 50 score shows the maximum fair trial and the minimum free press constraints with the same line.

We then plot $S = 75 + .15(FP) - .15(FT)$ on Figure 3. However, since we can only plot one dependent variable and one

FIGURE 3. FINDING THE OPTIMUM LEVEL OF FREE PRESS AND FAIR TRIAL SO AS TO MAXIMIZE SATISFACTION



Point A is where free press is maximized and fair trial is minimized within the constraints. At that point, FP = 65, FT = 35, and S = 80.

Point B is where fair trial is maximized and free press is minimized within the constraints. At that point, FP = 50, FT = 50, and S = 75.

Point C is where free press and fair trial are in the average city in the survey. At that point, FP = 38, FT = 62, and S = 71.

independent variable on this two dimensional graph, we express FT in terms of FP at the point where we spend all 100 of our civil liberties units. At that point FT = 100 - FP. Substituting 100 - FP for FT in our basic equation and simplifying, we get S = 75 + .15(FP) - .15(100 - FP) = 60 + .30FP. If we plot this line or relation between S and FP, we see that the more free press we have, the more satisfaction we will receive although we cannot have more than 65 free press.[28] At 65 FP, we get an S of 80.

Likewise we can plot S = 75 + .15(FP) - .15(FT) expressing FP in terms of FT instead of vice versa. Doing so and simplifying means S = 75 + .15(100 - FT) - .15(FT) = 90 - .30FT. If we plot this line or relation between S and FT, we can see that the less fair trial we have, the more satisfaction we will receive although we cannot have less than 35 fair trial. At 35 FT, we get an S of 80. Thus Figure 3 like Figure 2 says we can maximize our satisfaction within the constraints by allowing 65 percent free press and 35 percent fair trial for a maximum satisfaction of 80 satisfaction units. This means we allow witness testimony, test results, and also less damaging evidence to be released, but not editorial opinions on the case or more damaging evidence.

As an oversimplification of our problem, we could create a Figure 4 by ignoring the vertical satisfaction axis and simply say get all the free press one can up to the 65 FP maximum, and get as little fair trial as one can down to the 35 FT minimum.

We would, however, not know that free press had a higher correlation with satisfaction than fair trial does if we had no way of measuring satisfaction. In addition, if we ignore the satisfaction variable, then we cannot (1) analyze the relative satisfaction of the different groups of evaluators, (2) talk about amount of opportunity costs, (3) compare the optimum allocation with the empirical average allocation, or (4) draw upon relevant economic theory.

The Figure 3 perspective might be referred to as a calculus perspective since it involves the same basic operations one uses in applying differential calculus to find a maximum level on a curved or straight line. The linear programming (or optimum mix) perspective has the following advantages over the calculus (or optimum level) perspective:

1. The linear programming perspective emphasizes that our problem is basically one of choosing between free press and fair trial or one of finding an optimum mix between those two alternatives. This is reflected in the fact that the linear programming perspective puts those alternatives on opposite axes rather than on the same horizontal axis as in the calculus perspective.
2. The LP perspective (and especially a non-linear programming perspective with curved equal satisfaction lines) enables us to draw upon the vast body of theory which economists have developed with regard to indifference curves, consumption-possibility lines, and the maximizing of consumer satisfaction.

3. The LP perspective is especially designed to handle easily a problem with multiple constraints like the free press, fair trial problem. To handle such constraints, the calculus approach often requires the use of complicated equations involving what are called Lagrange multipliers. The LP approach is virtually the only useable approach if there are minimum and maximum constraints on the satisfaction variable and the total cost variable as well as the two activity variables.
4. The LP perspective involves much simpler arithmetic, algebra, and geometry. Geometrically speaking it enables us easily to see and understand on one graph the feasible region or feasible line segment, the benefits maximization point, the costs minimization point, and other key points. To do so using the calculus approach often requires using more graphs, more lines, and more points.
5. One can even use a form of the LP approach called requirements space to show on a two dimensional surface the optimum allocation among many activity variables simultaneously which would be extremely cumbersome if not impossible with the calculus approach.

In either approach a regression equation needs to be generated between free press and satisfaction from the raw questionnaire data after it is punched on IBM cards with at least one card per respondent and at least the two variables of free press and satisfaction

per card. Generating a regression equation is normally quite easy with a canned regression analysis program especially if one uses the simplifying formulas for obtaining multivariate regression equations when $X_1 + X_2 = 1.0$ as described in the appendix to this article.

With as simple an LP problem as depicted in Figure 2, after obtaining the regression equation, one can easily determine the optimum allocation (point A) or other allocations (like points B and C) and their corresponding satisfaction scores either visually or with simple algebra. For such a problem, one therefore need not use a canned LP program to arrive at the FP, FT, and S values of points A, B, or C. What is important is not the LP mathematics (which is referred to as the simplex algorithm), but rather the LP conceptual perspective which emphasizes (1) finding the optimum allocation between activities, (2) operating under constraints as to how much or how little of each activity one must have, and (3) having the optimum depend on the relation between the activities and some measure of satisfaction or benefits.

The calculus approach of Figure 3 does more clearly show than Figure 2 the opportunity costs we are suffering by not moving our boundary constraints out one notch in both directions (i.e., maximum free press up to 66 and minimum fair trial down to 34). This means we can somewhat more easily read off the incremental satisfaction in Figure 3 from those changes in the constraints than we can from Figure 2 although both approaches require using algebra to get the exact opportunity costs.

The main advantage of the calculus approach over the linear programming approach, however, occurs when the relation between the activities and satisfaction is substantially non-linear, especially with diminishing absolute returns rather than just diminishing marginal returns. Then the mathematics becomes substantially simpler if one thinks in terms of finding an optimum level on free press rather than an optimum mix between free press and fair trial provided one knows differential calculus. We now turn to the question of whether or not the relation between free press and satisfaction is substantially non-linear within the legal constraints.

B. A NON-LINEAR, DIMINISHING RETURNS PERSPECTIVE

As another alternative perspective, Figure 2 could be drawn with curved equal satisfaction lines that would reflect the fact that an extra unit of free speech (or free trial) gives less satisfaction when one already has much free speech (or fair trial) than when one has little free speech. Such curved lines could be based on an equation that has the non-linear form $S = a\,(FP)^{b1}\,(FT)^{b2}$ or the equivalent $\text{Log } S = \text{Log } a + b_1(\text{Log } FP) + b_2(\text{Log } FT)$ rather than the linear form $S = a + b_1(FP) + b_2(FT)$. We can obtain the values of a, b_1, and b_2 in the non-linear equation by feeding into a computer the logarithms of the free press, fair trial, and satisfaction

scores for each city along with a regression analysis program.[29] Doing so yields an equation which says $S = 79(FP)^{.17}(FT)^{-.03}$ where FP and FT are decimals ranging from 0 to 1.0.

The 79 in that equation indicates the number of units of satisfaction obtained if both FP and FT could equal 1.0. The .17 indicates the power to which FP should be raised to obtain a curved equation (of the form $Y = a(X_1)^{b_1}\,(X_2)^{b_2}$) that represents as close a fit to the data as possible. The .03 indicates the power to which the reciprocal of FT should be raised for the same purpose. The .17 also indicates that if FT is held constant and FP goes up 100 percent, then S will go up 17 percent. Likewise the -.03 indicates that if FP is held constant and FT goes up 100 percent, then S will go down 3 percent.[30]

In theory such a non-linear equation represents a better fit to the data than a linear equation when one is trying to find the optimum mix between alternative activities or policies. The range of diversity on the satisfaction variable or the activity variables in the real world, however, may not be so great as to produce much difference in the goodness of the fit between the non-linear equation and the linear one. This was the case with S, FP, and FT where the non-linear equation did not account for substantially more variation on S by FP and FT than did the linear equation at least for the combined group.[31] If $S = 79(FP)^{.17}(FT)^{-.03}$ had expressed the data substantially better than $S = 75 + .15(FP) - .15(FT)$, then figures 2 and 3 could have been drawn on the basis of the non-linear equation. The small increased predictive power of the non-linear equation, however, is not enough to offset the greater simplicity and clarity of the present linear versions of figures 2 and 3.

Even with the non-linear satisfaction lines, the optimum allocation to free press and free speech is still .65 FP (or 65 percent FP) and .35 FT since the curve of the satisfaction lines is so slight.[32] The non-linear optimum allocation produces somewhat less satisfaction than the linear one since $79 (.65)^{.17} (.35)^{-.03}$ equals an S of 74 rather than 80, but this lowered satisfaction is more accurate since the non-linear equation fits the dots slightly better.[33] Nevertheless, as mentioned above, the small increase in accuracy here probably does not sufficiently offset the substantial increase in complexity over the linear approach.

V. SOME CONCLUSIONS

Applying linear programming and indifference line analysis to the free press, fair trial issue provides a number of possible gains with regard to forcing one who makes the application (or consumes the results) to be more precise and imaginative in: (1) defining the problem, (2) deciding what data is needed to resolve the problem, (3) measuring the relevant alternative FP, FT variables, (4) graphing the problem,

(5) clarifying the legal constraints, (6) calculating the cost and benefit relations with the alternative variables, (7) deciding whose goals or values should be recognized, and (8) deriving various optimum allocations from the above considerations.

Although linear programming and indifference line analysis encourage precision, it has the further benefit that it does not require precision. Thus even if the free press measurement and the satisfaction measurement did not accurately position some respondents or cities, a substantial sample dilutes the impact of such measurement errors. In addition if the correlation between free press and satisfaction is invalidly too high or too low for the combined group of evaluators or for any separate set of evaluators, this will not affect the optimum allocation between free press and fair trial. This is so because so long as there is a positive correlation between free press and satisfaction, we should seek to have as much free press and as little fair trial as possible within the constraints. Likewise if there were a positive correlation between fair trial and satisfaction, we should seek to have as much fair trial as possible within the constraints. Thus the degree of correlation is not important for determining the optimum allocation although it does have a bearing on how much satisfaction will be achieved by that optimum allocation.

In addition to free press versus fair trial, linear programming and indifference line analysis can be applied to other policy problems which involve the allocation of limited resources to alternative variables in light of various constraints and goals.[34] Other applicable policy problems include (1) middle income housing versus lower income housing in public housing programs, (2) on-the-job training versus formal schooling in manpower development programs, and (3) law reform versus case handling in the operations of the OEO legal services program.[35] In making these applications, gains similar to the eight mentioned above can be obtained even when the alternative variables, the costs, and the benefits are non-monetary in nature. It is hoped this paper will further stimulate more such applications of linear programming and indifference line analysis to legal policy problems.

FOOTNOTES

Thanks are owed to Secil Tuncalp and Marian Neef of the University of Illinois for their help in processing the data for this article.

[1]See, for example, the following books: Chilton Bush, Free Press and Fair Trial (University of Georgia Press, 1971); H. Felsher and M. Rosen, The Press in the Jury Box (Macmillan, 1966); Alfred Friendly and Ronald Goldfarb, Crime and Publicity (Twentieth Century Fund, 1967); D. M. Gillmor, Free Press and Fair Trial (Public Affairs Press, 1966); John Lofton, Justice and the Press (Beacon Press, 1966); Harold Medina, Radio, Television and the Administration of Justice (Columbia U. Press, 1967), Paul Reardon, Fair Trial and Free Press (American Bar Association, 1966); U.S. Senate Committee on the Judiciary, Hearings on Free Press and Fair Trial (Government Printing Office, 1966).

[2]For further detail on linear programming than this article provides, see William Baumol, Economic Theory and Operations Analysis, (Prentice-Hall, 1965), 70-102; Samuel Richmond, Operations Research for Management Decisions (Ronald Press, 1968), 314-382; and Stuart Nagel, Minimizing Costs and Maximizing Benefits in Providing Legal Services to the Poor (Sage Publications, 1973). The Baumol book at pages 167-294 is

especially good on applying linear programming to deciding the optimum mix of products to buy in order to maximize one's benefits minus costs.

[3]For further detail on the methods and results of this survey, see Thomas Eimermann, Free Press, Fair Trial: An Empirical Look at the Problem and Its Solution (University of Illinois Ph.D. dissertation, 1971) (microfilm number 1-7121113-00000). In addition to the four above groups, the survey included related but different questionnaires directed to bar association officials which were not used for this article. The Ph.D. dissertation also provides data on relations between many variables related to free press, fair trial issues in addition to those shown in Figure 1.

[4]On judges, see note 15; on bar association officials, see note 3; and on criminal defendants, see note 25.

[5]In the few cases of blank responses, they were treated as neither a no nor a yes. If more than two items were unanswered for all three sources of information, that respondent was eliminated as not having sufficient knowledge of pretrial publicity practices in his community to be included.

[6]One could try to weight the relative importance of information from the police, prosecution, and defense rather than giving them equal weight, but no data is available for a meaningful weighting system. Likewise, one could say that

information from two sources is somewhat more likely to get into a newspaper than information from one source although not twice as likely, but no data is available for a meaningful system showing the amount of diminishing incremental likelihood due to additional sources.

[7]There is no need to determine whether the respondents come from the same city since, as will be seen, we are primarily comparing respondents rather than cities. More specifically, we are primarily comparing newspaper editors, police chiefs, prosecutors, and defense attorneys (when we are not combining the four groups together in equal numbers as described in note 18 below).

[8]The scale could be expressed as decimals ranging from 0 to 1.00 since percents are decimals. It is, however, easier to work with integers so long as one is consistent and so long as these numbers are not used as multipliers.

[9]No city could receive a free press score higher than 77 because the questionnaire did not include any items that were withheld by more than 77 percent of the cities although such items may or may not exist. Likewise, no city could receive a score lower than 2 because the questionnaire did not include any information items that were reported as generally not made available by less than 2 percent of the cities although mention that a crime had been committed and a suspect caught might be such an item.

[10]The above approach is similar to Guttman scaling although Guttman scaling involves re-ordering and sometimes eliminating some items and respondents contrary to the initial percentage scores in order to further reduce inconsistencies. See Margaret Hagood and Daniel Price, Statistics for Sociologists (Holt, 1962), 138-159; and Oliver Benson, Political Science Laboratory (Merrill, 1969), 235-267.

[11]Likewise, convert a ++ or a + response to a 0 if the item is worded unfavorably toward free press, and convert a -- or a - response to a 1 if the item is worded favorably toward free press.

[12]One could try to weight the relative importance of each of the four attitudinal items rather than giving them equal weight, but no data is available for a meaningful weighting system. Weights could be given by having a group of knowledgeable persons place each item in one of five categories (ranging from the item is very unfavorable toward free press, mildly unfavorable, neutral, mildly favorable, and very favorable) depending on the direction and strength of each item's wording. The weight for each item would be the average score it receives from this process. A similar process could be used to weight the information sources and combinations of sources as mentioned in note 5 above. See J. P. Guilford, Psychometric Methods (McGraw Hill, 1954), 456-462; and Bert

Green, "Attitude Measurement" in Gardner Lindzey, Handbook of Social Psychology (Addison Wesley, 1954), 335-369.

[13]On further aspects of measuring the difference between normative and empirical measures, see Stuart Nagel, "Measuring Unnecessary Delay in Administrative Proceedings: The Actual Versus the Predicted," 3 Policy Sciences 81 (1972).

[14]In order to reverse the rank order of the respondents on their satisfaction scores by changing the normative scoring system, it would be necessary to reverse their rank order among each other on their new normative scores toward free press since their empirical scores toward free press would not change if the empirical scoring system is held constant.

[15]Sheppard v. Maxwell, 385 U.S. 333 (1966); Irvin v. Dowd, 366 U.S. 717 (1961); Rideau v. Louisiana, 373 U.S. 723 (1963); and cases cited in the books referred to in note 1 above and in standard law library reference works. It would have been useful in this regard if the authors or the Reardon ABA committee (as part of its questionnaire survey of judges) would have asked judges to indicate for each item on a scale like the free speech scale if they would prohibit or discourage the item from being released by the press.

[16]Thomas Eimermann, Alternative Deterrents to Prejudicial and Libelous News Reporting (University of Illinois M.A. thesis, 1969). The 1968 questionnaires to newspaper

editors did ask questions about their publishing practices with regard to a set of items close in wording to items a through i in Figure 1 rather than just questions about the practices of police, prosecutors, and defense attorneys. Their practices can be interpreted as reflecting the legal constraints in their respective cities. The M.A. thesis also reports the results of a nationwide survey of newspaper editors made in 1963 by Robert Reid at the University of Illinois concerning their practices and attitudes with regard to potentially libelous reporting.

[17]See the Reardon (A.B.A.) and Medina (N.Y.C.B.A.) reports referred to in note 1 above. Also see Nicholas Katzenbach, "Statement of Policy Concerning the Release of Information by Personnel of the Department of Justice Relating to Criminal Proceedings," 28 Code of Federal Regulations § 50.2 (April 16, 1965). For collections of articles, see the relevant symposia in 42 Notre Dame Lawyer (1967); 22 Oklahoma Law Review (1969); and American Judicature Society, Selected Readings on Fair Trial, Free Press (A.J.S., 1971).

[18]So that no one of the four groups of respondents would disproportionately dominate this collevtive analysis, we equalized the four groups in the collective analysis by randomly eliminating some respondents from each group except the smallest group in order to bring the size of all the groups down to the size of the smallest group. No respondents were eliminated, however, when the analysis was done for each group separately.

[19]See the appendix to this article for exactly how the multiple regression equation was arrived at.

[20]For further detail on the derivation and meaning of regression slopes (like the + or - .15) and constants (like the 75), see Hubert Blalock, Social Statistics (McGraw Hill, 1972), 361-385; and J. P. Guilford, Fundamental Statistics in Psychology and Education (McGraw Hill, 1956), 365-379.

[21]Free press and fair trial (regarding prejudicial pre-trial publicity) have a negative correlation with each other in the sense that when one goes up, the other goes down since they are complements of each other. They have, however, a positive correlation when one is trying to show a constant level of satisfaction which an indifference line does. The correlation is positive here in the sense that if free press (which correlates positively with satisfaction) goes up, then fair trial (which correlates negatively with satisfaction) has to also go up to offset the increased satisfaction produced by the increase in free press if S is going to remain constant.

[22]To say the satisfaction indifference line between free press and fair trial of the editors is relatively flat compared to the other groups is saying the same thing as (1) the regression slope of +.42 (or the coefficient in the satisfaction equation) between free press and satisfaction of editors is relatively high compared to the other free press slopes and (2) the regression slope of -.42 between fair trial and satisfaction is relatively low compared to the other fair trial slopes.

23 To say the satisfaction indifference line between free press and fair trial of the defense attorneys is relatively steep compared to the other groups is saying the same thing as (1) their regression slope of +.08 between free press and satisfaction is relatively low and (2) their regression slope of -.08 between fair trial and satisfaction is relatively high.

24 If the satisfaction lines are curved rather than straight to indicate diminishing rather than constant returns (as explained in section IV-B), then one still obtains higher levels of satisfaction as one moves toward the northwest up to a point. That turning point, however, is beyond the legal constraints if the satisfaction lines are only slightly curved, or are quite curved but not backward bending.

25 On the defendant's perspective see, Jonathan Casper, American Criminal Justice: The Defendant's Perspective (Prentice Hall, 1972); Arnold Trebach, Rationing of Justice (Rutgers University Press, 1964); and Abraham S. Blumberg, Criminal Justice (Quadrangle Books, 1967).

26 These figures are arrived at by plugging a free press score of 66 and a fair trial score of 34 into the above four equations, and then subtracting from those four results the satisfaction scores previously arrived at when a free press score of 65 and a fair trial score of 35 were plugged into the above four equations. These subtraction figures provide a way of measuring the opportunity costs (or missed opportunities to

obtain greater satisfaction) of having a constraint which binds or limits the optimum. The satisfaction equations may, however not hold outside the feasible area that is within the constraints.

27 The additional satisfaction of the combined group by raising FP from 65 to 66 and lowering FT from 35 to 34 would be an increment of .30 units. This reflects an S of 79.80 for the 66 and 34 allocation versus an S of 79.50 for the 65 and 35 allocation using the equation 75 + .15(FP) - .15(FT).

28 As indicated in the appendix, the equation S = 60 + .30(FP) can be used to derive the equation S = 75 + .15 (FP) - .15 (FT), as well as the other way around.

29 No special formula need be used like the one discussed in the appendix since log of FP plus the log of FT does not equal 1.0 even though FP plus FT equals 1.0. If one uses the approach discussed in the appendix to derive a multivariate non-linear equation from the appropriate bivariate equations, then one obtains the equation $S = 41 + 41(FP)^{.18} - 41(FT)^{2.46}$ which produces virtually the same numerical results with the legal constraints as $S = 79(FP)^{.17}(FT)^{-.03}$ bearing in mind that FP plus FT must equal 1.0. The additive equation so derived in effect treats the FP part of the equation as a benefit and the FT part as a cost, and S thus is a net benefit. That equation can also allow FP to be 1.0 and FT to be zero with S reaching an unconstrained maximum of 82 rather than becoming zero as in the multiplicative equation (also known as a log-linear equation or a Cobb-Douglas function).

[30]For a simple discussion of non-linear curves and curve fitting, see J. Guilford, Psychometric Methods (McGraw Hill, 1954) p. 46-54 and p. 70-75; and M. Brennan, Preface to Econometrics (South-western, 1973) p. 46-48, 323-325, and 346-348.

[31]The correlation or square root of the variation accounted for between FP and S (without the logarithmic transformation) for the combined group is .37; for the editors, .76; the police, .38; the prosecutors, .43; and the defense attorneys, .16. The higher correlations between FP and S (with the logarithmic transformation) for the combined group is .40; for the editors, .81; the police, .38; the prosecutors, .64; and the defense attorneys .31 respectively.

[32]See note 24 above. The noted economist J. M. Clark said "Knowledge is the only instrument of production that is not subject to diminishing returns," P. Samuelson, Economics (McGraw Hill, 1973), p. 573. Clark, however, was referring to the general production of knowledge (which probably involves increasing returns) rather than to the more narrow production of newspaper articles on pending criminal trials (which seems to involve slightly decreasing returns as indicated by the fact that the exponent of FP is a positive decimal rather than a positive number greater than one).

[33]See note 31 above comparing the non-linear and linear correlation results. The S of 74 was arrived at by figuring $S = 79(.65)^{.17}(.35)^{-.03} = 79(\sqrt[6]{.65})(.35)^{0} = 79(.93)(1) = 74.$

[34]Another application of linear programming to the free press, fair trial problem involves arriving at an optimum mix of approaches to reducing the release of prejudicial crime reporting. The alternative activity variables analogous to the two dimensions of Figure 1 include (1) use of contempt power, (2) press self-restraint, (3) bar limitations on lawyers, (4) more careful juror selection and instructions, (5) easier change of venue or postponement of trial, and (6) use of libel suits. To some extent the degree of presence of these six approaches was measured or could have been measured in each city in the 1970 and 1968 surveys which provided the data for this article. As part of the linear programming analysis, their presence could then be related via a regression analysis to the degree of free press in each city. With the resulting regression equation, one can create a line or hyperplane on the algebraic equivalent of a six-dimensional graph in which all allocations on the line produce free speech at the 65 percent level and thus fair trial at the 35 percent level. The optimum point is any allocation along that line unless the line can be bounded by adding additional constraints.

[35]These three applications are described in detail in Charles Laidlaw, Linear Programming for Urban Development Plan Evaluation (Praeger, 1972); Ozay Mehmet, "Evaluation of Institutional and On-the-Job Manpower Training in Ontario," in Arnold Harberger, et al., Benefit-Cost Analysis 1971 (Aldine, 1972); and Stuart Nagel, Minimizing Costs and Maximizing Benefits in Providing Legal Services to the Poor (Sage Publications, 1973).

APPENDIX: DERIVING A MULTIVARIATE REGRESSION EQUATION WHERE $X_1 + X_2 = 1.0$

In the free press, fair trial issue (as conceptualized in Figure 2), free press and fair trial are the complements of each other. This means that if FP and FT scores are expressed as decimals rather than percentages, then FP plus FT = 1.0.

The general formula for deriving a multivariate regression equation with Y as a dependent variable and X_1 and X_2 as independent variables is:

(1) $$Y = a + (b_{YX_1 \cdot X_2})\, X_1 + (b_{YX_2 \cdot X_1})\, X_2$$

The b-coefficients show the slope between X_1 and Y holding X_2 constant and between X_2 and Y holding X_1 constant. The a-coefficient shows the point where the regression line or plane intersects the Y axis when X_1 and X_2 are both 0.

If $X_1 + X_2 = 1.0$, then formula 1 simplifies to:

(2) $$Y = .5\,(a_1 + a_2 + b_1X_1 + b_2X_2).$$

The a_1 and b_1 are the bivariate regression coefficients in the X_1 equation:

(3) $$Y = a_1 + b_1X_1$$

The a_2 and b_2 are the bivariate regression coefficients in the X_2 equation:

(4) $$Y = a_2 + b_2X_2$$

The values of a_1 and b_1 can be obtained by feeding into a computer the values for each respondent or subject for variables Y and X_1 (corresponding to S and FP) along with a regression analysis program. Likewise the computer will output values for the constants a_2 and b_2 if values are inputed for each respondent on Y and X_2 (corresponding to S and FT). Formula 2 above can be simplified even further, but before doing so, let us indicate why and how it is derived.

First, <u>why</u> use formula 2 above? A wrong alternative would be to feed values for each respondent for Y, X_1, and X_2 (corresponding to S, FP, and FT) into a computer along with a regression analysis program and expect thereby to obtain the a and two b's for formula 1. This usual procedure will not work because when $X_1 + X_2 = 1.0$, then the r-coefficient or correlation between X_1 and X_2 will be -1.00. This will make meaningless the usual procedure for calculating b (or unstandardized partial slope) because that procedure requires first calculating B (or standardized partial slope), and the denominator of B is $1 - (r_{X_1X_2})^2$. If $r_{X_1X_2} = -1.00$, however, then the denominator equals $1 - (-1)^2 = 1 - (1) = 0$ and dividing by zero yields a meaningless infinity. On the other hand, the fact that $r_{X_1X_2} = -1.00$ does not complicate feeding into a computer values for

each respondent on Y and X_1 in order to get a_1 and b_1 in the above third regression equation $Y = a_1 + b_1X_1$ or values on Y and X_2 to get a_2 and b_2 in $Y = a_2 + b_2X_2$.

Second, <u>how</u> does one mathematically derive formula 2 above which does yield meaningful multivariate results from the two bivariate equations where $X_1 + X_2 = 1.0$. A numerical proof that formula 2 works is the fact that if the average FP score of 38 for the combined group and the average FT score of 62 are plugged into the derived equation of S = 75 + .15(FP) - .15(FT), then the S of 71 which results is exactly the average S from the combined group.

Another numerical proof would be to create some hypothetical data for Y, X_1, and X_2 for two respondents, and then try to apply formula 2 to predicting Y from the values given for X_1 and X_2. For example, if the first respondent scored 10 on Y, .60 on X_1, and .40 on X_2, and the second respondent scored 15 on Y, .70 on X_1, and .30 on X_2, then that data yields the following equations:

$Y = -20 + 50\ X_1$ (from equation 3)

$Y = 30 - 50\ X_2$ (from equation 4)

$Y = 5 + 25\ X_1 - 25\ X_2$ (from equation 2)

If we now plug the data for respondent 1 into the multivariate equation above, we get Y = 5 + 25 (.60) - 25 (.40) = 5 + 15 - 10 which equals 10. Likewise if we plug the data for respondent 2 into the multivariate equation, we get Y = 5 + 25 (.70) - 25 (.30) = 5 + 17.5 - 7.5 which equals 15. Thus formula 2 with this numerical example provides perfect predictability, as a good multivariate regression equation should with only two respondents or dots to connect by a regression line.

An algebraic proof is to show that $a_1 + b_1X_1$ exactly equals $a_2 + b_2X_2$ so that the Y from formula 3 exactly equals the Y from formula 4. If so, by summing formulas 3 and 4, then $2Y = a_1 + b_1X_1 + a_2 + b_2X_2$ which is algebraically equal to formula 2. This algebraic proof is available frm the senior author on request. It involves expressing a_1 and b_1 in terms of the mean, standard deviations, and correlation coefficient needed to derive a_1 and b_1. It also involves expressing X_2 in terms of X_1 (i.e., $X_2 = 1.0 - X_1$). Then a_2 and b_2 are expressed in terms of the mean, standard deviation, correlation coefficient, and regression weight of X_1. With $a_1 + b_1X_1$ and $a_2 + b_2X_2$ both expressed in terms of the statistics of X_1, one can quickly see those two sums are algebraically equal.

Formula 2 can be simplified further so that one need only determine a_1 and b_1 in order to arrive at fomula 2 and indirectly formula 1. That simplified version of formula 2 is:

(5) $$Y = (a_1 + \frac{b_1}{2}) + (\frac{b_1}{2})X_1 - (\frac{b_1}{2})X_2$$

or if b is used to symbolize $b_1/2$, then the formula further simplifies to:

(6) $$Y = (a_1 + b) + bX_1 - bX_2$$

Formula 5 follows from the fact that $a_1 = M_Y - (M_{X_1})(b_{YX_1})$; $a_2 = M_Y - (M_{X_2})(b_{YX_2})$; $M_{X_2} = 1 - M_{X_1}$; $b_{YX_2} = - b_{YX_1}$; and $b_1 = b_{YX_1}$ where M stands for mean or average. Algebraic proof of these equalities such as $b_{YX_2} = - b_{YX_1}$ are included in the above-mentioned proof available from the senior author.

In terms of the free press data, this means S = $(60 + \frac{1}{2}30) + (\frac{1}{2}30)(FP) - (\frac{1}{2}30)(FT) = (60 + 15) + 15(FP) - 15(FT) = 75 + 15(FP) - 15(FT)$. If FP and FT are expressed in terms of percentages from 0 to 100 like S rather than in terms of decimals from 0 to 1, then the regression equation becomes $S = 75 + .15(FP) - .15(FT)$.

Formula 6 is not only a substantial simplification over the usual method for obtaining a multivariate regression equation, but as mentioned previously it is the only method that works with two independent variables that are complements of each other. This method of summing the two bivariate equations will also work when the equations are non-linear, provided the equations are first adjusted to be consistent with each other. This method will work too when there are three or more independent variables if one collapses the variables into two groups or modifies the formulas, assuming the three or more independent variables sum to 1.0 when they are scored as decimals. The method will not work if the two or more independent variables are not complementary since then the right sides of the bivariate regression equations are not algebraically equal.

In spite of the method's limitations, there are many relevant policy problems that involve deciding what is the optimum level on X to achieve a maximum Y or minimum -Y or what is the optimum mix of X and -X to achieve a maximum Y or minimum -Y. These problems can all benefit from this simplified way of relating X and -X simultaneously to Y in a multivariate regression equation. The resulting equation can thus be used to create the linear programming optimum mix perspective of Figure 2 or the calculus optimum level perspective of Figure 3 with all the policy insights which both those perspectives provide.

END