UTILIZATION OF AN EXECUTIVE DECISION GAME TO TEST BOWMAN'S MANAGERIAL COEFFICIENT THEORY

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Major professor

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ABSTRACT

UTILIZATION OF AN EXECUTIVE DECISION GAME TO TEST BOWMAN'S MANAGERIAL COEFFICIENT THEORY

By

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Bowman's managerial coefficient theory provides a conceptual framework to analyze repetitive decisions in a stable environment. According to Bowman the decision maker may be treated as a linear decision rule coefficient estimator. We can find the rule representing his behavior by performing a linear regression on a set of historical decision variables. According to this theory the decision maker's rule is unbiased relative to the optimal and heuristic rules, the latter are defined as concise empirical rules derived from a manager's behavior. Poor decision making is said to be characterized by large variances relative to optimal and heuristic rules. The theory has been extended to include learning effects (Carter, Jenicke and Remus).

A review of the literature reveals business gaming situations to be a valid laboratory for studying decision making. In this study three key decision variables in the Executive Game were analyzed over 8 periods of play in an undergraduate introduction to business course. The study reached the following conclusions:

1. Since linear decision rules had concurrent and predictive validity they may be used to represent the behavior of the subjects.

2. The heuristic rules were significantly different than rules which were allowed to contain all decision variables which entered at .05. The two sets of rules differed little in their ability to predict the decision maker's behavior.

3. The decision rules for the composite, best and worst decision makers had structurally different decision rules although each contained the same variables. The rules for the best subjects better explained their behavior than the composite or worst rules did for composite and worst subjects, respectively.

4. Evidence was found to support the hypothesis of learning occurring as play proceeded. This effect was manifest in terms of reduced bias over time.

5. Strong evidence was found that lower ranked subjects were more biased from heuristic rules.

6. Strong evidence was found that lower ranked subjects were more erratic decision makers than higher ranked subjects.

This study supports the general applicability of Bowman's theory to competitive simulation games such as the Executive Game. While it points to the necessity of including learning effects in the theory, it does not support Bowman's assertation of unbiased decision making and variance being the major source of economic inefficiencies.

This study demonstrates the value of games such as the Executive Game as a laboratory for exploring decision making behavior. The decision makers' behavior has been represented by linear decision rules which are heuristic rather than necessarily optimal. These rules provide a basis for further exploration of behavior patterns.

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By

William Edward Remus

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TABLE OF CONTENTS

LIST OF TABLES

Table		Page

LIST OF FIGURES

LIST OF ABBREVIATIONS AND NOMENCLATURE

LDR	Linear Decision Rule
$LDR_d^{s,m}$	A particular linear decision rule calculated from sample s using method m to predict decision variable d.
MAD	Mean Absolute Deviations
MSD	Mean Signed Deviations
R & D	Research and Development
ROI	Return on Investment

CHAPTER I

INTRODUCTION

This dissertation is the outcome of two relatively divergent interests. I have long been interested in business simulation games. As the following sections demonstrate there has been far from unanimous belief in the value of business games.

Decision making models also have been of great interest to me. Many decision models we advocate imply that managerial decision making is inadequate to the tasks to which the model is applied. It is rather as if the manager should hire a consultant to implement a technique and delegate the decision to him.

It was refreshing to encounter Bowman's theory given the above misgivings. Bowman's theory can loosely be construed to say the following things. First experienced managers making repetitive decisions are effective decision makers. They are able to gain an implicit if not explicit feel for the variables which are critical to their decision making; they are able to assign appropriate weights to the critical variables in order to make sound decisions. The decision rules a manager uses usually can be determined by regressing his decision on the set of decision variables.

The theory states that the decision rule derived from prior decisions is a useful and effective rule for future use in a stable environment. In fact, in some situations the derived rule may be better than an optimal rule obtained from a simplified model. Thus, Bowman's theory, if correct, gives us faith in the effectiveness of manager's making repetitive decisions. Further the theory provides a way to quantify the manager's decision making approach so that it may be explicitly used in the future.

If one incorporates learning then the theory would seem to be applicable to any sort of repetitive decision making, even by inexperienced decision makers (Carter, Jenicke and Remus). In particular, decision making in business games such as the Executive Game by Henshaw and Jackson should be amenable to such analysis. This paper includes a review of the literature which strongly supports the use of a business game as a laboratory to study decision making.

Such a study will provide the answers to a number of important research questions. First, such a study would test the validity of using Bowman's theory in a competitive, unstable environment where decisions are made by inexperienced subjects. We could test and verify the premises of Bowman's theory such as where it is only higher variance rather than bias that determines poor economic performance. We would find whether linear decision rules characterize the behavior of successful teams as well as the unsuccessful teams. It would be interesting to find if the best and worst teams differed in the structure of their rules.

We could address ourselves to whether different industries are characterized by different patterns of behavior, bias and variance. The learning effects could be examined by testing reduction in bias and increases in consistency over time. Lastly, we could test if teams of different rank had different rates of learning.

These questions will be discussed in great detail in the following sections of this paper.

CHAPTER II

LITERATURE REVIEW AND RESEARCH BACKGROUND

This chapter provides a necessary background to the study. First we will examine the literature on business gaming with the intent of demonstrating the appropriateness of using the gaming situation as a laboratory to study decision making. Then we will review the literature on Bowman's managerial coefficient theory. The third section describes the nature of the Executive Game. The chapter concludes with a discussion of the implications of Bowman's theory when applied to Executive Game. The implications form the basis for the experimental design.

Review of the Literature on Decision Making in Business Games

Many claims have been made for the benefits of playing business games. A recent study (Schriesheim and Schriesheim) examined the claims for the benefits made by the authors of various business games. The ten major claims they found are presented in table 1. The authors then content analyzed the literature on gaming to find if practitioner opinion agreed with those claims. A random selection of the literature when content analyzed revealed strong support for claims one, three and four. The remaining claims were not supported. It is the first of those that we are concerned with.

Table 1

Ten Most Commonly Made Claims About Business Games*

Claim: 1. They provide a vehicle for learning and practicing decision-making under risk and uncertainty.**

2. They teach the importance of planning and forecasting and provide a vehicle for learning and practice.

3. They develop a recognition and appreciation of functional interrelationships and dependencies in business firms.

4. They produce high interest and motivation in participants.

5. They teach facts and provide a vehicle for the application of specific techniques.

6. They provide an opportunity for the learning of interpersonal skills.

7. They provide an opportunity for learning to bear decision consequences without actual loss to the participant.

8. They provide an opportunity for the development of organizing ability.

9. They aid in the development of communications skills.

10. They provide a means of introduction to the computer in a manner which maximizes appreciation and minimizes fear of it.

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*Other claims are often made. For example, the claims that business games interest students in the study of business and that they teach business terminology are often made. These claims, however, do not have direct implications for managerial development and have thus been excluded from this listing.

**Implied within the claim that games "provide" for learning or practice of some ability or skill is that this is done in an effective manner. Although claims of this nature are not explicitly stated, they must be interpreted in this manner if they are to be evaluated.

It is certainly encouraging to know that practitioners see business games as "a vehicle for learning and practicing decision making under risk and uncertainty". Arguments can easily be constructed to support that viewpoint. The empirical studies on that question, however, are not so unequivocal in their support.

While there have been many studies on business gaming, few of these studies were more than anecdotal. Of the remainder, few dealt with decision making. The empirical decision making studies tended to take up the question of whether playing the game improved the problem solving and decision making abilities of the participants. A study on the Carnegie Tech Management Game (Cangelosi) examined several managerial skills including problem solving using pre and post in-basket tests. His subjects and controls were graduate students. He found no support for improved problem solving skills due to the gaming experience. A similar study (Moffie and Levin) using graduate students for subjects used the Educational Testing Service's in-basket exercise. Included in the eighteen measures found in the in-basket exercise were measures of problem solving and decision making ability. Again no support was found for enhanced problem solving or decision making skills for the gaming group. In both studies the authors argued the inadequacy of their design or instruments may have obscured the effect they were looking for.

These two studies are the only studies which had an adequate experimental design. Both, however, were subject to a very significant error. In order to find learning the post measure must be such that the learning acquired by gaming must be easily transferred to it.

In both experiments the subjects learn group decision making skills; thus we may not find group learning showing up on a test of individual learning unless that learning is readily transferable. The two studies could possibly be interpreted under learning theory as finding group learning did not transfer to individual problem solving situations. Almost all experimentors studying group gaming seem to consistently make this mistake and thus leave their findings open to question.

Thus we find practitioner support for but no methodlogically adequate studies to demonstrate improved decision making after the gaming experience.

Another series of experiments focused on the game environment as a decision making and/or behavior laboratory. The concern in these studies has not been to demonstrate the external validity of claims about the game but instead to study the mechanisms involved in various gaming situations. It is these mechanisms which are now of concern to us.

First we shall examine the literature about team decision making behavior during the play of the game (Norman):

1. Each team developed its own unique pattern of decision making.

2. Differences between teams' decision making behavior correspond with differences in their stated beliefs about the environment.

3. The team's focus was changed from the general goal of maximizing ROI to some more concise action objective around which it could model the game in meaningful terms.

4. Each team organized the elements of the game around their model of the game.

5. The team's model tended to persist even when partially contradicted; it was simply modified to reflect the new data.

6. Each team exhibited a style; e.g. ultraconservative, gamblers, etc. This style persisted.

An intriguing study by Philippatos and Moscato found that gaming subjects were able to learn the rules and objectives of games that they played given no information about the game. In other words, subjects were able to gain an intuitive if not explicit understanding of the games they played without any external guidance. This would imply that Norman's observations on team models of the game is accurate and the team decision models were useful and accurate.

Norman's findings are strongly bolstered by a series of studies on a aggregate production scheduling simulation game (Miller and Moskowitz, Carter and Hamner, Carter, Jenicke and Remus). Applying Bowman's managerial coefficient theory to the game they found stability in decision making and that their subjects derived decision rules as effective, if not more so, than the tractable optimal rules for the simulation. Significant learning effects were also found and measured as the simulation proceeded. These studies were made on individual rather than team decisions and will be examined in the next section.

Another significant finding was that game performance is, at least for certain games, related to subject matter knowledge (Rohrer, cited by Schriesheim and Schriesheim). While this may be obvious for certain special purpose games the finding that knowledge of marketing practices may enhance game success in a more general decision game is consistent with the behavioral findings to be cited in the coming paragraphs.

One area of mixed results in gaming is that of conservatism in decision making. One study suggests that student players become more risk prone as play proceeds (Lewin and Weber). Since a study by Moskowitz found students to be more risk conscious than managers when making initial gaming decision, we could argue that the gaming experience was a realistic developmental activity. A contrasting study (Babb, et. al.) found businessmen to make more conservative decisions than students when gaming; students behavior was characterized as erratic. The Slovic and Lichenstein review of the literature also arrived at no conclusion due to mixed results.

A reasonable explanation of the diversity of results on this issue is simply that subjects learn to play games well and understand intuitively what behavior is needed to win. They build simple but useful models of the game and use them to make decisions. This behavior is noted and measured in many studies (Miller and Moskowitz, Carter, Remus and Jenicke, Babb, et. al., Norman, Philippatos and Moscato, and more). It is not unreasonable to conclude that different gaming experiences elicit differing types of appropriate behavior once the learning effect has died out. This behavior may or may not be conservative depending on the nature of the game played. Thus Babb, et. al.'s assertion of businessmen being more conservative initially than students when playing the farm supply game may not be in conflict with Lewin and Weber's assertion to the contrary made for a different game. This point is made explicit by a study (Khera and Benson) that found the only differences in terms of decision making among businessmen and students was due to background. If the businessmen initially know more about a simulation of a given industry, then the students rapidly acquire background by gaming which puts them on an equal basis with the businessmen (Babb, et. al.). Thus we would argue that gaming effectively teaches the players the appropriate behavior to do well on that model. This is not an assertion that this learning would be appropriate for or even transfer to the real world. Babb found that businessmen transfer their business methodology to the play of a parallel simulation. This transfer, however, did not necessarily lead to gaming success. Apparently his farm supply and dairy management simulations required different winning strategies than their unsimulated counterparts.

I have been arguing up to this point that game players effectively learn the strategies needed to do well in the simulation game and that different games elicit different strategies. If the players learn appropriate strategies for the game and the game models is a valid version of business then the strategies they learn will be useful outside the game. This is a restrictive way to view the use of games.

Often games are used in quantitative methods courses to provide students with experience in using the analytical techniques covered in the course. In this case we would require only that the students be able to practice the techniques on the game that they would use in the non-simulated situation. Hopefully the game would reward the use of the techniques by an improved performance. This is a more powerful use of gaming since the analytical techniques are useful in many varied situations. In this use of the game less restrictive requirements are made of the game model.

In either case the decision making behavior of the players should provide an excellent data source for empirical studies.

The nature of team behavior has elicited a fair amount of literature suggesting or using the game as a behavioral laboratory. One such study (Rowland and Gardner) measured the subjects on the Fiedler's Least Preferred Coworker scale and then selected MARKSIM teams to reflect different patterns of managerial behavior. No particular configuration was predictive of game success although each configuration may lead to different perceptions of the game. Fiedler's measure is a largely discredited measure of managerial behavior and thus may have obscured the desired effects.

More frequently the behavioral phenomenon integral to the game is studied without any particular prestructuring. The results of these studies suggest that team performance generally is unrelated to the subject's intellectual ability, aptitudes, tests and grades (Rowland and Gardner), although there is also evidence to the contrary (McKenney and Dill). In the cases when this does occur, the R^2's are extremely small. Little relationship exists between the team performance and the four personality measures found on the Myer-Briggs test (Babb, Leslie, and Van Slyke) although they did find a relationship between game success and emotional stability and cautiousness. The latter affect was not particularly prominent.

Another study (Nash and Chentnik) attempted to predict success from the 16 psychological characteristics measured by the California Psychological Inventory. No coherent pattern of relationships emerged from the study.

Although research have been unable to predict overall performance, one study (Babb, et. al.) found microgame behavior to be correlated to psychological variables. For example, emotionally stable individuals showed less fluctuations in their pricing decision.

Let us summarize our findings:

1. We found practitioner support but no empirical support for improved decision making skills as a result of gaming.

2. We did find the gaming situation to be a good and popular laboratory for studying decision making behavior.

3. Many useful understandings about decision making behavior were available from the literature including the finding that players learned appropriate winning behavior for their particular model. This learning effect explains some apparent inconsistencies in the literature.

4. We found that if the game was a valid simulation of its real counterpart we could generalize our findings to the non-simulated situation.

5. We found games to be useful in providing practice in analytical techniques. This use made less restrictive requirements of the game model.

Review of the Literature on Bowman's Managerial Coefficient Theory

The managerial coefficient theory (Bowman) is a simple but effective approach to modeling decision making. The theory asserts that a decision maker's behavior may be modeled by a linear decision rule. That is, one can conceptualize the decision maker as a coefficient estimator for linear decision rules although he may not explicitly be involved in such an activity. We may visualize the decision maker as intuitively placing the right weights on the various decision variables available to him. The theory asserts that managers make good decisions implying that on the average appropriate weights are assigned to the decision variables. This is a rather appealing notion since many decision making models appear to imply that managerial decisions are inadequate unless a specialist utilizes a sophisticated model on the manager's behalf.

By examining a manager's prior behavior we can find his decision rules. If we know the key decision variables or ask the manager which variables he uses we can use multiple regression on his history of decisions. Stepwise regression may be used to discover this decision rules where the key variables are not already known and the full set of potential decision variables is known.

The rule derived from the manager's behavior is, in general, a very good rule. This statement applies to an experienced manager who is no longer learning the nature of the process of which he is making decisions. Another implied assumption is that the rule has been derived from a set of variables which the manager uses for his decision making. An incomplete set would give an inadequate decision rule. Others suggest that a stable environment is also assumed. Certainly if the environment were stable the theory would apply. But if the rule contains variables which reflect critical environmental fluctuations then that assumption may be relaxed. If the environmental instability causes the coefficients of the rules to change, we may use the most recent observations to update our rule to reflect those changes (Kunreuther). Naturally, to get an adequate data set for analysis the decision must be recurrent.

The theory asserts that economic inefficiency has at its source the variance from the rule rather than bias. This can only occur if the magnitude of the bias is small compared to the magnitude of the variance. Also the cost surfaces must be dish shaped. Convex cost functions such as the quadratic cost function are dish shaped.

Bowman defines bias and variance as follows:

> Departures of the decision making behavior of management from the preferred results, in this sense can be divided or factored into two components, one which in the manner of a grand average departing from some preferred figure, we call bias (which causes a relatively small criteria loss due to the dish shaped bottom of the criteria surface), and one which represents individual occurences of experiences departing from the grand average, we call variance (which causes larger criteria losses due to the individual occurances up the sides of the criteria dish shaped surface). It is the latter and more important component which seems to offer the tempting possibility of elimination through the use of decision rules incorporating coefficients derived from management's own recurrent behavior.

Bowman here asserts that the erratic decision making relative to a manager's rule is the source of inefficiency. Erratic decision making is often prompted by cues from the business environment. Cues from the environment to the extent that they are not reflected in the predictor variables of the linear decision rule must be considered as irrelevant to the decision at hand. If they were relevant certainly we should have included them in the rule. Thus the rule should be more efficient than actual behavior as the erratic cues are eliminated.

Let X be a random variable representing the series of decisions made by a manager. Assume that the decision X is associated with tne cost Y by the quadratic cost function:

$$Y = a + bX + cX^2$$

If we further assume that X is normally distributed around mean μ with standard deviation σ, we find:

$$E(Y) = a + bE(X) + cE(X^2)$$
$$= a + b\mu + c(\sigma^2 + \mu^2)$$

The minimum cost point is found:

$$dY/dX = b + 2cX = 0$$
$$X_{min} = -b/2c$$

Then the minimum cost is:

$$Y_{min} = a + b(-b/2c) + c(-b/2c)^2$$
$$= a - b^2/4c$$

The cost attributable solely to bias is just the expected cost less the minimum cost with the variance zero:

$$COST_{bias} = (E(Y) - Y_{min})|_{\sigma = 0}$$
$$= b\mu + c\mu^2 + b^2/4c$$

The cost solely attributable to variance is the expected cost less the minimum cost with the bias at zero:

$$COST_{variance} = (E(Y) - Y_{min})|_{bias = 0}$$
$$= (E(Y) - Y_{min})|_{\mu = -b/2c}$$
$$= (a + b\mu + c(\mu^2 + \sigma^2) - (a - b^2/4c))|_{\mu = -b/2c}$$
$$= c\sigma^2$$

If Bowman's assertion that cost attributable to variance is greater than the cost attributable to bias may be stated:

$$b\mu + c\mu^2 + b^2/4c < c\sigma^2$$

If Δ is defined as the difference between $\overline{X}$ and X_{min}:

$$\Delta = \mu + b/2c$$

or in terms of μ:

$$\mu = \Delta - b/2c$$

Placing the latter equation in the equation representing Bowman's assumption, we find:

$$b\Delta - b^2/2c + c(\Delta - b/2c)^2 + b^2/4c < c\sigma^2$$

$$c\Delta^2 < c\sigma^2$$

$$\Delta < \sigma$$

Then Bowman's assumption that the cost attributable to variance is greater than the cost attributable to bias is true if and only if the bias in X is less than one standard deviation.

Were there an optimal tractable solution to a given process we would expect that a regression analysis would give us a rule which would be about as efficient as the optimal, given the foregoing assumptions. Bowman does not assert that decision makers would end up with rules that are unbiased relative to the optimal nor does he assert that all managers will have the same insights and thus the same decision rules for a given process. In fact on the first point he asserts that a decision rule may even be better than the optimal rule. However, it might be reasonable to find managers having similar insights and thus identical rules or that their rule might be the same as the optimal.

Once a rule has been determined from past behavior, Bowman asserts that the rule will outperform the actual decision maker, given the previous assumptions. The decision maker is subject to irrelevant cues and moods which cause him to be erratic in decision making. The rule is not effected and thus yields better results.

The reason why the rule from Bowman's analysis may be superior to an optimal rule found by traditional analysis may not be readily apparent. An optimal rule is derived from some mathematical, tractable model for a process. The real world process does not necessarily conform with that simplified model of the process and in these instances, the Bowman rule may be better.

Now to summarize the theory in Bowman's own words:

1. In their decision making behavior, managers and/or their organizations can be conceived of as decision rule coefficient estimators, (not that they explicitly are coefficient estimators).

2. It is the variance in decision making rather than the bias that hurts (more) due to dish shaped criteria surfaces.

3. A decision rule with mean coefficients estimated from management's behavior should be better than actual performance.

4. It may be better than a rule with coefficients supplied by traditional analysis.

The literature thus far has been quite favorable toward the theory. Bowman in his original paper presented support for his theory with studies on ice cream, chocolate, candy and paint plants in the

Boston area. A study (Kunreuther) at Recordette Company, a electronics firm in the Boston area, found support for the theory and also found certain advantages relative to traditional Operations Research techniques. The study indicated some to the assumptions of the theory may not hold in real world situations.

A very interesting study attempted to use linear decision rules distinguish the psychotic from neurotics given the MMPI profile and demographic data (Goldberg). He found the linear rule to be better at recognizing the distinction than the actual clinical judgements of 29 psychologists. The literature review of this study alludes to a separate but parallel lineage for a psychological coefficient theory. A major review in this area (Slovic and Lichtenstein) includes a review and analysis of the use of linear regression to find rules used for clinical judgements. In all reported situations the linear model did a fairly good job of predicting judgements and often performed better than the actual decision maker. The latter supports only one part of the theory and does not examine parts two through four.

Two major studies (Miller and Moskowitz, Carter, Jenicke and Remus) have reexamined Bowman's theory as applied to a gaming situation using quadratic costs (Holt, Modigliana, Muth and Simon). In the former case the study was done pencil and paper style using a graduate class in industrial administration as subjects. In the latter case the subjects were undergraduates in a required course on quantitative methods and the game was played via interactive timeshare terminals. Both studies demonstrated the appropriateness of a linear model to represent the subjects' decisions. The Miller and Moskowitz study particularly addressed itself to the appropriateness of linear rules with various forecast horizons and degrees of error. The study found support for Bowman's assertion that the rule would yield better than actual performance and in some cases better than optimal performance. The first study, however, found that poor economic behavior was characterized by both bias and variance. A reanalysis of this data (Carter and Hamner) cross validated the rules demonstrating their appropriateness for future predictions and redemonstrated the finding that poor economic behavior was a function of both bias and variance.

The study by Carter, Jenicke and Remus addressed itself to the learning of linear decision rules when the cost coefficients were changed across various conditions of information. Their analysis of the data again demonstrated the usefullness of linear decision rules. Although not reported in that paper additional analysis revealed occasions of better than optimal performance using the derived rule and that the rule performance was better than actual performance. As in the analysis and reanalysis of the Miller and Moskowitz data, this study found rules manifesting both bias and variance. When the cost coefficients changed, in all cases, a learning effect occurred as the subjects reduced their variance and bias simultaneously. The question of whether variance is the sole determinant of poor economic performance was not explicitly addressed.

A number of interesting findings additionally arose from the latter study. The various treatment groups of subjects never acquired the optimal rule although they did both as well as and worse than the optimal performance. All treatment groups used the same rule in each of the three periods of the game, even though that rule differed from period to period. The learning effect may be modeled as a linear decrease in bias and a linear increase in mean absolute deviations (MAD) of the actual from the predicted over time. The learning period for this study and the cross validation earlier referenced was less than 8 decision cycles. The degree of information about the coefficient change did not effect the decision rule used.

Both the undergraduates and the graduates in industrial administration made similar estimation errors when making decisions although the graduates were more predictable. That is, they had a higher R^2.

The major review in this area (Slovic and Lichenshtein) found support for the following theories for multiple cue learning in judgemental tasks:

1. Subjects can learn to use linear cues appropriately.
2. Learning of non-linear functions is slower and less effective than learning linear cues and is especially difficult if subjects are not forewarned of the nonlinearity.
3. Subjects can learn to detect changes in relative cue weights over time but do so slowly.
4. It is easier to discover when to use a cue than to discover a functional relationship.
5. Subjects can learn to use valid cues even when they are not perceived with perfect reliability.

The Carter, Jenicke, and Remus study is consistent with the preceeding findings 1, 3 and 5 but does not address 2 and 4.

We may summarize our review of the literature on Bowman's theory as follows:

1. There is unanimous support for the utility of linear decision rules in representing decision making. These rules have been found to have both concurrent and cross validity.

2. We found support for the assertion that a linear decision rules may perform better than the actual decisions made. We also found instances where the rule performed as the optimal rule.

3. We found support for attributing poor economic performance to variance from the rule, but we also found bias to effect economic performance.

4. The literature revealed the need to include in the theory the role of learning in reducing bias and increasing mean average deviations of the actual from the predicted over time.

In general, Bowman's theory is strongly supported.

The Executive Game

The Executive Game (Henshaw and Jackson) is an descendent of the UCLA Executive Game #2. This game allows up to 9 teams to compete for product sales within each industry. The industry is an oligopoly; thus purely competitive dynamics do not hold. This type of situation is realistic for many major American industries. The firms manufacture only one product.

Each period represents one quarter of actual time. The firms are required to make 8 decisions for each period; these are the starred variables shown in table 2. To make these decisions they have their results from prior periods of play, an example is in figure 1, and industry wide yearly reports. The latter reports show individual firms expenditures on marketing and R and D, their net profit, their sales volume in units, and return on investment. Additionally this report shows for the end of the year the cash assets, inventory on finished goods and raw material, owner's equity and plant replacement value. General economic conditions, inflation, and tax situations affect play and decision making. To aid the decision makers

EXECUTIVE GAME

MODEL 1 PERIOD 1 JAS PRICE INDEX 101.9 FORECAST,ANNUAL CHANGE 6.3 0/0
SEAS.INDEX 95 NEXT QTR. 115 ECON.INDEX 99 FORECAST,NEXT QTR. 94

INFORMATION ON COMPETITORS

	PRICE	DIVIDEND	SALES VOLUME	NET PROFIT
FIRM 1	$ 6.15	$ 50000	466000	$ 118009
FIRM 2	$ 6.25	$ 53000	471573	$ 27966
FIRM 3	$ 6.50	$ 100000	350696	$ -121412
FIRM 4	$ 6.25	$ 23000	464328	$ 30525
FIRM 5	$ 6.00	$ 65000	526122	$ 164746
FIRM 6	$ 6.20	$ 30000	451500	$ 81478
FIRM 7	$ 6.22	$ 65000	449757	$ 42738
FIRM 8	$ 6.15	$ 70000	646000	$ 149559
FIRM 9	$ 6.25	$ 48000	453497	$ -21965

FIRM 11 2

OPERATING STATEMENTS

MARKET POTENTIAL	471573	
SALES VOLUME	471573	
PERCENT SHARE OF INDUSTRY SALES	11	
PRODUCTION,THIS QUARTER	525000	
INVENTORY,FINISHED GOODS	104427	
PLANT CAPACITY,NEXT QUARTER	431889	

INCOME STATEMENT

RECEIPTS,SALES REVENUE		$ 2947333
EXPENSES,MARKETING	$ 325000	
RESEARCH AND DEVELOPMENT	160000	
ADMINISTRATION	332800	
MAINTENANCE	95000	
LABOR(COST/UNIT EX.OVERTIME $ 1.43)	830245	
MATERIALS CONSUMED(COST/UNIT 1.57)	826436	
REDUCTION,FINISHED GOODS INV.	-160280	
DEPRECIATION(2.500 0/0)	207500	
FINISHED GOODS CARRYING COSTS	52213	
RAW MATERIALS CARRYING COSTS	60000	
ORDERING COSTS	50000	
SHIFTS CHANGE COSTS	0	
PLANT INVESTMENT EXPENSES	33062	
FINANCING CHARGES AND PENALTIES	0	
SUNDRIES	84700	2896677
PROFIT BEFORE INCOME TAX		50656
INCOME TAX(IN.TX.CR. 0 0/0,SURTAX 0 0/0)		22690
NET PROFIT AFTER INCOME TAX		27966
DIVIDENDS PAID		53000
ADDITION TO OWNERS EQUITY		-25034

CASH FLOW

RECEIPTS,SALES REVENUE		$ 2947333
DISBURSEMENTS,CASH EXPENSE	$ 2023021	
INCOME TAX	22690	
DIVIDENDS PAID	53000	
PLANT INVESTMENT	575000	
MATERIALS PURCHASED	1300000	3973711
ADDITION TO CASH ASSETS		-1026378

FINANCIAL STATEMENT

NET ASSETS,CASH	$ 20622
INV. VALUE,FINISHED GOODS	313280
INVENTORY VALUE,MATERIALS	1673564
PLANT BOOK VALUE(REPLACE.VAL.$ 9108566)	8667500
OWNERS EQUITY(ECONOMIC EQUITY 11116332)	10674966

Figure 1 Output of the Executive Game

the authors provide a pro forma balance sheet and explicit instructions for its use in determining what decisions to make.

One of the strongest features of the Executive Game is its underlying model. Over the years the game has been amended such that there remain few, if any, strategies for beating the game. The model manifests numerous effects that we would find in real world oligopolies and punishes erratic behavior. The manual for the game outlines some of the model's functioning explicitly and gives one the FORTRAN program so that the remainder of the model may be found. The model is much too elaborate to be discussed in detail in this paper. Players can find conditionally optimal rules to implement their game plan but the game does not have a full set of global and tractable optimal rules.

The Executive Game has been in use for many years and is easily implemented even on relatively small computers.

Applying Bowman's Theory to the Executive Game

Bowman's theory has been applied to simulation games prior to this study (Miller and Moskowitz; Carter and Hamner; Carter, Jenicke and Remus). The aggregate production simulation involved in the latter studies has the following properties:

1. Each subject plays the game independently; his outcomes are not determined by the play of other subjects.

2. All subjects were given identical production scheduling environments including identical sales forecasts.

3. The underlying scheduling model (Holt, Modigliana, Muth and Simon) had a set of tractable optimal decision rules to guage performance by.

The Executive Game does not have the above properties. The subjects are aggregated into industries; the subjects compete for the sales within the industry. This situation is a better analogue of situations to which we would ultimately wish to apply Bowman's theory. In his original paper Bowman cited competitive examples of the application of his theory, e.g. the ice cream company.

The Executive Game has no underlying tractable optimal rule although it is a mathematical model of a competitive environment. Thus we need to develop a heuristic model for the subject's decision making before further proceeding with the analysis. This is no barrier to testing the theory since many situations, including the ice cream example, to which we want to apply the theory may have no tractable solution. In fact this lack of need for an optimal rule is one of the advantages of the theory. The optimal rule does, however, provide a benchmark for evaluating a subject's decision making processes. Thus Bowman's theory would seem applicable to the Executive Game.

Now let's review the implications of the theory and frame them in terms of the game:

1. Each subject can be thought of as a decision rule coefficient estimator (not that they explicitly are coefficient estimators).

2. To the extent to which we can include the relevant variables upon which a subject makes his decision, we may find his decision model via multiple regression.

3. To the extent that the environment changes and we have inadequate predictor variables to represent the change, our decision rule will lack high predictive value. Note that to the extent that the set of excluded variables are independent from the included variables the rules based on included variables will be stable. Again the ice cream production scheduling is such an example.

4. It is the variance in the decision making rather than its bias from optimal that leads to lowered profits due to the dish shaped criteria surfaces.

5. Cues from the environment and measurements of other variables in the environment must either be irrelevant or at some stable level. If this is not true and they are not explicitly accounted for in the decision rule the performance of the rule will be reduced if the manager uses that cue or variable in his decision making. Multiple regression will remove to some extent the effects of managers using irrelevant cues and variables. When the decision was made these irrelevant cues and variables led to larger variances.

6. There is the implication that managers have good insight into their decisions. Thus Bowman would not predict differences among subsets of managers in their ability to intuit good rules. Further, the amount of bias should be zero for all groups of managers and the amount of variance should be the same for any set of managers.

7. Bowman's theory is said to apply to experienced managers implying that other phenomenon may occur in the case of inexperienced managers. Although not explicitly stated this leaves room within the theory for learning to take place. This is how inexperienced managers become experienced.

The purpose of this study is to explore the implications of the theory on the Executive Game and to examine some areas where the theory may need to be expanded. This includes the following research questions.

1. Can we find a set of heuristic rules which represent the behavior of the subjects?

2. Will these heuristic models represent equally well the behavior of the best teams, worst teams and overall sample?

3. Will the amount of bias be a function of team rank?

4. Will the best teams exhibit less variance than the worst teams?

5. Will there be any learning effects taking place as the game proceeds? If so, what is the nature of these effects?

6. Will there be an interaction between rank and time thus demonstrating differential learning?

The sixth question will find whether the rates of learning might explain the differing ranks.

CHAPTER III

THE EXPERIMENTAL DESIGN AND ANALYSIS PLAN

This chapter presents the methodology and approach of this dissertation. The first section outlines the experimental environment in which the data was collected. The second section presents the general approach to analyzing the data and third section gives the details of the procedures used to derive models to represent the subject's behavior.

Description of the Experimental Environment

The data for this paper were collected from the students playing the Executive Game in the Michigan State University Introduction to Business course, Management 101. This course is an elective course open to students both inside and outside of the College of Business. The course is intended to be a survey of the topics involved in business administration and also to aid undergraduate students selecting their major area in the college. The data was taken during the Winter quarter of 1974 when the class consisted of 107 students. 29% of the class were female, 76% were freshman, 23% were sophomores, and 1% were juniors.

The instructor's intent in using the Executive Game was to provide a vicarious business simulation for the students. He tried to relate the game situations to real business situations and discuss the interrelationships among the various aspects of the business.

All students were required to play the game and were given points toward their overall course grade based on their final rank in their respective industries. The game was no more than 10% of the overall grade.

It is relevant to discuss why each firm consisted of only one student rather than organizing them into teams. In the prior quarter the instructor had had difficulty when he organized the students into teams. They complained that other team members did not aid in decision making or even attend team meetings. Occasionally teams decided to have a different individual make the decision each week so as to reduce work. The instructor attributed the difficulty to the fact that some students were taking this course because it was an easy course to pass and so wanted to do as little as possible to pass. Thus when these people were forced to get involved they rebelled. The instructor felt that by making one man firms these intrateam conflicts would be eliminated and decision making responsibility placed firmly on the shoulders of each individual. Also, with this approach a more effective motivation system could be arrived at to gain student involvement.

Luckily, the latter occurred concurrently with my plan to investigate decision making and thus reinforced the instructor's approach. Since Bowman's managerial coefficient theory applies to individual decision makers this organization of the class was necessary also.

Early in the quarter the students received a lecture on the Executive Game and some of the considerations in making decisions for the game; this lecture was given by Dr. Richard Henshaw, a co-author of the Executive Game. The students were then divided into 13 industries of 9 firms each. Each firm consisted of one student. The students made one practice decision and output was received for that decision; then the game began in serious.

The cycle of the game went as follows; the students made their decision and punched the decision card before the Thursday meeting, they turned in their decision card at the Thursday meeting, and they received their output the following Tuesday. Figure 1 shows a typical Executive Game output. They then had 2 days in which to make their next decision.

All teams began the game at exactly the same financial and marketing position; in other words, their previous history as reflected in the Executive Game history cards was identical.

The students played a total of 8 periods of Executive Game following the practice period. The decisions for the seventh and eighth period were turned in at the same class meeting. This was done to try to eliminate the possibilities of "end of game tricks", i.e., so that firms could not shut down in that last period. Then the final ranking would represent standing of on-going firms.

When a student incorrectly punched a card, the graduate assistant made the necessary correction which the student had no right to contest. Should a student fail to input a decision he would be assigned a very poor decision to be used in the play of Executive

Game. All variables were poor choices; in particular the price was set to $7.51 when the average price for all teams averaged $6.25 with only a small dispersion.

Once the game had begun in earnest only one subject dropped the course; thus industry seventeen was reduced from nine to eight teams. Industry twenty-two consisted of mostly late admissions to the course. The late admissions had a very poor record of turning in decisions.

General Procedure of Data Analysis

The data analysis was performed on a set of thirty-three variables per decision per subject. These variables (explained in table 2) were punched into their decision cards each period, on the history cards which were used to make the transition from period to period, and from a program which output a special set of profit and financial parameters. For certain analyses the period 1 data was eliminated; since all subjects had the same period 1 history a regression looking for predictors from the historic variables could not yield meaningful results. In searching for decision rules often period 8 data was ignored since the subjects had no feedback from period seven prior to making decision eight. In all cases, all bogus $7.51 decisions and associated variables were eliminated from the data set.

Three general groups of data were formed for the analysis procedures:

1. the composite data set consisting of all non-bogus observations

Table 2

Variables Used in the Executive Game

1 Industry Number - subjects were divided into 12 nine man industries, only intraindustry competition occurred.

2 Team Number - each team in an industry was uniquely designated by a team number.

3 Period Number - each period of play was designated by a period number, each period represented a quarter of a fiscal year.

4 *Price - subjects decision as to the price their products were to be sold for this period.

5 *Marketing - the expenditure the subjects decided upon for this period.

6 *R & D - the expenditure subjects made for research and development this period.

7 *Maintenance - the expenditure subjects made for plant maintenance, including preventitive maintenance, this period.

8 *Volume - the production volume in units that the subjects decided to schedule for this period.

9 *Plant and Equipment - the expenditures to be made this period to compensate for the aging of equipment and to buy new equipment and plant capacity.

10 *Materials - the dollar value of materials ordered from which to manufacture the product, this order will not be delivered until next period.

11 *Dividend - the subjects declared dividend for this period. If paying the dividend reduces net assets below ten million dollars only the portion which leaves the ten million intact will be paid.

12 +Price Index - the subjects price for his product last period.

13 +Marketing Index - an exponentially smoothed measure of his past marketing expenditures.

14 +R & D Index - an exponentially smoothed measure of the subjects past R & D expenditures.

15 +Maintenance Index - an exponentially smoothed measure of the subject's past maintenance expenditures.

Table 2 (cont'd.)

16 +Raw Materials Inventory - dollar value of the raw material inventory at the end of the prior period.

17 +Plant Capacity - measured in units of output capacity at the end of the prior period.

18 +Stock of Finished Goods - remaining at the end of the prior period, in units of product.

19 +Market Potential - the potential units of sales in this firm's market at the end of the prior period.

20 +Sales Volume - firm's actual sales in units for the prior period.

21 +Cash on Hand - at the end of the prior period.

22 +Raw Materials Inventory Deflated - as 16 only value is deflated.

23 +Book Value - the value of the plant after assets have been allowed to depreciate.

24 +Standard Cost for a Unit of Product - prior period.

25 Profit - the dollar value of the firm's net profit in this quarter.

26 Inventory of Finished Goods - in dollars at the end of this period.

27 True Dividend - the dividend actually paid out this period.

28 Return on Investment - calculated for this period.

29 Rank - firm rank in the industry based on ROI, this period.

30 Annual Change - forecast for the annual inflation rate for this period.

31 Next Seasonal Index - seasonal index forecast for this period.

32 Next Economic Index - economic index forecast for this period.

2. the best data set consisting only of those subjects who finished first in their respective industry

3. the worst data set consisting only of those subjects who finished last in their respective industry without the bogus decisions

The worst group did incur a fair amount of bogus decisions. Only 51 of 72 decisions on the worst teams from period 2 through 7 were made by the subjects.

Once the data sets had been prepared the data analysis consists of the following steps:

1. Using the composite data a heuristic model was found which described the subjects behavior for key decisions.

2. Alternative models were found using a stepwise regression computer program to make the best possible prediction. This was done by allowing the computer to do the whole task and also by beginning with the heuristic model and allowing the computer to add variables which significantly improve its predictive ability. This step was performed across the composite, best and worst sets of data.

3. The key decision rules were cross validated on the composite data set.

4. The LDR's thus found were compared across data sets and methods of determination.

5. The bias and variance across time, rank and industry were examined particularly looking for linear effects.

6. The effect of the interaction of rank and time on measures of variance and bias were examined.

This study uses Bowman's definitions for variance and bias. Bias is defined as the signed difference between the preferred and actual value for a variable. When taken across a data set we would expect the sum of the signed differences to equal zero if the rule is unbiased.

Variance is defined as the departures of the actual from the mean decision. In this study mean absolute deviations (MAD) of the actual from the predicted shall be used to examine the propositions about variance and learning.

Analysis of variance is used for all of the bias and variance testing. The design appears to be fixed effects model when we are blocking on industry. When we block on rank, or time, the fixed effects is appropriate. We will convert the first case to a random effects analysis of variance by using the Cornfield-Tukey bridge arguement.

Our testing applies to Michigan State University students taking Management 101, Introduction to Business in Winter of 1974. 76% were freshmen, 23% were sophomores, and 1% were juniors. 29% of the class were female. The course was a 4 credit elective.

Now generalize the testing to a hypothetical population of similar subjects and assume this population is infinite. The latter population is rather restrictive when we try to generalize our results. The restrictions on class level and sex could be safely relaxed to allow us to generalize to business undergraduates. We have now random effects model when we block on industry.

This preceding brief listing of steps will be greatly elaborated in the sections of the paper dealing with each particular topic.

Finding the Heuristic Models

In many gaming situations the underlying mathematical model may be solved for an optimal solution. In the case of the Executive Game no global solution has been found, although some conditionally optimal rules exist. To perform the hypothesis testing that this paper undertakes it is essential to have some baseline if not optimal solution. This heuristic model then may be used as a basis of intergroup comparisons.

There are a number of approaches to finding this model. I have used the following:

1. Choose the set of criterion variables to be examined.

2. For each criterion variable choose a subset of independent variables which could possibly be thought of as inducing fluctuations in the criterion variables.

3. Use stepwise regression to regress that set of criterion variable on the independent variables at an alpha of .05.

4. Examine the included variables for the amount of variation explained by each. Eliminate those which only explain less than 2% of variation.

5. Regress the variables from step 4 and find if the total explained variation is of a reasonable order relative to step 3. If not, add back variables and repeat this step.

The derived heuristic rules should, concisely characterize the rule used by the decision maker; the heuristic rule should have face validity also.

To choose the criterion variables to be examined, I used these guidelines:

1. The variable must be one that the subjects actually control.

2. The variables should explain more variation in Executive Game profit or ROI than variables not included.

3. The better these criterion variables are explained by allowable independent variables the more useful the results of this paper will be.

Guideline 1 limits my choice to the following variables; price, marketing, R & D, maintenance, production volume, dividend, price, plant and equipment expenditures, and materials expenditures. Guideline 2 was examined by performing a stepwise regression to find which variables best explained profit and ROI. Thirteen variables were used to predict ROI including volume, price, R & D and marketing index (an exponentially smoothed marketing expenditure variable). The twelve variables used to predict profit included volume, price, dividend, marketing index, and R & D.

This analysis yields the following:

1. Winning the Executive Game requires the subject to give attention to all aspects of his firm.

2. The variables (both decision variables and variables internal to the firm) explain 84% of the variation in ROI, the long term profitability of the firm.

3. The variables (both decision variables and variables internal to the firm) explain 48% of the variation in profit in the current period.

4. The Executive Game decisions (with their subsequent impact on the internal variables) are quite predictive of long term profit. Each period's profit has a much greater unexplained variation.

5. Short term profit varies:
   a. directly with cash on hand, material inventories, stock of finished goods, the expenditure level for the maintenance program, production volume, and price
   b. inversely with the expenditures on the marketing program.
   c. directly with R & D this period but inversely with the R & D overall expenditure program

   when all variables are considered simultaneously.

6. ROI varies:
   a. directly with cash on hand, production volume, material inventory, book value of plant and equipment, stock of finished goods, dividends paid, price, and dollar volume of sales
   b. inversely with standard cost per unit, plant capacity, R & D expenditures, and expenditures on the marketing program

   when all the variables are considered simultaneously.

The preceding findings demonstrate that Executive Game is a reasonable and intergrative business simulation; simplistic explanations of profit and ROI, had they occurred, would have indicated to the contrary.

Guideline 2 reduces the set of criterion variables from the original to price, marketing, production volume, and R & D. Maintenance is not included in this subset as it is predictive only of short term profit and even then, the maintenance expenditure does not have an immediate impact on the profits. Dividend paid is "predictive" of only ROI and then it is more likely that it is simply symptomatic of good profits rather than "predictive". Thus it is excluded from consideration. Plant and equipment expenditures are not directly predictive of short term profit or ROI although they do reflect themself in plant capacity and book value which are predictive of ROI. Even then there are many other factors influencing book value and capacity. Thus it is also excluded from consideration. Material expenditures are not directly predictive of profit or ROI although it effects the level of material inventory which, in turn, predicts profit and ROI. Also material inventory levels is probably more symptomatic of good profits than predictive.

Guideline 3 eliminates R & D expenditures from further consideration since the explained variance is low (9%). Also the only predictor variable for current R & D is the exponentially smoothed average of previous R & D expenditures called R & D index. The fact that this decision was not characterized well by a linear rule may question the universality of Bowman's Theory.

The variables to be used as criterion variables in the rest of the analyses are price, marketing, and production volume. I then preceded to use the 5 steps listed earlier to find the heuristic models.

CHAPTER IV

THE RESULTS OF THE ANALYSIS

This chapter is composed of 13 sections. Each section addresses itself to a particular portion of the analysis. It is divided into two broad segments. The first segment demonstrates the utility and interrelationships of the linear decision rules. The second section examines the issues of bias, variance and learning. The implications of these findings are explicated in the next chapter.

Interrelationships Among the Heuristic Price LDR's

The heuristic price LDR uses the price index and the forecast of the next economic index as predictor variables. Regressions were made for price forcing the latter two variables to be the only variables in the equation; this was done for the best, worst, and composite data. The results are reported in table 3.

Before beginning to use the LDR's we should evaluate whether the betas found by this least squares analysis are unbiased estimates of the true betas. In particular, when autocorrelation occurs and there is a lagged variable, the betas may be overestimated (Malinvaud).

Table 4 contains the tests for the autocorrelation effect. Our preference here is for the Durbin test for a lagged variable (Johnson, p. 313) if the required conditions are met, as this LDR has a lagged variable. If that test is not available then the Von Neumann ratio

Table 3

Linear Decision Rules for the Price Decision

Composite Rule n=600 $\bar{R}^2$=.3084

Price = 2.71465396 + .0175611 (Next Econ. Index)

+ .29882493 (Price Index)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	2.71465396	.23063603	(2.33,3.09)
$\hat{\beta}_1$	.01756110	.00108810	(0 ,.035)
$\hat{\beta}_2$	.29882493	.02459381	(.258,.339)

Best Rule n=72 $\bar{R}^2$=.5574

Price = -.05403077 + .02767492 (Next Econ. Index)

+ .59488454 (Price Index)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	-.05403077	.81995670	(-1.40, 1.29)
$\hat{\beta}_1$	.02767492	.00297038	(.0228,.0325)
$\hat{\beta}_2$	.59488454	.09263832	(-.442, .747)

Worst Rule n=51 $\bar{R}^2$=.2637

Price = 4.04612529 + .00941562 (Next Econ. Index)

+ .20677078 (Price Index)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	4.04612529	.50036453	(3.22,4.87)
$\hat{\beta}_1$	.00941562	.00304465	(.004,.014)
$\hat{\beta}_2$	.20677078	.04971813	(.125,.288)

(Thiel, p. 199) may be applicable under restricted circumstance. The table reveals that the price LDR on the composite sample does have statistically significant positive autocorrelation. The LDR's on the best and worst samples do not have statistically significant autocorrelation at the 5%.

Even though for the best and worst sample price LDR's we can accept the hypothesis of zero autocorrelation, the fact that lagged variables exist in the LDR means that the betas will slightly underestimate the true betas (Johnson, p. 306). The bias is -2/n %, where n is the sample size. Thus the betas are underestimated by 4% in the worst sample and 3% in the best sample. In both cases the correction is so small that it may be ignored.

The composite price LDR has statistically significant autocorrelation. There is no easy way to deal with this as it implies the possibility of underestimation of the calculated autocorrelation coefficient, .1385 in this case, and an equally large overestimation of the beta of the lagged variable, .0246 for this case.

In each table describing a linear decision rule I have reported the $\bar{R}^2$ for that rule. Since $\bar{R}^2$ may be plagued with measurement and independence problems, the value is reported for descriptive and informational purposes only.

Hypothesis 1: Having checked the appropriateness of the LDR's as calculated by least squares, we need now to examine if the LDR's for the best, worst and composite sample are statistically equivalent.

$H_0^{(1)}$: $LDR_p^{c,1} = LDR_p^{b,1} = LDR_p^{w,1}$

Table 4

Tests for Autocorrelation in the Price LDR's

H_0: zero autocorrelation

H_1: non-zero autocorrelation

Composite Rule n=600 α =.05

Durbin Test for Lagged Variables

r=.1385 $Var(\hat{\beta}_2)=.0246^2$

$$H=.1385\sqrt{\frac{600}{1+600(.0246)^2}} = 4.25$$

Reject H_0 since 4.25 is greater than 1.86

Best Rule n=72 α=.05

Durbin Test for Lagged Variables

r=.1 $Var(\hat{\beta}_2)=.0926^2$

$$H=.1\sqrt{\frac{72}{1+72(.0926)^2}} =1.37$$

Do not reject H_0 since 1.37 is less than 1.86

Worst Rule n=51 α=.05

Durbin Test for Lagged Variables

r=.16 $Var(\hat{\beta}_2)=.0497^2$

$$H=.16\sqrt{\frac{51}{1+51(.0497)^2}} = 1.222$$

Do not reject H_0 since 1.222 is less than 1.86

Results: This hypothesis was tested by a test of structural equivalence (Huang, p. 108); this tests the equivalence of the three families of betas. The hypothesis is rejected indicating at least one of the three is different than the other LDR's. To find the nature of this difference table 5 also contains the results of bounding the betas of the composite rule to find if the betas of the worst and best rules fall in that range. The table demonstrates that both best and worst rules are different than the composite.

Hypothesis 2: The previous test does not tell us if the LDR's for the best and worst sample are structurally equivalent. Thus we test the following hypothesis on the period 1 through 7 composite data.

$H_0^{(2)}: \quad LDR_p^{b,1} = LDR_p^{w,1}$

Results: This hypothesis is also rejected indicating the non-equivalence of the coefficients of the best and worst LDR's tested as a family. This test is the test of pairwise structural equivalence (Huang, p. 108). The test is contained in table 5.

Interrelationships among the Heuristic Marketing LDR's

The heuristic marketing LDR uses the marketing index (an exponentially smoothed marketing expenditure average) and marketing potential as predictor variables. Regressions were made for marketing forcing these two variables into the equation; this was done on the best, worst and composite data sets. The results are reported in table 6.

At this point we again address ourselves to the issue of autocorrelation. In table 7 the Durbin test for lagged variables, the

Table 5

Equivalence of the Coefficients of the Price LDR's

The Family Test at α=.05

H_0: $LDR_p^{c,1} = LDR_p^{b,1} = LDR_p^{w,1}$

Q_1=.962 Q_2=.754 Q_3=.208 n=123 K=3 J=2

$$F = \frac{.208/4}{.754/115} = 7.6$$

Reject H_0 since 7.6 is greater than $_{.95}F_{4,115}=2.45$

Individual Coefficient Tests using Confidence Intervals

for the Composite Rule at α=.10

Composite Rule

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$
Best Rule Betas	Outside	Within	Outside
Worst Rule Betas	Outside	Within	Outside

The Family Test for the Equivalence of the Worst and Best Price LDR's

on the Composite Sample from Periods 1 thru 5 at α=.05

H_0: $LDR_p^{b,1} = LDR_p^{w,1}$

Q_1=37.558 Q_2=10.042 Q_3=27.516 n=702 K=3

$$F = \frac{27.516/8}{10.042/694} = 237.7$$

Reject H_0 as 237.7 is greater than $_{.95}F_{8,694}=1.94$

Table 6

Linear Decision Rule for the Marketing Decision

Composite Rule n=600 $\bar{R}^2$=.5024

Marketing = .77532008 + 1.005355 (Marketing Index)

- .07496595 (Market Potential)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	.77532008	.11912130	(.579, .97)
$\hat{\beta}_1$	1.005355	.04438912	(.932,1.078)
$\hat{\beta}_2$	-.07496595	.01707401	(-.103,-.04)

Best Rule n=72 $\bar{R}^2$=.7501

Marketing = .71053198 +1.18925394 (Marketing Index)

- .15391043 (Market Potential)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	.71053198	.26166915	(.28 ,1.14)
$\hat{\beta}_1$	1.18925394	.08362376	(1.05 ,1.327)
$\hat{\beta}_2$	-.15391043	.03584165	(-.213,-.095)

Worst Rule n=51 $\bar{R}^2$=.5911

Marketing = .17672373 +1.03799056 (Marketing Index)

+ .01757419 (Market Potential)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	.17672373	.34378036	(-.39 , .74)
$\hat{\beta}_1$	1.03799056	.15221942	(.787,1.288)
$\hat{\beta}_2$	.01757419	.04216553	(-.05 , .087)

Table 7

Tests for Autocorrelation in the Marketing LDR's

H_0: zero autocorrelation

H_1: non-zero autocorrelation

Composite Rule n=600 α=.05

Durbin Test for Lagged Variables

$nVar(\hat{\beta}_1)=1.182$ thus this test is not applicable

Von Neumann Ratio Test

VNR=1.842 K=3

Do not reject H_0 as VNR is within the range of 1.84 to 2.16

Durbin Watson Test

d=1.66 since tables are not available for n=600,

this test cannot be utilized

Best Rule n=72 α=.05

Durbin Test for Lagged Variables

r=.095 $Var(\hat{\beta}_1)=.0836^2$

$$H=.095\sqrt{\frac{72}{1+72(.0836)^2}}=1.14$$

Do not reject H_0 since 1.14 is less than 1.86

Worst Rule n=51 α=.05

Durbin Test for Lagged Variables

$nVar(\hat{\beta}_1)=1.181$ thus this test is not applicable

Von Neumann Ratio Test

VNR=1.841 K=3

Do not reject H_0 as VNR is within the range 1.525 to 2.475

Table 7 (continued)

Tests for Autocorrelation in the Marketing LDR's

Durbin Watson Test

d=2.03 K=3 d_u=1.63

Do not reject H_0 as d is less than 4-d_u but greater than d_u

Von Neumann ratio, and Durbin-Watson statistic are reported. Recall that for LDR's with lagged variables the first test is most appropriate if available and the latter two useful under certain restrictive assumptions. We find in all cases that the available tests accept the hypothesis of zero autocorrelation. Recall that the betas are slightly underestimated. The amount of underestimation is .4%, 3%, and 4% respectively for the composite, best and worst marketing LDR's. The correction factor will be ignored as it is quite small.

Returning to table 6, we again note a significantly higher $\bar{R}^2$ for the best sample rule. This again indicates that an LDR with the hypothesized variables is most predictive of the behavior of the first place teams in each industry.

Hypothesis 3: Having checked the appropriateness of the LDR's we again examine the structural equivalence of the LDR's evaluated on the best, worst and composite samples.

$H_0^{(3)}$: $LDR_m^{c,1} = LDR_m^{b,1} = LDR_m^{w,1}$

Results: As in the case of the price LDR's we reject the null hypothesis at alpha of .05. Thus at least one of the three LDR's is significantly different than the others. Table 8 which shows the results of that test also contains the results of bounding the betas on the composite rule. We find some betas from both best and worst rules to be outside the confidence interval; both best and worst LDR's are different than the composite LDR.

Hypothesis 4: There remains the possibility that the best and worst rules may be structurally equivalent. We then test on following hypothesis on the period 1 through 7 composite data set:

Table 8

Equivalence of the Coefficients of the Marketing LDR

The Family Test at α=.05

H_0: $LDR_m^{c,1} = LDR_m^{b,1} = LDR_m^{w,1}$

Q_1=36.35 Q_2=32.21 Q_3=4.14 n=123 J=2 K=3

$$F = \frac{4.14/4}{32.21/115} = 3.7$$

Reject H_0 since 3.7 is greater than $_{.95}F_{4,115}$=2.43

Individual Coefficient Tests using Confidence Intervals

for the Composite Rule at α=.10

Composite Rule

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$
Best Rule Betas	Within	Outside	Outside
Worst Rule Betas	Outside	Within	Outside

The Family Test for the Equivalence of the Worst and Best Marketing

LDR's on the Composite Sample from Periods] thru 7 at α=.05

H_0: $LDR_m^{b,1} = LDR_m^{w,1}$

Q_1=384.77 Q_2=366.4 Q_3=18.37 K=3 n=702

$$F = \frac{18.37/8}{366.4/694} = 4.35$$

Reject H_0 as 4.35 is greater than $_{.95}F_{8,694}$=1.94

$H_0^{(4)}$: $LDR_m^{b,1}=LDR_m^{w,1}$

Results: This test is also rejected indicating the nonequivalence of the best and worst sample marketing LDR's when tested as a family. The test may be found in table 8.

Interrelationships among the Heuristic Volume LDR's

The heuristic production volume LDR uses the market potential, current marketing expenditure and R & D index (an exponentially smoothed R & D average) as predictor variables. Regressions were made for the volume forcing the latter three variables into the equation and allowing no others to enter. This was done on the best, worst and composite samples. The results are reported in table 9.

The problem of autocorrelation arises again but since lagged variables are not present we have less to contend with. The appropriate tests here are either the Von Neumann ratio or the Durbin-Watson statistic. We find, as shown in table 10, that all tests retain the hypothesis of a zero autocorrelation. If autocorrelation did exist we would still have unbiased estimates of the betas, however, the standard deviation of the errors would be underestimated (Johnson, p. 246). Even though the tests did not support the hypothesis of autocorrelation the correction factors for the standard deviation of the betas were computed. In no case was the value given in table 9 for each variable more than .1% from the true value.

Again the LDR from the best sample has the highest $\bar{R}^2$. This rule is most appropriate for the first placed teams in each industry.

<u>Hypothesis</u> 5: Since the hypothesis of zero autocorrelation was not rejected we can now test the structural equivalence of the LDR's

Table 9

Linear Decision Rules for the Volume Decision

Composite Rule n=600 $\bar{R}^2$=.4467

Volume = 1.51751553 + .39804395 (Marketing)

+ .25942319 (Market Potential) + .55468906 (R and D Index)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	1.51751553	.20982065	(1.17,1.86)
$\hat{\beta}_1$	.39804395	.04121948	(.33,.466)
$\hat{\beta}_2$	.25942319	.02365509	(.22,.298)
$\hat{\beta}_3$	.55468906	.10468355	(.382,.727)

Best Rule n=72 $\bar{R}^2$=.7150

Volume = 1.65821861 + .32567365 (Marketing)

+ .27161655 (Market Potential) + .69930199 (R and D Index)

	Coefficient	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	1.65821861	.38175701	(1.03 ,2.288)
$\hat{\beta}_1$	.32567365	.06760973	(.215, .436)
$\hat{\beta}_2$	.27161655	.04597963	(.196, .347)
$\hat{\beta}_3$	.69930199	.19419633	(.38 ,1.019)

Table 9 (continued)

Linear Decision Rules for the Volume Decision

Worst Rule n=51 $\bar{R}^2$=.3236

Volume = 2.18782496 - .32567365 (Marketing)

+ .24345501 (Market Potential) + .97220350 (R and D Index)

	Coefficients	Standard Error	Confidence Interval at 90%
$\hat{\beta}_0$	2.18782496	.65973499	(1.10 ,3.27)
$\hat{\beta}_1$	-.14096602	.24921883	(-.55 , .269)
$\hat{\beta}_2$	.24345501	.08408995	(.105, .38)
$\hat{\beta}_3$	.97220350	.41486383	(.85 ,1.13)

Table 10

Tests for Autocorrelation in the Volume LDR's

H_0: zero autocorrelation

H_1: non-zero autocorrelation

Composite Rule n=600 α =.05

Von Neumann Ratio Test

VNR=1.96 K=4

Do not reject H_0 since VNR is within the range of 1.84 to 2.16

Durbin Watson Test

d=1.77 since n=600 no tables are available

Best Rule n=72 α=.05

Von Neumann Ratio Test

VNR=1.946 K=4

Do not reject H_0 since VNR lies in the range of 1.525 to 2.475

Durbin Watson Test

d=1.91 K=4 d_u=1.70

Do not reject H_0 since d lies within the range of d_u to $4-d_u$

Worst Rule n=51 α=.05

Von Neumann Ratio Test

VNR=2.012 K=4

Do not reject H_0 since VNR lies in the range of 1.515 to 2.485

Durbin Watson Test

d=1.96 K=4 d_u=1.67

Do not reject H_0 as d lies within the range of d_u to $4-d_u$

as determined on the best, worst and composite samples.

$H_0^{(5)}$: $LDR_v^{c,1}=LDR_v^{b,1}=LDR_v^{w,1}$

Results: As was found in the case of the price and marketing LDR's, we find we must reject this hypothesis in favor of the assertion that at least one of the LDR's is different than the others. Table 11 contains that test and the results of bounding the betas on the composite LDR. We find some of the betas the best and worst rules are outside the confidence interval, thus both the best and worst sample LDR are different than the composite sample LDR.

Hypothesis 6: Once again we check the possibility of the worst and best LDR's being structurally equivalent.

$H_0^{(6)}$: $LDR_v^{b,1}=LDR_v^{w,1}$

Results: For the third time we reject the structural equivalence of the best and worst sample LDR's as tested on period 1 through 7 composite sample data; this result is shown in table 11.

Cross Validation of the Heuristic LDR's

The appropriateness of heuristic models for the price, marketing, and volume decisions may be evaluated in yet another way. The technique of cross validation (Hamner) segments time series data and finds appropriate LDR's for that segment of data which was collected earlier in time. Then the derived LDR's are evaluated on the remaining observations. The $\bar{R}^2$ for both segments should be statistically equal if the rule is equally predictive of behavior in both periods. However, some shrinkage would not be unexpected. The cross validation should demonstrate the validity of the heuristic models.

Table 11

Equivalence of the Coefficients of the Volume LDR's

The Family Test at $\alpha=.05$

$H_0;\ LDR_v^{c,1}=LDR_v^{b,1}=LDR_v^{w,1}$

$Q_1=95.5$ $Q_2=79.25$ $Q_3=15.75$ $n=123$ $J=2$ $K=4$

$$F=\frac{15.75/5}{79.25/113}=4.49$$

Reject H_0 since 4.49 is greater than ${}_{.95}F_{5,113}=2.29$

Individual Coefficient Tests using the Confidence Intervals for the Composite Rule at $\alpha=.10$

Composite Rule

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$
Best Rule Betas	Within	Outside	Within	Within
Worst Rule Betas	Outside	Outside	Within	Outside

The Family Test for the Equivalence of the Worst and Best Volume LDR's on the Composite Sample from Periods 1 thru 7 at $\alpha=.05$

$H_0:\ LDR_v^{b,1}=LDR_v^{w,1}$

$Q_1=974.906$ $Q_2=710.724$ $Q_3=264.182$ $n=702$ $K=4$

$$F=\frac{264.182/10}{710.724/692}=25.72$$

Reject H_0 since 25.72 is greater than ${}_{.95}F_{10,692}=1.83$

Table 12 shows the LDR for price derived on period 2 through 4 observations on the composite sample. The LDR has an R of .4886. The table also indicates that the betas of the period 2 through 4 LDR are not outside the confidence intervals of the composite LDR for all periods. When this price LDR is used on period 5 through 7 observations we find a R of .4862. A test utilizing Fisher's r to z and pooling the variances finds no significant differences between the R's. Recall that we earlier found autocorrelation for this LDR, however, the weight of the evidence supports the cross validation of the price LDR in spite of the autocorrelation.

The numerator of the Fisher's r to z contains the sum of the reciprocals of the degrees of freedom for the two correlation coefficients. Should there be a lack of independence in estimating the correlation coefficients we would want to adjust downward the degrees of freedom. This would reduce the size of the test statistic and make acceptance of the null hypothesis more likely. Since I have not adjusted the degrees of freedom, the tests are more conservative than would be necessary should dependence be a problem.

Table 13 shows the LDR for marketing derived on period 2 through 4 observations on the composite sample while allowing only the heuristic variables to enter into the regression. The LDR has a R of .7469. The table also indicates that the betas of the period 2 through 4 are outside the confidence interval of the composite LDR for all periods for marketing. When this LDR is used on period 5 through 7 observations we find a R of .6803. The test utilizing Fisher's r to z and pooling the variances finds no significant

Table 12

Cross Validation of the Price LDR

Composite Rule n=305 Periods 2 thru 4 R=.4886

Price = 2.12401974 + .01988191 (Next Econ. Index)

+ .35990635 (Price Index)

	Coefficient	Standard Error	Confidence Interval at 95%
$\hat{\beta}_0$	2.12401974	.53233557	(1.08 ,3.17)
$\hat{\beta}_1$	.01988191	.00434644	(.011, .028)
$\hat{\beta}_2$	.35990635	.03736443	(.286, .433)

Comparison of the Period 2 thru 4 LDR and the Composite LDR

using the Confidence Intervals on the Composite LDR

Composite Rule $\alpha = .10$

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$
Period 2 thru 4 Betas	Within	Within	Within

Correlation of the Predictions and the Actual Price in Periods 5 thru 7

R=.4862

Testing the Equivalence of the R's using Fisher's r to z and

Pooling the Variances at α=.05

H_0: $\rho_1 = \rho_2$

H_1: $\rho_1 \neq \rho_2$

$$z = \frac{(.5343-.5314)}{\sqrt{(1/302)+(1/292)}} = .0354$$

Do not reject since z is less than 1.86

Table 13

Cross Validation of the Marketing LDR

Composite Rule n=305 Periods 2 thru 4 R=.7469

Marketing = .44218993 + 1.34129482 (Marketing Index)

- .20485693 (Market Potential)

	Coefficient	Standard Error	Confidence Interval at 95%
$\hat{\beta}_0$	.44218993	.21021730	(.0284, .856)
$\hat{\beta}_1$	1.34129482	.08891652	(1.17 ,1.51)
$\hat{\beta}_2$	-.20485693	.06204873	(-.326 ,-.08)

Comparison of the Period 2 thru 4 LDR and the Composite LDR

using Confidence Intervals on the Composite LDR

Composite Rule α = .10

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$
Period 2 thru 4 Betas	Outside	Outside	Outside

Correlation of the Predictions and the Actual Marketing

in Periods 5 thru 7 R=.68032

Testing the Equivalence of the R's using Fisher's r to z and

Pooling the Variances at α=.05

H_0: $\rho_1 = \rho_2$

H_1: $\rho_1 \neq \rho_2$

$$z = \frac{(.966-.829)}{\sqrt{(1/302)+(1/292)}} = 1.6748$$

Do not reject H_0 since z is less than 1.86

differences between the R's at alpha equals .05. The two preceding results may appear contradictory. The marketing LDR meets the definitional requirements for being cross validated at .05. The confidence intervals are three tests each with an alpha of .10 or a combined probability of a type I error of .30. In order to make the comparison meaningful they must be at the same alpha level. Thus performing confidence intervals at .02 might be much more suitable; the combined alpha is .06. In this case, all betas would fall within the confidence interval on the composite marketing rule. There remains no contradiction.

Lastly we test the volume LDR. The period 2 through 4 normative rule of volume is given in table 14; it has an R of .5747. The betas for this rule are entirely inside the confidence intervals for the composite volume LDR. When this rule is used on period 5 through 7 observations we find an R of .6194. Again Fisher's r to z test with pooled variances finds no significant difference in the R's.

Summary of the Interrelationships among Heuristic LDR's

Thus far we have found:

1. The LDR's for each decision variable had statistically different betas in each of the three data samples they were calculated for.

2. The heuristic LDR's always had the highest $\bar{R}^2$ on best team data sample suggesting the best teams were more consistent.

3. In 8 of 9 cases the null hypothesis of zero autocorrelation could be accepted at the .05 level. When corrections to the betas were made for the lagged variables the correction was less than 4%.

4. All three rules cross validate.

Table 14

Cross Validation of the Volume LDR

Composite Rule n=305 Periods 2 thru 4 R=.5747

Volume = 1.70101805 + .32858938 (Marketing)

+ .27581115 (Market Potential) + .47962004 (R and D Index)

	Coefficient	Standard Error	Confidence Interval at 95%
$\hat{\beta}_0$	1.70101805	.31600816	(1.08 ,2.32)
$\hat{\beta}_1$	.32858938	.05269466	(.225, .432)
$\hat{\beta}_2$	.27581115	.06006159	(.158, .393)
$\hat{\beta}_3$	.47962004	.16210260	(.162, .797)

Comparison of the Period 2 thru 4 LDR and the Composite LDR

using Confidence Intervals on the Composite LDR

Composite Rule $\alpha = .10$

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$
Period 2 thru 4 Betas	Within	Within	Within	Within

Correlations of the Predictions and the Actual Volume

in Periods 5 thru 7 R=.61949

Testing the Equivalence of the R's using Fisher's r to z and

Pooling the Variances at α=.05

$H_0: \rho_1 = \rho_2$

$H_1: \rho_1 \neq \rho_2$

$$z = \frac{(.724-.655)}{\sqrt{(1/302)+(1/292)}} = .8435$$

Do not reject H_0 since z is less than 1.86

Analysis of the Equivalence of Method 2 and 3 LDR's

The research design utilized the development of LDR's by 3 methods. These were:

Method 1: Construct a heuristic decision model and then fit those variables to the data.

Method 2: Begin with the method 1 variables but allow other variables to enter the equation through the stepwise regression technique.

Method 3: Instruct the stepwise regression to program select the variables to be entered and the order in which to enter them.

We would expect method 2 and 3 LDR's to be very close, if not identical. The stepwise regression program will construct only a locally optimal LDR; hence, different starting points may yield different LDR's. Table 15 summarizes the comparisons between method 2 and 3 LDR's. We conclude:

1. In 5 of 9 cases the LDR's are identical.

2. In 3 of the remaining 4 cases the LDR's are not significantly different in terms of their coefficient of determination. Since this test (Burr) is also a test for finding variables to enter into regression equations we can confidently assert no improvement could be gained from changing from one form of the LDR to the other.

3. In the case of the marketing decision in the worst sample the two LDR's are significantly different, hence the LDR from method 3 is preferable to the method 2 LDR.

The tests thus summarized indicate the statistical equivalence in 8 of the 9 cases under consideration. Then by comparing method 1 and method 3 LDR's we adequately compare method 2 LDR's also.

Analysis of the Equivalence of Method 1 and 3 LDR's

Now we are prepared to compare method 1 and 3 LDR's; we will proceed with a series of tests which will demonstrate that many of the

Table 15

Comparison of Method 2 and 3 Linear Decision Rules

	Price LDR	Marketing LDR	Volume LDR
Composite Data Set	No significant Difference $F=.62 < {}_{.95}F_{1,590}=3.84$	Identical LDR's	Identical LDR's
Best Data Set	Identical LDR's	Identical LDR's	Identical LDR's
Worst Data Set	No Significant Difference $F=2.243 < {}_{.95}F_{1,45}=4.08$	A Significant Difference $F=7.6 > {}_{.95}F_{2,44}=3.23$	No Significant Difference $F=.868 < {}_{.95}F_{1,44}=4.08$

LDR pairs are statistically different. Then we shall then argue that these statistical differences are of no practical significance.

First recall that method 2 LDR's are the heuristic variables plus other variables in a LDR. Since in all cases variables were added to the heuristic set we can immediately assert that there is a difference in terms of $\bar{R}^2$ between method 1 and 2 LDR's. This is because improvement in LDR R^2 is the criterion for the admission of a new variable.

Now let's turn to the criteria of adding significantly to the sum squared explained by the regression. In a test analogous to testing for linear and quadratic components in an ANOVA table we test the contribution of the additional variables. These tests are summarized in table 16. In all cases a significant contribution is made to the explained variance of the regression by the new variables.

Another test of the differences between method 1 and 3 LDR's is the test of structural equivalence, a family test on the betas of the two LDR's (Huang, p. 108). All the extra variables in the method 3 LDR are assumed to be in the method 1 LDR only at a zero level. The results of these tests are summarized in table 17. Note the method 1 and method 3 LDR's are not structurally different when evaluated on the best and worst samples. The composite sample method 1 and method 3 LDR's are, however, significantly different. The results of this test and the previous tests on the best and worst sample are not conflicting since they test different aspects of the relationship between the LDR's. Hence, LDR's from the same structural family may induce significant differences in the explained sum squares or R^2.

Table 16

Comparison of Method 1 and 3 LDR's on Contribution to Sum Squares

	Price LDR	Marketing LDR	Volume LDR
Composite Data Set	F=22.2 which is greater than $_{.95}F_{7,590}=2.01$	F=17.3 which is greater than $_{.95}F_{9,588}=1.88$	F=10.8 which is greater than $_{.95}F_{8,588}=1.94$
Best Data Set	F=7.9 which is greater than $_{.95}F_{4,65}=2.53$	F=9.12 which is greater than $_{.95}F_{4,65}=2.53$	F=22.9 which is greater than $_{.95}F_{2,65}=3.15$
Worst Data Set	F=6.86 which is greater than $_{.95}F_{2,46}=3.22$	F=5.878 which is greater than $_{.95}F_{1,47}=4.07$	F=7.172 which is greater than $_{.95}F_{2,45}=3.22$

A Significant Difference was Found in all Tests

Table 17

Structural Equivalence of Method 1 and 3 LDR's

	Price Rule	Marketing Rule	Volume Rule
Composite Data Set	Significant Difference $F=1.635 > {}_{.95}F_{24,576}=1.52$	Significant Difference $F=2.76 > {}_{.95}F_{24,576}=1.52$	Significant Difference $F=2.91 > {}_{.95}F_{20,580}=1.57$
Best Data Set	No Significant Difference $F=1.407 < {}_{.95}F_{12,60}=1.83$	No Significant Difference $F=1.17 < {}_{.95}F_{14,58}=1.84$	No Significant Difference $F=.735 < {}_{.95}F_{14,58}=1.84$
Worst Data Set	No Significant Difference $F=.51 < {}_{.95}F_{10,41}=2.08$	No Significant Difference $F=.7 < {}_{.95}F_{12,39}=2.00$	No Significant Difference $F=.49 < {}_{.95}F_{8,43}=2.18$

Having found some evidence of statistical differences among rules, it will be necessary to examine the value of these differences when predicting the criterion. Tables 18 through 20 contain the confidence intervals on the predictions for Y at the grand mean $\overline{Y}$ and the grand mean $\overline{Y}$ at the grand mean $\overline{Y}$.

At this point we can argue whether these differences are of a practical value. The best way to approach this point is to think of the LDR's in terms of predicting the future. Then we could examine the degree of improvement of method 3 over method 1 LDR's. This approach is embodied in table 21. If we were to predict the future using method 1 LDR we can find a confidence interval within which we would expect the true value of the criterion to be 95% of the time. Now if we were to predict using method 3 LDR's we would have a slightly smaller interval. The latter table contains the degree of confidence that the true value would lie outside the method 3 interval but inside the method 1 LDR. In other words this is the degree of confidence that method 3 interval would give us useful information above and beyond that of the method 1 LDR's. This is done by using the significance level on the heuristic distribution of the limits of the method 3 confidence interval.

Table 21 then tells us that method 3 LDR's give us, at best, a rule which would be more useful than the method 1 rule 7.8% of the time. In the average case method 3 is more useful only about 4.4% of the time. That small amount of improvement is not of much practical value except in the most critical of circumstances. Further, the cost of getting the additional information might be relatively large as information on three times as many variables is needed.

Table 18

Confidence Intervals on Price LDR Predictions

	Method 1	Method 2	Method 3
Composite Data Set	SSE=.1018, K=3 $\bar{Y}\pm.20$, $\bar{Y}\pm.008$	SSE=.0925, K=11 $\bar{Y}\pm.18$, $\bar{Y}\pm.007$	SSE=.0925, K=10 $\bar{Y}\pm.18$, $\bar{Y}\pm.007$
Best Data Set	SSE=.069, K=3 $\bar{Y}\pm.136$, $\bar{Y}\pm.016$	SSE=.0586, K=7 $\bar{Y}\pm.116$, $\bar{Y}\pm.013$	SSE=.0586, K=7 $\bar{Y}\pm.116$, $\bar{Y}\pm .013$
Worst Data Set	SSE=.0939, K=3 $\bar{Y}\pm.188$, $\bar{Y}\pm.026$	SSE=.084, K=5 $\bar{Y}\pm.169$, $\bar{Y}\pm.024$	SSE=.086, K=4 $\bar{Y}\pm.172$, $\bar{Y}\pm.024$

Average Price is 6.255

KEY

SSE = Standard Error of the Estimate

K = Number of Structural Coefficients

$\bar{Y} \pm 1.96$ SSE = Interval on Y at $\bar{Y}$

$\bar{Y} \pm 1.96\ SSE/\sqrt{n}$ = Interval on $\bar{Y}$ at $\bar{Y}$

Table 19

Confidence Intervals on Marketing LDR Predictions

	Method 1	Method 2	Method 3
Composite Data Set	SSE=.732, K=3 $\bar{Y} \pm 1.43$, $\bar{Y} \pm .057$	SSE=.6567, K=12 $\bar{Y} \pm 1.287$, $\bar{Y} \pm .051$	SSE=.6567, K=12 $\bar{Y} \pm 1.287$, $\bar{Y} \pm .051$
Best Data Set	SSE=.5137, K=3 $\bar{Y} \pm 1.017$, $\bar{Y} \pm .12$	SSE=.4004, K=7 $\bar{Y} \pm .79$, $\bar{Y} \pm .09$	SSE=.4004, K=7 $\bar{Y} \pm .79$, $\bar{Y} \pm .09$
Worst Data Set	SSE=.539, K=3 $\bar{Y} \pm 1.08$, $\bar{Y} \pm .152$	SSE=.514, K=4 $\bar{Y} \pm 1.03$, $\bar{Y} \pm .146$	SSE=.4434, K=6 $\bar{Y} \pm .89$, $\bar{Y} \pm .125$

Average Marketing was 3.25 (in hundred thousands)

KEY

SSE = Standard Error of the Estimate

K = Number of Structural Coefficient

$\bar{Y} \pm 1.96$ SSE = Interval on Y at $\bar{Y}$

$\bar{Y} \pm 1.96$ SSE/$\sqrt{n}$ = Interval on $\bar{Y}$ at $\bar{Y}$

Table 20

Confidence Intervals on the Volume LDR Predictions

	Method 1	Method 2	Method 3
Composite Data Set	SSE=1.003, K=4 $\bar{Y}\pm1.96$, $\bar{Y}\pm.079$	SSE=.937, K=12 $\bar{Y}\pm1.84$, $\bar{Y}\pm.074$	SSE=.937, K=12 $\bar{Y}\pm1.84$, $\bar{Y}\pm.074$
Best Data Set	SSE=.569, K=4 $\bar{Y}\pm1.126$, $\bar{Y}\pm.13$	SSE=.4444, K=6 $\bar{Y}\pm.876$, $\bar{Y}\pm.103$	SSE=.4444, K=6 $\bar{Y}\pm.876$, $\bar{Y}\pm.103$
Worst Data Set	SSE=1.1, K=4 $\bar{Y}\pm2.2$, $\bar{Y}\pm.31$	SSE=.981, K=6 $\bar{Y}\pm1.97$, $\bar{Y}\pm.277$	SSE=.978, K=5 $\bar{Y}\pm1.96$, $\bar{Y}\pm.277$

Average Volume is 5.35 (in hundreds of thousands)

KEY

SSE = Standard Error of the Estimate

K = Number of Structural Coefficients

$\bar{Y} \pm 1.96$ SSE = Interval on Y at $\bar{Y}$

$\bar{Y} \pm 1.96\ SSE/\sqrt{n}$ = Interval on $\bar{Y}$ at $\bar{Y}$

Table 21

Improvement in the Degree of Confidence of Method 3 over Method 1 LDR's

	Price LDR	Marketing LDR	Volume LDR
Composite Data Set	.045	.03	.0158
Best Data Set	.043	.078	.0786
Worst Data Set	.0218	.0512	.0318

When we consider the predictions on the grand mean $\overline{Y}$ at $\overline{Y}$, the percent of the time when method 3 is more useful than method 1 LDR's is identical with Y at $\overline{Y}$ which we just discussed. However if we return to the confidence intervals contained in tables 18 through 21, we find that the value of that difference in intervals is very small. For example, the difference for the composite price LDR's is .2¢. On the marketing LDR it is $1200 and on the volume LDR it is 1000 units. These are all quite small when considered in terms of the magnitude of the mean of these variables. Thus for predicting the grand mean Y we can additionally argue that the magnitude of the gain in reliability is relatively small.

Our findings in comparing method 1 and 3 LDR's are:

1. There are statistically significant differences in the R^2's and additions to the sums squared explained variance.

2. In the best and worst samples the LDR's are from the same structural family; the LDR's on the composite sample are significantly different.

3. Even though the differences are statistically significant the practical differences are not apparent in terms of improvement in our predictions.

Thus we conclude that the heuristic models can be statistically improved upon, however, little practical value can be gained from such an inclusion of new variables.

Realizing that my argument for a lack of practical difference among the various methods to obtain LDR's might not be completely accepted the subsequent hypotheses examining bias, variance, and learning were examined for both method 1 and method 3 LDR's.

In fact, given the statistically significant differences of the method 1 and 3 rules, we could be criticized if we did not test both.

One could argue if bias or variance was demonstrated across rank, time or industry for the method 1 LDR's it was simply because these heuristic rules were inadequate representatives of the subject's behavior. This point could be strenghtened by pointing to the statistically significant differences in method 1 and 3 LDR's. However, if we test method 3 LDR's we test the best possible rule by all criteria including that of statistical significance. Then no criticism such as the foregoing is available. As we will see the bias and variance effects across time, rank and industry are, if anything, even stronger for the method 3 LDR's. Or looked at another way, the method 1 LDR's may obscure the outcome of the tests. The difference in the outcome of these tests for method 1 and 3 LDR's could result from random effects rather than true differences in the method 1 and 3 rules. However, no test is available to demonstrate that assertion.

It is important to note that method 1 LDR's should be tested also since we desire to have our results applicable to rules calculated by both method 1 and 3 procedures.

Bias in Decision Making among Teams of Different Rank

In an earlier discussion we examined Bowman's assertion that due to dish shaped cost surfaces the variance rather than bias was the major source of economic inefficiency. We found that given further assumptions on the model his assertion would hold. Bias must be measured relative to some preferred rule. The optimal rules would certainly be appropriate, however, they do not exist for the price, marketing and volume rules in the Executive Game. The most appropriate available standard would be the rules used by the best team in each industry.

If bias is not a determinant of team performance then we would not expect bias to fluctuate across team standings. The latter hypothesis is tested and the results shown in table 22.

The first three tests are on the heuristic best price, marketing and volume rules. Only in the case of the volume do we find significant fluctuations in bias across rank. A linear equation is a significant predictor at .05 of those fluctuations; however, it is not clear from the equation that the best teams are more unbiased than the worst teams.

The next three tests all show significant fluctuations in bias relative to the method 3 best rules. In all three cases a linear trend based on team rank is apparent at .05. These equations predict that the worse the team the more highly biased it will be to the best team's decision rule. Apparently simplifying the method 3 to the heuristic rule obscured this effect.

The conclusions based on the method 3 rules point to the need to re-evaluate the role of bias in Bowman's theory.

Variance in Decision Making among Teams of Different Rank

Bowman has asserted that variance is the major source of economic inefficiency. Thus we would expect that variance would discriminate the levels of team performance. In particular we would hypothesize that variance should be a direct linear function of final team rank.

As earlier discussed, the mean average deviation of the actual from the predicted value was used to measure the variance. This measure would show the degree to which teams consistently used a decision rule. Thus it is a measure of erratic behavior which

Table 22

Significance Levels for the Tests on Bias across Final Team Rank

Heuristic LDR's	Price LDR	Marketing LDR	Volume LDR
Best Rules on the Composite Data Set	.242	.621	.009 with linear effects equation 1

Method 3 LDR's			
Best Rules on the Composite Data Set	.033 with linear effects equation 2	.106 with linear effects equation 3	.003 with linear effects equation 4

Equation 1: Mean Volume = .173 - .041 (Rank)
Equation 2: Mean Price = .033 - .009 (Rank)
Equation 3: Mean Marketing = .0677 - .03 (Rank)
Equation 4: Mean Volume = .196 + .064 (Rank)

Bowman thinks is the underlying cause of inefficiency. The standards of performance we shall use to calculate the MAD are the best rules.

These results parallel those on bias. The MAD for the best heuristic volume rule has significant fluctuations across rank. These fluctuations are fit at .05 by a linear equation. The equation shows MAD to be a function of rank such that the lower ranked teams had larger MAD's.

All method 3 MAD's had significant fluctuations across time which were fitted by a linear equation. Again the lower the rank the larger the MAD. Table 23 summarizes these findings.

The results support the contention that variance (as measured by MAD) discriminates the levels of team performance. This finding lends support to Bowman's assertion that variance is a source of economic inefficiency.

Learning

An earlier study (Carter, Jenicke, and Remus) had indicated the need for including in the theory learning effects. This paper will examine two interrelated measures of learning.

In the preceding section we introduced MAD of the actual from the predicted decision as a measure of erratic decision making. In this case however, we used the composite rules which characterize aggregate behavior as the preferred rule. This was done to find how the subjects learned their own rules rather than the optimal rules. If learning were to take place we would hypothesize that the MAD would decrease over time.

Table 23

Significance Level for the Tests on MAD Across Rank

Heuristic LDR's	Price LDR	Marketing LDR	Volume LDR
Best Rules on the Composite Data Set	.745	.051	.0005 with linear effects equation 1

Method 3 LDR's			
Best Rules on the Composite Data Set	.033 with linear effects equation 2	.0005 with linear effects equation 3	.0005 with linear effects equation 4

Equation 1: Volume MAD = .453 +.05 (Rank)
Equation 2: Price MAD = .10 + .01 (Rank)
Equation 3: Marketing MAD = .36 + .03 (Rank)
Equation 4: Volume MAD = .515 + .083 (Rank)

Another measure of interest evaluates the average propensity to use a LDR. A decision maker could be behaving erratically while, on the average, be using the composite LDR. The measure is the mean signed deviations (MSD) of the actual from the predicted decision. We would hypothesize that if learning occurred as time progressed, the decision makers would get closer to the rule characterizing their aggregate behavior, thus reducing the MSD.

Table 24 contains the results of the tests of learning using MSD. Both the heuristic price and volume LDR's yield linear trends in MSD over time. As predicted, MSD is reduced as play proceeds. This table also shows that all three method 3 LDR's manifested linear trends to their MSD. Again, MSD was reduced as time progressed.

Table 25 contains the results of the tests of learning using MAD. These results are mixed. We find the heuristic price and volume LDR's have significant fluctuations in MAD over time. The MAD for the price LDR is reduced as time proceeds, however, the volume LDR shows the opposite effect. The linear trend in the latter case explains only 9% of the variance in all means. This may be a type II error.

The method 3 price and volume rules also show significant fluctuations in MAD's. The price rule, as in the heuristic rule, has a linear trend in the predicted direction. The volume rule shows no linear trend again suggesting that the heuristic volume rule trend was a type II error.

We conclude that the learning effect has been demonstrated in terms of mean signed deviations of the actual from the predicted decisions. The learning effect in mean absolute deviations was only

Table 24

Significance Levels for the Tests on MSD across Time Periods

Heuristic LDR's	Price LDR	Marketing LDR	Volume LDR
Composite Rules on the Composite Data Set	.0005 with linear effects equation 1	.777	.0005 with linear effects equation 2
Method 3 LDR's			
Composite Rules on the Composite Data Set	.0005 with linear effects equation 3	.037 with linear effects equation 4	.0005 with linear effects equation 5

Equation 1: Mean Price = .174 - .0332 (Period Number)
Equation 2: Mean Volume = .173 - .041 (Period Number)
Equation 3: Mean Price = -.26 + .049 (Period Number)
Equation 4: Mean Marketing = .14 - .02 (Period Number)
Equation 5: Mean Volume = .59 - .112 (Period Number)

Table 25

Significance Levels for the Tests on MAD across Time Periods

Heuristic LDR's	Price LDR	Marketing LDR	Volume LDR
Composite Rules on the Composite Data Set	.0005 with linear effects equation 1	.322	.0005 with linear effects equation 2

Method 3 LDR's			
Composite Rules on the Composite Data Set	.0005 with linear effects equation 3	.920	.0005 with no linear effects

Equation 1: Price MAD = .10 - .022 (Period Number)
Equation 2: Volume MAD = .384 + .066 (Period Number)
Equation 3: Price MAD = .28 - .04 (Period Number)

manifest in 1 of 3 cases and therefore not well supported. Both of these learning effects relative to the optimal rule were found by Carter, Jenicke, and Remus. We interpret these results as indicating an increased propensity to use the composite rules and weak support for a reduction of erratic behavior as play proceeds.

Summary of the Effects of Rank and Time

The findings of our tests in the preceding three sections are:

1. We found that bias relative to the best rule was a linear function of rank. The lowest ranked teams had the largest bias.

2. We found that variance (defined in terms of MAD) relative to the best rule was a linear function of rank. The lowest ranked teams had the largest variance.

3. The degree of support for the findings on bias and variance were equally strong.

4. Learning was manifest as play proceeded by an increased average propensity to use the linear decision rule characterizing aggregate behavior.

5. Weak support was found for reduced erratic behavior relative to composite rules as play progressed.

CHAPTER V

SUMMARY AND CONCLUSIONS

In the prior chapter we evaluated a number of significant research questions. It is the intent of this chapter to integrate those results into existing theoretical frameworks. This includes restating Bowman's theory in the light of this and other studies. This chapter also includes a plan for research projects which will expand and elaborate this area of study.

Conclusions

The results of this study have implications for Bowman's managerial coefficient theory.

Even in competitive business simulation games we can conceptualize the decision maker as a decision rule coefficient estimator. The heuristic models found have concurrent and cross validity. Once a heuristic model is found according to the guidelines, little practical improvement seems to be gained from the addition of more variable.

Significant levels of bias occurred over the ranks of the teams. It often had a linear trend such that we can assert that the poorer ranked teams were more biased relative to the best rules than the better teams. So we could argue that, at least with environments in which the manager is not fully experienced in decision making, we can distinguish the better firms from the poorer firms on the degree of bias they have from industry leaders. Thus, using the industry leaders as a bench mark to examine a firms decisions seems to be a good idea.

Thus we note that, with the exception of fully experienced managers in stable environments decision making may be biased relative to industry leaders. In particular, Bowman's theory should include stipulations as to poorer teams being more biased than better teams at least while learning is going on.

The variance is asserted to be the cause of the poorer economic performance of some firms since the cost surface is postulated to be dish shaped. We found that the degree of variance (as measured by MAD) did distinguish the better from the poorer teams. The degree of support for both bias and variance discriminating team performance is equally strong. Thus variance may not be the major source of inefficiency.

We examined learning in terms of increased propensity to use the composite rules and reduced erratic behavior relative to the composite LDR's. Strong support was found for the former indicating that the subjects in the aggregate tend to get closer to the composite rules as play proceeds. Weaker support was found for the reduction of aggregate erratic behavior over time relative to the composite rules.

Thus we would suggest the following additions to Bowman's theory:

1. Linear decision rules may be appropriate for unstable, competitive environments. They have both concurrent and cross validity.

2. The linear decision rules used by the best, worst and the aggregate industry may be significantly different. That is, different managers may have different insights into similar decision making situations.

3. Bias from the first place teams' rule discriminates levels of team performance. The lower the rank the larger the bias.

4. Variance (as measured by MAD) discriminates the levels of team performance. The lower rank teams have a larger MAD relative to the best teams' rules.

5. Both of the preceding effects are equally strong. Thus economic inefficiency may not be solely attributable to variance.

6. Learning was manifest as both increased propensity to use the composite rules and reduced erratic behavior relative to the composite rule as play progresses.

All of the foregoing must be qualified by the obvious fact that the data from which the conclusions were drawn came from inexperience young decision makers. The results are also confounded by the fact that all subjects had the same classroom influences while they were playing this game; this is a business game rather than the business world. We might point out in support of the preceding that the learning effects also appeared in an earlier piece of empirical research (Carter, Jenicke and Remus) done with a aggregate production scheduling game. The other questions were not addressed by the latter study.

Need for Further Study

This section reliably appears in all dissertation and alludes to studies that need to be performed but seldom are performed. For a change of pace I shall use this section to outline my direction for future study in this topic area.

It is now clear that the Executive Game being played singly by inexperienced decision makers, yields results which are consistent with the literature and which allow us to examine new and interesting hypotheses. Further this source of data is readily available in quite large quantities, at a low price. In Management 101 this source of data is fully institutionalized.

The first need is to replicate the major findings of this study on the data generated by play in the Spring of 1974. Particularly of concern is that these derived rules may have been idiosyncratic to the winter version of Management 101. The autocorrelation on the price LDR needs further examination and perhaps even a non-lagged rule selected.

Then I will be able to return to the data which has been used for this study. There are many questions which can be asked of these data not examined in the hundred plus tests in this paper. Extension of this analysis to other variables in the Executive Game could aid us to understand the mechanisms which lead to game success. I need to examine the interrelationship of bias and variance in each industry to see if idiosyncratic patterns of covariation occur within each industry. The game play then could be selectively replicated using the linear decision rules to assert that rules in this competitive environment give better results than actual behavior. Ultimately we could devise a linear model based on our derived rules which would actually compete with live decision makers period by period.

An analysis of the individual decision rules has yet to be made. I can then address myself to the equivalence of various individual rules to the composite and examine the effects of non-composite rule behavior.

Data has been collected on student grades and national test scores. Also a questionnaire has been filled out by all participants which examines the decision making behavior and their opinions about the benefits of the game and the real managerial world. The latter data can be used to try to develop behavioral and attitudinal correlates of decision making parameters such as bias and variance, learning effects, and the variance not examined by the decision rules.

Bowman claims his theory applies also to group decision making. Fortunately all the hypothesis of this paper are amenable to the data from Executive Game when played by teams in Management 409 and 833. This is virgin territory.

These studies are bootstrapped into the Carter, Jenicke and Remus studies on aggregate production scheduling which is now institutionalized in Management 306. Thus cross fertilization will undoubtedly occur.

The aim of my future work will be to add more rigor to the field.

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APPENDIX COMPUTER PRINTOUTS

The following nine computer printous are the outputs for LDR's found on the composite data set. The first three are the heuristic price, marketing and volume rules. The three method 2 rules then follow in the latter order. The method 3 rules for price, marketing and volume are the last three printouts in this section.

DEPENDENT VARIABLE--X(4) PRICE
AOV FOR OVERALL REGRESSION

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	2.79267231	2	1.39633616	134.5271	<0.0005
ERROR	6.19661502	597	.01037959		
TOTAL (ABOUT MEAN)	8.98928733	599			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.3107	.5574	.3084	.5553	.10188027

MULTIPLE CORR COEFS

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	2.71465396	.23063603	0.00000	0.00000	11.7703	138.5398	<0.0005	.43399	.15070
ICE INDE	12	.29882493	.02459381	.52048	.04284	12.1504	147.6326	<0.0005	.44527	.14020
NEXT E I	32	.01755110	.00108310	.69135	.04284	16.1393	260.4762	<0.0005	.55115	.00990

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	325.83625610	2	162.91812805	303.4495	<0.0005
ERROR	320.52158027	597	.53688707		
TOTAL (ABOUT MEAN)	646.35783637	599			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
600	.5041	.7100	.5024	.7088	.73272578

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	.77532008	.11912130	0.00000	0.00000	6.5087	42.3627	<0.0005	.25741	.46892
TG INDEX	13	1.00535500	.04438912	.78219	.03454	22.6487	512.9628	<0.0005	.67981	.07803
T POTENT	19	-.07496595	.01707401	-.15163	.03454	-4.3906	19.2778	<0.0005	-.17686	.48810

DEPENDENT VARIABLE--X(8)   VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	490.26482059	3	163.42160686	162.1881	<0.0005
ERROR	600.53272160	596	1.00760524		
TOTAL (ABOUT MEAN)	1090.79754219	599			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.4495	.6704	.4467	.6683	1.00379542

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	1.51751553	.20982065	C.00000	C.00000	7.2324	52.3082	<0.0005	.28405	.40114
MKTG	5	.39804395	.04121948	.30640	.03173	9.6567	93.2518	<0.0005	.36782	.36332
AD INDEX	14	.55463306	.10468355	.18809	.03550	5.2997	28.0765	<0.0005	.21211	.42352
T POTENT	19	.25942319	.02365509	.40393	.03683	10.9669	120.2731	<0.0005	.40977	.33836

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	3.94221167	10	.39422117	46.0061	<0.0005
ERROR	5.04707567	589	.00856889		
TOTAL (ABOUT MEAN)	8.98928733	599			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.4385	.6622	.4290	.6550	.09256829

(MULTIPLE CORR COEFS: R2, R, R BAR 2, R BAR)

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	-10.19099709	2.55324404	0.00000	0.00000	-3.9914	15.9312	<0.0005	-.16228	.42336
NEXT E I	32	-.00250454	.00388405	-.09860	.15291	-.6448	.4158	.519	-.02656	.43815
RICE INDE	12	.40653441	.02656476	.70809	.04627	15.3035	234.1979	<0.0005	.53338	.21530
LES VOLU	20	.02143445	.00469630	.20041	.04391	4.5641	20.8311	<0.0005	.18482	.41869
VOLUME	8	-.01941750	.00382736	-.21390	.04216	-5.0733	25.7388	<0.0005	-.20462	.41401
TG INDEX	13	.04248985	.00781791	.28032	.05159	5.4349	29.5386	<0.0005	.21853	.41039
MKTG	5	-.02278188	.00554692	-.19318	.04704	-4.1071	16.8685	<0.0005	-.16686	.42247
STD COST	24	4.15945218	.82715508	2.84814	.56639	5.0286	25.2871	<0.0005	.20289	.41444
SOFG	15	-.01801229	.00701614	-.08531	.03323	-2.5673	6.5908	.010	-.10520	.43226
NEXT S I	31	.00353107	.00073924	.26618	.05931	4.7766	22.8163	<0.0005	.19311	.41680
NUAL CHN	30	.18697975	.04400916	1.94938	.45891	4.2488	18.0519	<0.0005	.17244	.42134

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	392.78851720	11	35.70804702	82.8031	<0.0005
ERROR	253.56931917	588	.43124034		
TOTAL (ABOUT MEAN)	646.35783637	599			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.6077	.7795	.6004	.7748	.65668892

MULTIPLE CORR COEFS: R2, R, R BAR 2, R BAR

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	-5.93189421	2.29346516	0.00000	0.00000	-2.5864	6.6896	.010	-.10606	.60323
TG INDEX	13	.94046576	.04654898	.73170	.03622	20.2038	408.1948	<0.0005	.64012	.33535
T POTENT	19	-.05931827	.02429142	-.11796	.04913	-2.4008	5.7637	.017	-.09852	.60385
VOLUME	9	.18796200	.02683247	.24418	.03486	7.0050	49.0703	<0.0005	.27753	.57496
LES VOLU	20	-.08695442	.03408751	-.09588	.03759	-2.5509	6.5072	.011	-.10462	.60335
INTENANC	7	.32640111	.08262936	.11094	.02808	3.9502	15.6039	<0.0005	.16078	.59728
ATERIALS	10	-.01373803	.00670324	-.05629	.02737	-2.0569	4.2309	.040	-.08452	.60487
ICE INDE	12	1.06209955	.22093288	.21816	.04538	4.8073	23.1101	<0.0005	.19446	.59228
PRICE	4	-1.05329021	.27774018	-.12422	.03275	-3.7924	14.3820	<0.0005	-.15452	.59810
STD COST	24	2.03803713	.55456447	.16458	.04478	3.6750	13.5058	<0.0005	.14984	.59868
PAD	5	.12956658	.03652063	.11245	.03170	3.5478	12.5866	<0.0005	.14477	.59930
AD INDEX	14	-.27281160	.08421064	-.12017	.03710	-3.2396	10.4952	.001	-.13242	.60069

DEPENDENT VARIABLE--X(8) VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	572.58157504	11	52.05287046	59.0624	<0.0005
ERROR	518.21596715	588	.88131967		
TOTAL (ABOUT MEAN)	1090.79754219	599			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.5249	.7245	.5160	.7184	.93878628

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	.58929079	2.55133380	0.00000	0.00000	.2309	.0533	.817	.00952	.52488
AD INDEX	14	.34929983	.10354304	.11810	.03511	3.3638	11.3153	.001	.13741	.51578
MKTG	5	.36252039	.04062639	.27906	.03127	8.9233	79.6248	<0.0005	.34535	.46059
T POTENT	19	.16012991	.03303573	.24933	.05144	4.8472	23.4951	<0.0005	.19602	.50594
NEXT F I	32	.06773715	.01370953	.24230	.04900	4.9453	24.4556	<0.0005	.19983	.50516
ATERIALS	10	.02873714	.00958840	.09050	.03045	2.9723	8.8348	.003	.12167	.51778
PRICE	4	-1.93932718	.39277154	-.17665	.03555	-4.9375	24.3794	<0.0005	-.19953	.50522
SOFG	19	-.30326040	.07288856	-.13039	.03134	-4.1606	17.3106	<0.0005	-.16911	.51093
LES VOLU	20	.21273242	.04620469	.18056	.03922	4.6041	21.1980	<0.0005	.18604	.50779
ICE INDE	12	.85684347	.30897724	.13548	.04885	2.7732	7.6904	.006	.11362	.51871
NEXT S I	31	.01097507	.00415548	.08075	.03057	2.6413	6.9762	.008	.10828	.51928
CASH	21	-.01155580	.00455636	-.07920	.03123	-2.5362	6.4323	.011	-.10402	.51972

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	3.93864869	9	.43762763	51.1223	<0.0005
ERROR	5.05063864	590	.00856040		
TOTAL (ABOUT MEAN)	8.98928733	599			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.4381	.6619	.4295	.6554	.09252245

MULTIPLE CORR COEFS

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	-9.04425211	1.83116918	0.00000	0.00000	-4.9391	24.3944	<0.0005	-.19926	.41492
NNUAL CHN	30	.16939067	.03451804	1.76600	.35997	4.9073	24.0817	<0.0005	.19803	.41522
RICE INDE	12	.40632072	.02654954	.70772	.04624	15.3042	234.2201	<0.0005	.53308	.21510
ALES VOLU	20	.02131546	.00469035	.19929	.04385	4.5445	20.6528	<0.0005	.18390	.41848
VOLUME	3	-.01935873	.00382471	-.21336	.04213	-5.0641	25.6451	<0.0005	-.20410	.41373
KTG INDEX	13	.04254745	.00781353	.28070	.05155	5.4454	29.6519	<0.0005	.21875	.40991
MKTG	5	-.02275618	.00554403	-.19296	.04701	-4.1046	16.8480	<0.0005	-.16662	.42211
STD COST	24	3.75144760	.53249689	2.56877	.36462	7.0450	49.6322	<0.0005	.27856	.39088
SOFG	19	-.01801966	.00701236	-.08535	.03321	-2.5696	6.6028	.010	-.10520	.43186
NEXT S I	31	.00314277	.00042857	.25471	.03473	7.3332	53.7752	<0.0005	.28902	.38694

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	392.89856536	11	35.71805137	82.8623	<0.0005
ERROR	253.45927131	588	.43105318		
TOTAL (ABOUT MEAN)	646.35783637	599			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.6079	.7797	.6005	.7749	.65654641

(MULTIPLE CORR COEFS: R2, R, R BAR 2, R BAR)

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	.77776011	1.62702247	0.00000	0.00000	.4780	.2285	.633	.01971	.60771
TG INDEX	13	.92981985	.04610930	.72341	.03587	20.1653	406.6410	<0.0005	.63940	.33568
ICE INDE	12	1.09214081	.22484569	.22431	.04019	4.8568	23.5889	<0.0005	.19639	.59213
VOLUME	8	.18803831	.02680918	.24428	.03483	7.0140	49.1955	<0.0005	.27786	.57506
PRICE	4	-1.04929238	.27653221	-.12374	.03261	-3.7944	14.3977	<0.0005	-.15460	.59826
NUAL CHN	30	-.12391280	.03301329	-.15973	.04305	-3.7104	13.7670	<0.0005	-.15125	.59868
T POTENT	19	-.04927390	.02378640	-.09967	.04811	-2.0715	4.2912	.039	-.08512	.60500
INTENANC	7	.32343877	.08264284	.10992	.02809	3.9133	15.3142	<0.0005	.15932	.59765
LES VOLU	20	-.08307367	.03432445	-.09160	.03785	-2.4202	5.8576	.016	-.09932	.60396
ATERIALS	10	-.01394096	.00669395	-.05692	.02735	-2.0808	4.3295	.038	-.08549	.60498
RAD	5	.12832793	.03649243	.11137	.03167	3.5166	12.3662	<0.0005	.14352	.59962
RAD INDEX	14	-.28376969	.08436065	-.12560	.03716	-3.3638	11.3149	.001	-.13740	.60032

DEPENDENT VARIABLE--X(8) VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	572.58157504	11	52.05287046	59.0624	<0.0005
ERROR	518.21596715	588	.88131967		
TOTAL (ABOUT MEAN)	1090.79754219	599			

CASES	R2	MULTIPLE CORR COEFS R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
600	.5249	.7245	.5160	.7184	.93878628

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	.58929079	2.55183380	0.00000	0.00000	.2309	.0533	.817	.00952	.52488
KT POTENT	19	.16012991	.03303573	.24933	.05144	4.8472	23.4951	<0.0005	.19602	.50594
MKTG	5	.35252039	.04062639	.27906	.03127	8.9233	79.6248	<0.0005	.34535	.46059
RAD INDEX	14	.34320983	.10354304	.11810	.03511	3.3638	11.3153	.001	.13741	.51578
NEXT L I	32	.06779715	.01370953	.24230	.04900	4.9453	24.4556	<0.0005	.19983	.50516
MATERIALS	10	.02879714	.00968340	.09050	.03045	2.9723	8.8349	.003	.12167	.51778
PRICE	4	-1.93932718	.39277154	-.17605	.03566	-4.9375	24.3794	<0.0005	-.19953	.50522
SOFG	18	-.30326040	.07288856	-.13039	.03134	-4.1606	17.3106	<0.0005	-.16911	.51093
ALES VOLU	20	.21273242	.04620469	.18056	.03922	4.6041	21.1980	<0.0005	.18654	.50779
RICE INDE	12	.85684347	.30837724	.13548	.04885	2.7732	7.6904	.006	.11362	.51871
NEXT S I	31	.01097567	.00415549	.08075	.03057	2.6413	6.9762	.008	.10828	.51928
CASH	21	-.01155580	.00455536	-.07920	.03123	-2.5362	6.4323	.011	-.10402	.51972

The following nine computer printouts are the outputs for LDR's found on the best data set. The first three are the heuristic price, marketing and volume rules. The next three are the method 2 price, marketing and volume rules. The last three are the method 3 price, marketing and volume rules.

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	.43854109	2	.21927054	45.7026	<0.0005
ERROR	.33104641	69	.00479777		
TOTAL (ABOUT MEAN)	.76958750	71			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
72	.5698	.7549	.5574	.7466	.06926597

MULTIPLE CORR COEFS: R2, R, R BAR 2, R BAR

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	-.05403077	.81995670	0.00000	0.00000	-.0659	.0043	.948	-.00793	.56981
NEXT E I	32	.02767492	.00297038	1.28764	.13820	9.3170	86.8061	<0.0005	.74642	.02867
PRICE INDE	12	.59483454	.09263832	.88749	.13820	6.4216	41.2367	<0.0005	.61162	.31276

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	56.78494705	2	28.39247352	107.5807	<0.0005
ERROR	18.21033507	69	.26391790		
TOTAL (ABOUT MEAN)	74.99528212	71			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
		MULTIPLE CORR COEFS			
72	.7572	.8702	.7501	.8661	.51372940

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	.71053198	.26166915	0.00000	0.00000	2.7154	7.3733	.008	.31071	.73123
KTG INDEX	13	1.18925394	.08362376	.98633	.06935	14.2215	202.2506	<0.0005	.86349	.04543
KT POTENT	19	-.15391043	.03584165	-.29782	.06935	-4.2942	18.4400	<0.0005	-.45922	.69229

DEPENDENT VARIABLE--X(8) VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	58.82030703	3	19.60676901	60.3773	<0.0005
ERROR	22.08214267	68	.32473739		
TOTAL (ABOUT MEAN)	80.90244969	71			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
72	.7271	.8527	.7150	.8456	.56985734

(MULTIPLE CORR COEFS: R2, R, R BAR 2, R BAR)

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	1.65821361	.38175701	0.00000	0.00000	4.3436	18.8673	<0.0005	.46604	.65132
MKTG	5	.32567365	.06760973	.31356	.06509	4.8170	23.2031	<0.0005	.50439	.63392
MKT POTENT	19	.27161655	.04597363	.50604	.08566	5.9073	34.8965	<0.0005	.58236	.58698
RAD INDEX	14	.69933199	.19419633	.30222	.08393	3.6010	12.9672	.001	.40019	.67500

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	.54629351	6	.09104892	26.5040	<0.0005
ERROR	.22329399	65	.00343529		
TOTAL (ABOUT MEAN)	.76958750	71			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
72	.7099	.8425	.6831	.8265	.05861136

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	-.33006373	.72417683	0.00000	0.00000	-.4558	.2077	.650	-.05644	.70893
NEXT E I	32	.02739501	.00279800	1.27462	.13018	9.7909	95.8620	<0.0005	.77196	.28194
PRICE INDE	12	.65833122	.08373913	.98214	.12488	7.8645	61.8505	<0.0005	.69827	.43376
SOFG	18	-.14215527	.03778550	-.29403	.07815	-3.7624	14.1559	<0.0005	-.42289	.64666
RAD INDEX	14	.07131863	.02007918	.31602	.08897	3.5519	12.6158	.001	.40316	.65354
VOLUME	8	-.03395157	.01127308	-.34811	.11558	-3.0117	9.0706	.004	-.34994	.66936
CASH	21	-.00284577	.00138137	-.16071	.07801	-2.0601	4.2441	.043	-.24757	.69091

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	64.57245767	6	10.76207628	67.1157	<0.0005
ERROR	10.42282444	65	.16035115		
TOTAL (ABOUT MEAN)	74.99528212	71			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
72	.8610	.9279	.8482	.9210	.40043869

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	1.36672918	.55119747	0.00000	0.00000	2.4354	5.9311	.018	.28917	.84834
MKTG INDEX	13	.98081183	.08126555	.81345	.06740	12.0692	145.6661	<0.0005	.83154	.54956
MKT POTENT	19	-.24351151	.04202882	-.47120	.08133	-5.7939	33.5695	<0.0005	-.58358	.78924
VOLUME	8	.45456596	.08014437	.47213	.08324	5.6718	32.1698	<0.0005	.57538	.79224
RAD INDEX	14	-.68509363	.14356685	-.30752	.06444	-4.7719	22.7715	<0.0005	-.50935	.81233
NEXT S I	31	-.01297037	.00504328	-.12531	.04872	-2.5718	6.6142	.012	-.30391	.84688
MAINTENANC	7	.57017225	.23027441	.16058	.06485	2.4761	6.1309	.016	.29358	.84791

DEPENDENT VARIABLE--X(8) VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	67.87523091	5	13.57504618	68.7755	<0.0005
ERROR	13.02721878	66	.19738210		
TOTAL (ABOUT MEAN)	80.90244969	71			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
72	.8390	.9160	.8268	.9093	.44427706

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	-5.14147110	1.49644798	0.00000	0.00000	-3.4358	11.8046	.001	-.38951	.81018
RAD INDEX	14	.64117419	.15166675	.27710	.06555	4.2275	17.8719	<0.0005	.46161	.79537
MKTG	5	.46801312	.05737189	.45060	.05524	8.1575	66.5454	<0.0005	.70856	.67662
MKT POTENT	19	.12171112	.04714352	.22675	.08783	2.5817	6.6653	.012	.30286	.82271
NEXT E I	32	.09221989	.01669599	.41849	.07577	5.5231	30.5051	<0.0005	.56223	.76455
MAIN INDEX	15	-2.13819024	.48672168	-.23658	.05385	-4.3930	19.2988	<0.0005	-.47566	.79189

DEPENDENT VARIABLE--X(4)   PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	.54629351	6	.09104892	26.5040	<0.0005
ERROR	.22329399	65	.00343529		
TOTAL (ABOUT MEAN)	.76958750	71			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
72	.7099	.8425	.6831	.8265	.05861136

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	-.33006378	.72417683	0.00000	0.00000	-.4558	.2077	.650	-.05644	.70893
NEXT E I	32	.02733501	.00279800	1.27462	.13018	9.7909	95.8620	<0.0005	.77196	.28194
RICE INDE	12	.65833122	.08370913	.98214	.12488	7.8645	61.8505	<0.0005	.69827	.43376
SOFG	18	-.14216527	.03779550	-.29403	.07815	-3.7624	14.1559	<0.0005	-.42289	.64666
RAD INDEX	14	.07131863	.02007918	.31602	.08897	3.5519	12.6158	.001	.40316	.65354
VOLUME	9	-.03395157	.01127308	-.34811	.11559	-3.0117	9.0706	.004	-.34994	.66936
CASH	21	-.00284577	.00138137	-.16071	.07801	-2.0601	4.2441	.043	-.24757	.69091

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	64.57245767	6	10.76207628	67.1157	<0.0005
ERROR	10.42282444	65	.16035115		
TOTAL (ABOUT MEAN)	74.99528212	71			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
72	.8510	.9279	.8482	.9210	.40043869

(MULTIPLE CORR COEFS: R2, R, R BAR 2, R BAR)

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	1.36672918	.56119747	0.00000	0.00000	2.4354	5.9311	.018	.28917	.84834
KTG INDEX	13	.98081183	.08126555	.81345	.06740	12.0692	145.6561	<0.0005	.83154	.54956
RAD INDEX	14	-.68500363	.14356685	-.30752	.06444	-4.7719	22.7715	<0.0005	-.50935	.81233
VOLUME	8	.45456595	.08014437	.47213	.08324	5.6718	32.1598	<0.0005	.57538	.79224
KT POTENT	13	-.24351151	.04202992	-.47120	.08133	-5.7939	33.5695	<0.0005	-.58358	.78924
NEXT S I	31	-.01297037	.00504328	-.12531	.04872	-2.5718	6.6142	.012	-.30391	.84688
INTENANC	7	.57017226	.23027441	.16058	.06485	2.4761	6.1309	.016	.29358	.84791

DEPENDENT VARIABLE--X(8) VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	67.87523091	5	13.57504618	68.7755	<0.0005
ERROR	13.02721878	66	.19738210		
TOTAL (ABOUT MEAN)	80.90244969	71			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
72	.8390	.9160	.8268	.9093	.44427706

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	F9	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	-5.14147110	1.49644798	0.00000	0.00000	-3.4358	11.8046	.001	-.38951	.81018
T POTENT	13	.12171112	.04714352	.22675	.08793	2.5917	6.6053	.012	.30286	.82271
MKTG	5	.46801312	.05737189	.45060	.05524	8.1575	66.5454	<0.0005	.70856	.67662
NEXT F I	32	.09221989	.01669699	.41849	.07577	5.5231	30.5051	<0.0005	.56223	.76455
IN INDEX	15	-2.13819024	.48672168	-.23658	.05385	-4.3930	19.2988	<0.0005	-.47566	.79189
AD INDEX	14	.64117419	.15166575	.27710	.05555	4.2275	17.8719	<0.0005	.46161	.79537

The following nine computer printouts are the outputs for LDR's found on the worst data set. The first three are the heuristic price, marketing and volume rules. The next three are the method 2 price, marketing and volume rules. The last three are the method 3 price, marketing and volume rules.

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	.17552949	2	.08776475	9.9535	<0.0005
ERROR	.42323913	48	.00881748		
TOTAL (ABOUT MEAN)	.59876863	50			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
51	.2932	.5414	.2637	.5135	.09390145

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	4.04612529	.50036453	0.00000	0.00000	8.0864	65.3891	<0.0005	.75939	-.66977
NEXT E I	32	.00941562	.00304465	.40663	.13149	3.0925	9.5636	.003	.40760	.15232
PRICE INDE	12	.20677079	.04971813	.54684	.13149	4.1589	17.2961	<0.0005	.51467	.03845

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	21.64293825	2	10.82146912	37.1331	<0.0005
ERROR	13.98834509	48	.29142386		
TOTAL (ABOUT MEAN)	35.63128333	50			

CASES	R2	MULTIPLE CORR COEFS R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
51	.6074	.7794	.5911	.7688	.53983688

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	.17672373	.34378336	0.00000	0.00000	.5141	.2643	.610	.07399	.60525
MKTG INDEX	13	1.03799056	.15221342	.75214	.11030	6.8190	46.4993	<0.0005	.70147	.22710
MKT POTENT	19	.01757419	.04216553	.04597	.11030	.4168	.1737	.679	.06005	.60599

ELAPSED 3.609 04/01/74

DEPENDENT VARIABLE--X(8) VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	34.58369753	3	11.52789918	9.4808	<0.0005
ERROR	57.14855724	47	1.21592675		
TOTAL (ABOUT MEAN)	91.73225477	50			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
51	.3770	.6140	.3372	.5807	1.10269069

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	2.18782496	.65973499	0.00000	0.00000	3.3162	10.9973	.002	.43545	.23124
MKTG	5	-.14095602	.24921383	-.08786	.15532	-.5656	.3199	.574	-.08223	.37277
MKT POTENT	19	.24345501	.08408995	.39691	.13709	2.8952	8.3820	.006	.38904	.26590
RAD INDEX	14	.97220350	.41486383	.37129	.15844	2.3434	5.4917	.023	.32345	.30421

DEPENDENT VARIABLE--X(4)   PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	.27276638	4	.06819160	9.6221	<0.0005
ERROR	.32600225	46	.00708701		
TOTAL (ABOUT MEAN)	.59876863	50			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
51	.4555	.6749	.4082	.6389	.08418435

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	4.23967332	.43782546	0.00000	0.00000	8.6910	75.5328	<0.0005	.78835	-.43846
NEXT E I	32	.00540426	.00295489	.23339	.12761	1.8289	3.3450	.074	.26036	.41595
PRICE INDE	12	.22087183	.04830508	.58413	.12775	4.5724	20.9072	<0.0005	.55900	.20809
RAD INDEX	14	.07839245	.02597351	.36910	.12278	3.0062	9.0374	.004	.40522	.34858
DIVIDEND	11	-.13744103	.05408789	-.29734	.11701	-2.5411	6.4570	.014	-.35084	.37912

DEPENDENT VARIABLE--X(5)   MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	23.19792283	3	7.73264094	29.2306	<0.0005
ERROR	12.43336050	47	.26453959		
TOTAL (ABOUT MEAN)	35.63128333	50			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
51	.6511	.8069	.6288	.7930	.51433412

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	-4.55070946	1.97719772	0.00000	0.00000	-2.3016	5.2973	.026	-.31827	.61173
MKTG INDEX	13	1.15021270	.15223574	.83346	.11031	7.5555	57.0851	<0.0005	.74057	.22723
MKT POTENT	19	-.06929380	.05393007	-.18126	.14081	-1.2873	1.6571	.204	-.18454	.63875
NEXT E I	32	.05075327	.02093372	.28414	.11719	2.4245	5.8781	.019	.33341	.60741

DEPENDENT VARIABLE--X(8) VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	48.39698254	5	9.67939651	10.0512	<0.0005
ERROR	43.33527223	45	.96300605		
TOTAL (ABOUT MEAN)	91.73225477	50			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
51	.5276	.7264	.4751	.6893	.98132872

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	1.97389523	.59982420	0.00000	0.00000	3.2908	10.8293	.002	.44042	.41390
RAD INDEX	14	.35678659	.40583678	.13626	.15499	.8791	.7729	.384	.12994	.51948
MKTG	5	.27400840	.25221572	.17077	.15719	1.0864	1.1803	.283	.15987	.51520
MKT POTENT	19	.15551315	.07927983	.25517	.12925	1.9742	3.8974	.055	.28232	.48667
CASH	21	-.03169406	.00971351	-.41444	.12710	-3.2609	10.6333	.002	-.43719	.41596
DIVIDEND	11	1.81755317	.62691286	.31769	.10958	2.8992	8.4054	.006	.39672	.43935

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	.24906058	3	.08302023	11.1577	<0.0005
ERROR	.34970795	47	.00744059		
TOTAL (ABOUT MEAN)	.59876863	50			

CASES	R2	MULTIPLE CORR COEFS R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
51	.4160	.6449	.3787	.6154	.08625888

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	4.93925795	.31021162	0.00000	0.00000	15.9222	253.5171	<0.0005	.91848	-2.73437
DIVIDEND	11	-.17031570	.05227087	-.36846	.11319	-3.2583	10.6167	.002	-.42926	.28403
ICE INDE	12	.19072284	.04652419	.50440	.12304	4.0994	16.8054	<0.0005	.51321	.20712
AD INDEX	14	.08912594	.02588440	.42130	.12236	3.4432	11.8558	.001	.44882	.26863

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	26.78279915	5	5.35655983	27.2414	<0.0005
ERROR	8.84848419	45	.19663298		
TOTAL (ABOUT MEAN)	35.63128333	50			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
51	.7517	.8670	.7241	.8509	.44343318

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	-8.59229458	2.85574187	0.00000	0.00000	-3.0087	9.0523	.004	-.40924	.70171
KTG INDEX	13	1.02231339	.13100725	.74078	.09493	7.8035	60.8944	<0.0005	.75832	.41562
NEXT E I	32	.04953233	.01449655	.27730	.08116	3.4168	11.6748	.001	.45387	.68724
RICE INDE	12	.69956996	.28488589	.23984	.09767	2.4556	6.0300	.018	.34375	.71839
RAD	5	.26433955	.07955931	.27629	.08315	3.3226	11.0396	.002	.44384	.69074
AINTENANC	7	-.98032289	.42773785	-.18492	.08064	-2.2930	5.2581	.027	-.32345	.72265

DEPENDENT VARIABLE--X(8)   VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	47.65269068	4	11.91317267	12.4322	<0.0005
ERROR	44.07956409	46	.95825139		
TOTAL (ABOUT MEAN)	91.73225477	50			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
51	.5195	.7207	.4777	.6912	.97890316

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	2.13811275	.56858866	0.00000	0.00000	3.7604	14.1405	<0.0005	.48490	.37176
T POTENT	13	.16492306	.07850506	.26888	.12799	2.1008	4.4132	.041	.29587	.47337
CASH	21	-.03511719	.00888347	-.45921	.11616	-3.9531	15.6269	<0.0005	-.50356	.35623
DIVIDEND	11	1.94751932	.60772725	.34040	.10622	3.2046	10.2694	.002	.42721	.41220
MKTG	5	.41270469	.19629501	.25721	.12234	2.1025	4.4203	.041	.29609	.47330

The following three computer printouts are the outputs for LDR's found on the period 2 through 4 portion of the composite data set. They are the heuristic price, marketing and volume rules.

DEPENDENT VARIABLE--X(4) PRICE

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	.74915394	2	.37457697	47.3471	<0.0005
ERROR	2.38921000	302	.00791129		
TOTAL (ABOUT MEAN)	3.13836393	304			

CASES	R2	MULTIPLE CORR COEFS R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
305	.2387	.4886	.2337	.4834	.08894544

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
NSTANT	0	2.12401974	.53233557	0.00000	0.00000	3.9900	15.9201	<0.0005	.22378	.19858
NEXT E I	32	.01988191	.00434644	.24420	.05339	4.5743	20.9242	<0.0005	.25455	.18596
ICE INDE	12	.35990635	.03736443	.51423	.05339	9.6323	92.7817	<0.0005	.48479	.00482

DEPENDENT VARIABLE--X(5) MKTG

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	175.73328714	2	87.86664357	190.5108	<0.0005
ERROR	139.28721841	302	.46121595		
TOTAL (ABOUT MEAN)	315.02050554	304			

CASES	R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
	MULTIPLE CORR COEFS				
305	.5578	.7469	.5549	.7449	.67912882

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CO STANT	0	.44218993	.21021730	0.00000	0.00000	2.1035	4.4247	.036	.12017	.55137
MK G INDEX	13	1.34129492	.08891652	.88213	.05949	15.0849	227.5535	<0.0005	.65552	.22469
MK POTENT	19	-.20435693	.06204873	-.19307	.05849	-3.3015	10.9002	.001	-.18664	.54189

DEPENDENT VARIABLE--X(8)   VOLUME

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	99.42771719	3	33.14257240	49.4808	<0.0005
ERROR	201.61189790	301	.66980697		
TOTAL (ABOUT MEAN)	301.03961508	304			

CASES	R2	MULTIPLE CORR COEFS R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
305	.3303	.5747	.3236	.5689	.81841736

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
ONSTANT	0	1.70101835	.31600816	0.00000	0.00000	5.3928	28.9749	<0.0005	.29633	.26581
MKTG	5	.32353938	.05269466	.33613	.05390	6.2357	38.8843	<0.0005	.33824	.24376
KT POTENT	13	.27581115	.06036159	.26591	.05790	4.5921	21.0877	<0.0005	.25588	.28336
RAD INDEX	14	.47962034	.16210260	.15142	.05118	2.9587	8.7542	.003	.16811	.31080

The following three printouts show the analysis of variance on bias relative to the best heuristic LDR's across team final rank. They are as follows:

1. Best price LDR on the composite sample
2. Best marketing LDR on the composite sample
3. Best volume LDR on the composite sample

The next three printouts cover in the same order the three analysis of variances for bias relative to the best method 3 LDR's across final team rank.

S T A T I S T I C S F O R E A C H C A T E G O R Y

DEPENDENT VARIABLE IS X(39) BP
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- -.617757 MAXIMUM VALUE- .8172

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	67.542261	701	.09635130		37.5582838	.21061305	31.050499
CATEGORY							
1.000000	6.319478	84	.07523188	-.021119	3.7204386	.19772844	3.245012
2.000000	6.934838	84	.08255759	-.013794	3.9816899	.20266794	3.409166
3.000000	5.228172	82	.06375819	-.032593	3.8731567	.20904893	3.539818
4.000000	7.729697	83	.09312888	-.003222	3.8025615	.19389158	3.082704
5.000000	6.786677	83	.08176720	-.014584	4.1459946	.20926997	3.591067
6.000000	8.596431	79	.10881559	.012464	4.1473540	.20292503	3.211928
7.000000	10.481858	74	.14164673	.045295	5.6312462	.23833111	4.146525
8.000000	7.433335	77	.09560175	.000250	4.1229052	.21164639	3.404349
9.000000	8.026776	55	.14594138	.049590	4.1329371	.23418489	2.961498

A N A L Y S I S O F V A R I A N C E T A B L E (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(39) BP
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE	SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
TWEEN CATEGORIES	.45843085	8	.05730386	1.29623	.242
THIN CATEGORIES	30.59206824	692	.04420819		
TAL	31.05049910	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.121507	.014764

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(41) BM
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- -4.149578 MAXIMUM VALUE- 3.8129

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	-3.277713	701	-.00467577		366.3934278	.72346202	366.378102
CATEGORY							
1.000000	-3.632201	84	-.04324049	-.038565	28.0339785	.57953991	27.876920
2.000000	2.206448	84	.02626724	.030943	25.3012288	.55148509	25.243271
3.000000	-2.575375	82	-.03140701	-.026731	40.2785837	.70446284	40.197699
4.000000	6.459634	83	.07782692	.082503	45.7276486	.74264619	45.224915
5.000000	6.679188	83	.08047215	.085148	65.2047165	.88804545	64.667228
6.000000	-4.094679	79	-.05183138	-.047156	45.7336865	.76394265	45.521454
7.000000	-10.994553	74	-.14857504	-.143899	64.6858157	.92937033	63.052300
8.000000	.267236	77	.00347059	.008146	38.6859152	.71345147	38.684988
9.000000	2.406588	55	.04375614	.048432	12.7418543	.48374602	12.636551

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(41) BM
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE	SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES	3.27277588	8	.40909698	.77965	.621
WITHIN CATEGORIES	363.10532609	692	.52471868		
TOTAL	366.37810197	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.094513	.008933

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(43) BV
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- -9.011512 MAXIMUM VALUE- 5.6904

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	177.484758	701	.25318796		710.7235007	.97525564	665.786497
CATEGORY							
1.000000	3.495258	84	.04161021	-.211578	24.6103567	.54291625	24.464918
2.000000	7.605839	84	.09054570	-.162642	34.9951062	.64290784	34.306430
3.000000	20.436819	82	.24922950	-.003958	63.2446253	.84729903	58.151167
4.000000	15.708425	83	.18925814	-.063930	62.9463321	.85520918	59.973385
5.000000	15.752459	83	.18978866	-.063399	159.1333625	1.37549859	155.143725
6.000000	21.845773	79	.27652877	.023341	105.1071919	1.12697807	99.066207
7.000000	20.765918	74	.28062051	.027433	84.4591206	1.03785054	78.630778
8.000000	40.375490	77	.52435701	.371169	124.5635217	1.11598533	94.652253
9.000000	23.798779	55	.43270507	.179517	52.5598836	.88466330	42.262031

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(43) BV
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		19.13560251	8	2.39195031	2.55970	.009
LINEAR	14.03424903		1	14.03424903	15.01846	<0.0005
OTHER	5.10135349		7	.72876478	.77987	.604
WITHIN CATEGORIES		646.65089472	692	.93446661		
TOTAL		665.78649724	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.169533	.028741

IF RESTRICTED TO A LINEAR TERM ONLY,(X(43)=- .01581834+ .05632420*X(51))

SIMPLE CORRELATION COEFFICIENT

R	SQUARED (R2)
.1452	.0211

REGRESSION SUM OF SQUARES
14.03424903

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	-.01581834				
FRANK	51	.05632420	.01451788	3.8796	15.0516	<0.0005

STATISTICS FOR EACH CATEGORY

DEPENDENT VARIABLE IS X(55) LBP
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- -.677932 MAXIMUM VALUE- .8599

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	54.158456	701	.07725885		35.7957270	.21250717	31.611507
CATEGORY							
1.000000	5.693054	84	.06777445	-.009484	2.9690701	.17641772	2.583226
2.000000	5.268190	84	.06271654	-.014542	3.5580950	.19720008	3.227693
3.000000	3.283198	82	.04003900	-.037220	3.4007943	.20090346	3.269338
4.000000	5.483123	83	.06606178	-.011197	3.1702975	.18505346	2.808072
5.000000	4.084491	83	.04921074	-.028048	3.6705257	.20569709	3.469526
6.000000	6.623343	79	.08387784	.006619	3.8640065	.20594381	3.308203
7.000000	7.660732	74	.10352341	.026265	6.1008064	.26964566	5.307741
8.000000	6.702737	77	.08704853	.009790	4.6962097	.23262649	4.112746
9.000000	9.356576	55	.17011957	.092861	4.3659198	.22665781	2.774183

ANALYSIS OF VARIANCE TABLE (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(55) LBP
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
TWEEN CATEGORIES		.75077725	8	.09384716	2.10436	.033
LINEAR	.37972108		1	.37972108	8.51461	.004
OTHER	.37105616		7	.05300802	1.18862	.307
THIN CATEGORIES		30.86072960	692	.04459643		
TAL		31.61150685	700			

MULTIPLE CORRELATION COEFFICIENT
R .154111   SQUARED (R2) = ETA .023750

IF RESTRICTED TO A LINEAR TERM ONLY,[X(55)=+ .03301018+ .00926473*X(51)]

SIMPLE CORRELATION COEFFICIENT
R .1096   SQUARED (R2) .0120

REGRESSION SUM OF SQUARES .37972108

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.03301018				
FRANK	51	.00926473	.00317805	2.9152	8.4986	.004

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(56) LBM
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- -4.187759 MAXIMUM VALUE- 3.3385

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	-55.558823	701	-.07925653		406.3068220	.75772538	401.903422
CATEGORY							
1.000000	-1.703961	84	-.02028525	.058971	16.5802224	.44648098	16.545657
2.000000	2.162527	84	.02574437	.105001	25.0021029	.54823298	24.946430
3.000000	-6.937323	82	-.08460760	-.005351	37.3294409	.67350611	36.742448
4.000000	.105381	83	.00126964	.080526	34.2700859	.64647215	34.269952
5.000000	2.214899	83	.02668553	.105942	79.1912620	.98235752	79.132156
6.000000	-6.089211	79	-.07707862	.002178	57.5450028	.85541754	57.075655
7.000000	-13.257995	74	-.17916209	-.099916	55.1780182	.85048486	52.802688
8.000000	-23.041259	77	-.29922414	-.219968	82.9327278	1.00025343	76.038526
9.000000	-9.012387	55	-.16386158	-.084605	18.2779531	.55779286	16.801175

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(56) LBM
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
(BE)TWEEN CATEGORIES		7.54873381	8	.94359173	1.65578	.136
LINEAR	4.18838362		1	4.18838362	7.34963	.007
OTHER	3.36035019		7	.48005003	.84238	.552
(WI)THIN CATEGORIES		394.35468806	692	.56987672		
(T)OTAL		401.90342188	700			

MULTIPLE CORRELATION COEFFICIENT
R .137049
SQUARED (R2) = ETA .018782

IF RESTRICTED TO A LINEAR TERM ONLY,[X(56)=+ .06770074- .03076973*X(51)]

SIMPLE CORRELATION COEFFICIENT
R -.1021
SQUARED (R2) .0104

REGRESSION SUM OF SQUARES
4.18838362

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.06770074				
FRANK	51	-.03076973	.01134091	-2.7132	7.3613	.007

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(57) LBV
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- -8.771779 MAXIMUM VALUE- 7.4691

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	352.914123	701	.50344383		1209.4067227	1.21404535	1031.734286
CATEGORY							
1.000000	20.896464	84	.24876742	-.254676	50.9556148	.74249056	45.757255
2.000000	28.555589	84	.34114987	-.162294	64.3733888	.81104720	54.597197
3.000000	43.424023	82	.52956132	.026117	91.1097222	.91701365	68.114036
4.000000	39.520212	83	.47614714	-.027297	102.5360759	1.01042517	83.718640
5.000000	36.704439	83	.44222216	-.061222	187.5430863	1.44539458	171.311570
6.000000	29.905333	79	.37854851	-.124895	185.4550321	1.49415705	174.135413
7.000000	32.972384	74	.44558087	-.057863	232.0475852	1.72553527	217.355454
8.000000	77.761767	77	1.00989308	.506449	189.7983797	1.20997667	111.267309
9.000000	43.072307	55	.78313285	.279689	105.5868377	1.15354124	71.855499

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(57) LBV
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
TWEEN CATEGORIES		33.62191095	8	4.20273887	2.91380	.003
LINEAR	18.30187128		1	18.30187128	12.68885	<0.0005
OTHER	15.32003967		7	2.18857710	1.51736	.158
THIN CATEGORIES		998.11237480	692	1.44235892		
TAL		1031.73428576	700			

MULTIPLE CORRELATION COEFFICIENT
R .180521 SQUARED (R2) = ETA .032588

IF RESTRICTED TO A LINEAR TERM ONLY,[X(57)=+ .19624779+ .06432032*X(51)]

SIMPLE CORRELATION COEFFICIENT
R .1332 SQUARED (R2) .0177

REGRESSION SUM OF SQUARES 18.30187128

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.19624779				
FRANK	51	.06432032	.01810336	3.5529	12.6234	<0.0005

The following three printouts show the analysis of variance on MAD relative to the best heuristic LDR's across final team rank. The order is:

1. Best price LDR on the composite data set
2. Best marketing LDR on the composite data set
3. Best volume LDR on the composite data set

The next three printouts cover in the same order the three analysis of variances for MAD relative to the best method 3 LDR's across final team rank.

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(40)   ABP
CATEGORY VARIABLE IS X(51)   FRANK

(OVERALL) MINIMUM VALUE- .000092 MAXIMUM VALUE- .8172

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	98.304238	701	.14023429		37.5582838	.18428494	23.772659
CATEGORY							
1.000000	10.262455	84	.12217209	-.018062	3.7204386	.17239116	2.466653
2.000000	10.474938	84	.12470164	-.015533	3.9816899	.17953917	2.675448
3.000000	11.154456	82	.13602995	-.004204	3.8731567	.17054078	2.355817
4.000000	10.902625	83	.13135693	-.008877	3.8025615	.17002246	2.370426
5.000000	11.318130	83	.13636302	-.003871	4.1459946	.17815519	2.602620
6.000000	11.121449	79	.14077783	.000544	4.1473540	.18193055	2.581701
7.000000	12.293036	74	.16612211	.025888	5.6312462	.22173355	3.589101
8.000000	11.157769	77	.14490609	.004672	4.1229052	.18158935	2.506077
9.000000	9.619380	55	.17489782	.034664	4.1329371	.21302619	2.450529

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(40)   ABP
CATEGORY VARIABLE IS X(51)   FRANK

SOURCE OF VARIANCE	SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
ETWEEN CATEGORIES	.17428794	8	.02178599	.63885	.745
ITHIN CATEGORIES	23.59837071	692	.03410169		
OTAL	23.77265865	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.085624	.007331

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(42) ABM
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- .001268 MAXIMUM VALUE- 4.1496

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	346.569558	701	.49439309		366.3934278	.52786880	195.051832
CATEGORY							
1.000000	34.684698	84	.41291307	-.081480	28.0339785	.40645712	13.712214
2.000000	32.663567	84	.38885198	-.105541	25.3012288	.38962349	12.599936
3.000000	42.263536	82	.51540898	.021016	40.2785837	.47784983	18.495577
4.000000	41.015140	83	.49415831	-.000235	45.7276486	.55721078	25.459676
5.000000	50.501320	83	.60844964	.114057	65.2047165	.64842414	34.477206
6.000000	42.175752	79	.53387028	.039477	45.7336865	.54558021	23.217306
7.000000	43.548887	74	.58849848	.094105	64.6859157	.73145996	39.057362
8.000000	39.435660	77	.51216442	.017771	38.6859152	.49321530	18.487861
9.000000	20.279997	55	.36872722	-.125666	12.7418543	.31222224	5.264067

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(42) ABM
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE	SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES	4.28062663	8	.53507833	1.94093	.051
WITHIN CATEGORIES	190.77120569	692	.27568093		
TOTAL	195.05183231	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.148142	.021946

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(44)   ARV
CATEGORY VARIABLE IS X(51)   FRANK

(OVERALL)   MINIMUM VALUE-   .003774   MAXIMUM VALUE-   9.0115

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	486.778431	701	.69440575		710.7235007	.72967875	372.701759
CATEGORY							
1.000000	37.343192	84	.44456181	-.249844	24.6103567	.31063478	8.008999
2.000000	42.228404	84	.50271909	-.191687	34.9951062	.40725472	13.766081
3.000000	57.513505	82	.70138421	.005979	63.2446253	.53177505	22.905561
4.000000	48.403125	83	.58317017	-.111236	62.9453321	.65969450	34.719073
5.000000	67.971938	83	.81893865	.124533	159.1333626	1.11786240	102.468540
6.000000	64.421029	79	.81545605	.121050	105.1071919	.82099530	52.574673
7.000000	59.631302	74	.80582841	.111423	84.4581206	.70619105	36.405523
8.000000	67.020145	77	.87039149	.175985	124.5685217	.93425145	66.334758
9.000000	42.245822	55	.76810585	.073730	52.5538836	.61026134	20.110621

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(44)   ARV
CATEGORY VARIABLE IS X(51)   FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
ETWEEN CATEGORIES		15.40792789	8	1.92599098	3.73022	<0.0005
LINEAR	11.26746852		1	11.26746852	21.82262	<0.0005
OTHER	4.14045936		7	.59149419	1.14559	.332
ITHIN CATEGORIES		357.29383067	692	.51632056		
OTAL		372.70175855	700			

MULTIPLE CORRELATION COEFFICIENT
R   SQUARED (R2) = ETA
.203325   .041341

IF RESTRICTED TO A LINEAR TERM ONLY,[X(44)=+ .45337024+ .05046771*X(51)]

SIMPLE CORRELATION COEFFICIENT
R   SQUARED (R2)
.1739   .0302

REGRESSION SUM OF SQUARES
11.26746852

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.45337024				
FRANK	51	.05046771	.01081126	4.6681	21.7909	<0.0005

S T A T I S T I C S F O R E A C H C A T E G O R Y

DEPENDENT VARIABLE IS X(64) ALBP
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- .000032 MAXIMUM VALUE- .8599

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	102.119687	701	.14567716		35.7957270	.17287163	20.919221
CATEGORY							
1.000000	8.848903	84	.10534408	-.040333	2.9690701	.15665519	2.036891
2.000000	10.830115	84	.12892994	-.016747	3.5580960	.16138593	2.161770
3.000000	11.351417	82	.13841972	-.007257	3.4037943	.15029488	1.829673
4.000000	10.183754	83	.12269583	-.022981	3.1702975	.15315002	1.920793
5.000000	11.337703	83	.13659890	-.009078	3.6705267	.16085929	2.121808
6.000000	11.491993	79	.14546826	-.000209	3.8640065	.16764914	2.192286
7.000000	13.441864	74	.18164681	.035973	6.1008064	.22388643	3.659135
8.000000	13.719917	77	.17818074	.032504	4.6962097	.17212239	2.251585
9.000000	10.913017	55	.19845485	.052778	4.3659198	.20183335	2.199782

A N A L Y S I S O F V A R I A N C E T A B L E (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(64) ALBP
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
TWEEN CATEGORIES		.54549877	8	.06818735	2.31601	.019
LINEAR	.46379538		1	.46379538	15.75296	<0.0005
OTHER	.08170339		7	.01167191	.39644	.935
THIN CATEGORIES		20.37372244	692	.02944180		
TAL		20.91922121	700			

MULTIPLE CORRELATION COEFFICIENT
R .161482
SQUARED (R2) = ETA .026076

IF RESTRICTED TO A LINEAR TERM ONLY,[X(64)=+ .09677466+ .01023914*X(51)]

SIMPLE CORRELATION COEFFICIENT
R .1483
SQUARED (R2) .0222

REGRESSION SUM OF SQUARES .46379538

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.09677466				
FRANK	51	.01023914	.00257197	3.9810	15.8488	<0.0005

STATISTICS FOR EACH CATEGORY

DEPENDENT VARIABLE IS X(65) ALBM
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- .000731 MAXIMUM VALUE- 4.1878

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	358.612162	701	.51157227		406.3068220	.56423245	222.850784
CATEGORY							
1.000000	26.440933	84	.31477301	-.196799	16.5802224	.31541387	8.257330
2.000000	33.733555	84	.40164946	-.109923	25.0021029	.37143535	11.451030
3.000000	42.067797	82	.51302191	.001450	37.3294409	.44092690	15.747739
4.000000	35.783910	83	.43116760	-.080405	34.2700859	.47932791	18.839930
5.000000	56.955536	83	.68621248	.174640	79.1912620	.69936900	40.107594
6.000000	43.644240	79	.55245874	.040886	57.5450028	.65470057	33.433361
7.000000	44.333455	74	.59910074	.087528	55.1780182	.62611886	28.617812
8.000000	51.040747	77	.66286685	.151295	82.9327278	.80376997	49.099509
9.000000	24.603889	55	.44734344	-.064229	18.2779591	.36695874	7.271571

ANALYSIS OF VARIANCE TABLE (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(65) ALBM
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		10.02490680	8	1.25311335	4.07448	<0.0005
LINEAR	4.25905723		1	4.25905723	13.84826	<0.0005
OTHER	5.76584956		7	.82369279	2.67822	.010
WITHIN CATEGORIES		212.82587632	692	.30755185		
TOTAL		222.85078372	700			

MULTIPLE CORRELATION COEFFICIENT
R .212096
SQUARED (R2) = ETA .044985

IF RESTRICTED TO A LINEAR TERM ONLY,[X(65)=+ .36338033+ .03102824*X(51)]

SIMPLE CORRELATION COEFFICIENT
R .1382
SQUARED (R2) .0191

REGRESSION SUM OF SQUARES
4.25905723

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.36338033				
FRANK	51	.03102824	.00840773	3.6904	13.6194	<0.0005

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(66) ALBV
CATEGORY VARIABLE IS X(51) FRANK

(OVERALL) MINIMUM VALUE- .003617 MAXIMUM VALUE- 8.7718

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	638.659301	701	.91106890		1209.4067227	.94683238	627.544095
CATEGORY							
1.000000	45.432265	84	.54086031	-.370209	50.9556148	.56379849	26.383105
2.000000	54.925117	84	.65387044	-.257198	64.3733888	.59556407	28.459478
3.000000	68.108526	82	.83059179	-.080477	91.1097222	.65300199	34.539340
4.000000	65.902203	83	.79400244	-.117066	102.5360759	.78250353	50.209566
5.000000	81.892965	83	.98666224	.075593	187.5430863	1.14093665	106.742388
6.000000	84.450597	79	1.06899490	.157926	185.4560321	1.10464505	95.178774
7.000000	87.339572	74	1.18026449	.269196	232.0475852	1.32914531	128.963790
8.000000	89.197445	77	1.15840837	.247339	189.7983797	1.06666791	86.471313
9.000000	61.410607	55	1.11655650	.205488	105.5868377	.82796521	37.018425

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(66) ALBV
CATEGORY VARIABLE IS X(51) FRANK

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		33.57791634	8	4.19723954	4.88999	<0.0005
LINEAR	30.40947666		1	30.40947666	35.42955	<0.0005
OTHER	3.16843968		7	.45263424	.52734	.814
WITHIN CATEGORIES		593.96617828	692	.85833263		
TOTAL		627.54409462	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.231316	.053507

IF RESTRICTED TO A LINEAR TERM ONLY, [X(66)=+ .51508974+ .08290961*X(51)]

SIMPLE CORRELATION COEFFICIENT

R	SQUARED (R2)
.2201	.0485

REGRESSION SUM OF SQUARES 30.40947666

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.51508974				
FRANK	51	.08290961	.01389626	5.9663	35.5970	<0.0005

The following three printouts show the analysis of variance for MSD from the heuristic LDR's across time periods. In each case it is evaluated on the composite data set. They are in the order composite price, marketing and volume LDR's.

The subsequent three printouts show the analysis of variance for MSD from the method 3 composite LDR's across time periods. They are evaluated on the composite data set and have the same order as the preceding tests.

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(33) CP
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- -.567915 MAXIMUM VALUE- .5789

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	29.734310	701	.04241699		15.7624619	.14393065	14.501222
CATEGORY							
1.000000	29.734306	101	.29439907	.251982	9.5659469	.09911632	.812095
2.000000	1.751291	103	.01699312	-.025424	.8672395	.09061319	.837497
3.000000	-1.315136	103	-.01276831	-.055185	.7833269	.08683052	.769035
4.000000	-2.027226	99	-.02047703	-.062894	.7656004	.08595732	.724089
5.000000	3.534821	97	.03644146	-.005976	.7401319	.07979909	.611318
6.000000	.222873	100	.00222873	-.040228	1.3163750	.11529012	1.315887
7.000000	-2.163623	98	-.02207775	-.064495	1.7214414	.13135538	1.673674

A N A L Y S I S   O F   V A R I A N C E   T A B L E (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(33) CP
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		7.75762922	6	1.29293804	133.05947	<0.0005
LINEAR	3.08710496		1	3.08710496	317.70165	<0.0005
OTHER	4.67052326		5	.93410465	96.13103	<0.0005
WITHIN CATEGORIES		6.74359378	694	.00971699		
TOTAL		14.50122200	700			

MULTIPLE CORRELATION COEFFICIENT
R .731412
SQUARED (R2) = ETA .534964

IF RESTRICTED TO A LINEAR TERM ONLY,(X(33)=+ .17418442- .03319043*X(3))

SIMPLE CORRELATION COEFFICIENT
R -.4614
SQUARED (R2) .2129

REGRESSION SUM OF SQUARES 3.08710496

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.17418442				
PERIOD	3	-.03319043	.00241390	-13.7497	189.0542	<0.0005

STATISTICS FOR EACH CATEGORY

DEPENDENT VARIABLE IS X(35) CM
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- -4.333131 MAXIMUM VALUE- 3.5310

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	-3.795941	701	-.00541504		353.0800138	.71019058	353.059459
CATEGORY							
1.000000	-3.795941	101	-.03758357	-.032169	32.5584336	.56934847	32.415769
2.000000	3.562384	103	.03458625	.040001	51.6503050	.71075144	51.527095
3.000000	4.710491	103	.04573292	.051148	45.4878494	.66621866	45.272425
4.000000	.082938	99	.00083776	.006253	49.5899102	.71134997	49.589841
5.000000	3.560824	97	.03670953	.042125	56.2676674	.76469536	56.136951
6.000000	-10.091092	100	-.10091092	-.095496	58.2514466	.76033715	57.233145
7.000000	-1.825546	98	-.01862802	-.013213	59.2744017	.78148943	59.240395

ANALYSIS OF VARIANCE TABLE (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(35) CM
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE	SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
ETWEEN CATEGORIES	1.64383711	6	.27397285	.54106	.777
ITHIN CATEGORIES	351.41562155	694	.50636257		
OTAL	353.05945867	700			

MULTIPLE CORRELATION COEFFICIENT
R .068235
SQUARED (R2) = ETA .004656

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(37)   CV
CATEGORY VARIABLE IS X(3)   PERIOD

(OVERALL) MINIMUM VALUE- -9.226249 MAXIMUM VALUE- 5.6773

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	7.376500	701	.01052282		661.5132117	.97206378	661.435590
CATEGORY							
1.000000	7.376513	101	.07303478	.062512	60.9814901	.77744291	60.441748
2.000000	-11.705611	103	-.11364671	-.124170	55.2836785	.72729258	53.953374
3.000000	37.873323	103	.35767304	.357150	72.3408248	.75677935	58.416928
4.000000	1.421327	99	.01435683	.003834	77.3293526	.89162176	77.908957
5.000000	9.393932	97	.09684466	.086322	51.9703872	.72930571	51.061135
6.000000	-23.224527	100	-.23224527	-.242768	145.1765106	1.18825354	139.782724
7.000000	-13.755456	98	-.14036179	-.150885	197.8314579	1.42112456	195.900717

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(37)   CV
CATEGORY VARIABLE IS X(3)   PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		23.97000642	6	3.99500107	4.34930	<0.0005
LINEAR	4.69374025		1	4.69374025	5.11001	.024
OTHER	19.27626617		5	3.85525323	4.19716	.001
WITHIN CATEGORIES		637.46558370	694	.91853831		
TOTAL		661.43559012	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.190366	.036239

IF RESTRICTED TO A LINEAR TERM ONLY,[X(37)=+ .17299983- .04092576*X(3)]

SIMPLE CORRELATION COEFFICIENT

R	SQUARED (R2)
-.0842	.0071

REGRESSION SUM OF SQUARES
4.69374025

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.17299983				
PERIOD	3	-.04092576	.01831032	-2.2351	4.9958	.026

STATISTICS FOR EACH CATEGORY

DEPENDENT VARIABLE IS X(52) LCP
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- -.702036 MAXIMUM VALUE- .3311

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	-46.605373	701	-.06648413		27.3247854	.18603482	24.226268
CATEGORY							
1.000000	-46.604933	101	-.46143498	-.394951	22.2741467	.08769267	.769000
2.000000	.065066	103	.00063171	.067116	.8022869	.08868571	.802246
3.000000	.245146	103	.00238006	.068864	.6031571	.07686081	.602574
4.000000	-.697449	99	-.00704494	.059439	.5481069	.07444992	.543193
5.000000	.260523	97	.00268684	.069171	.4640992	.06947714	.463399
6.000000	.170407	100	.00170407	.068168	1.1466602	.10760805	1.146370
7.000000	-.044235	98	-.00045137	.066033	1.4863283	.12378516	1.486308

ANALYSIS OF VARIANCE TABLE (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(52) LCP
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		18.41317737	6	3.06886290	366.37841	<0.0005
LINEAR	6.84620243		1	6.84620243	817.33882	<0.0005
OTHER	11.56697494		5	2.31339499	276.18633	<0.0005
WITHIN CATEGORIES		5.81309046	694	.00837621		
TOTAL		24.22626783	700			

MULTIPLE CORRELATION COEFFICIENT
R .871809 SQUARED (R2) = ETA .760050

IF RESTRICTED TO A LINEAR TERM ONLY,(X(52)=- .26271044+ .04942675*X(3))

SIMPLE CORRELATION COEFFICIENT
R .5316 SQUARED (R2) .2826

REGRESSION SUM OF SQUARES 6.84620243

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	3	-.26271044				
PERIOD	3	.04942675	.00297868	16.5935	275.3439	<0.0005

STATISTICS FOR EACH CATEGORY

DEPENDENT VARIABLE IS X(53)   LCM
CATEGORY VARIABLE IS X(3)   PERIOD

(OVERALL) MINIMUM VALUE- -3.293729 MAXIMUM VALUE- 3.1054

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	24.858972	701	.03546216		292.7459533	.64571599	291.864401
CATEGORY							
1.000000	24.858987	101	.24612858	.210666	39.2866820	.57591818	33.168175
2.000000	-2.961365	103	-.02875112	-.064213	46.5070146	.67462315	46.421872
3.000000	3.032308	103	.02943989	-.006022	34.3846476	.57985273	34.295377
4.000000	-.153783	99	-.00155337	-.037016	44.0157361	.67017738	44.015497
5.000000	2.975979	97	.03069050	-.004772	46.3187706	.69392757	46.227406
6.000000	-2.690119	100	-.02690119	-.062363	38.5254304	.62322931	38.453063
7.000000	-.204035	98	-.00208199	-.037544	43.7076717	.67126014	43.707247

ANALYSIS OF VARIANCE TABLE (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(53)   LCM
CATEGORY VARIABLE IS X(3)   PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		5.57576375	6	.92929396	2.25273	.037
LINEAR	1.95179972		1	1.95179972	4.73141	.030
OTHER	3.62396403		5	.72479281	1.75699	.120
WITHIN CATEGORIES		286.28863682	694	.41251965		
TOTAL		291.86440056	700			

MULTIPLE CORRELATION COEFFICIENT
R   SQUARED (R2) = ETA
.138217   .019104

IF RESTRICTED TO A LINEAR TERM ONLY,[X(53)=+ .14023531- .02639094*X(3)]

SIMPLE CORRELATION COEFFICIENT
R   SQUARED (R2)
-.1318   .0067

REGRESSION SUM OF SQUARES
1.95179972

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.14023531				
PERIOD	3	-.02639094	.01216556	-2.1693	4.7059	.030

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(54) LCV
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- -9.061001 MAXIMUM VALUE- 6.7544

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	102.574442	701	.14632588		681.5545377	.97581120	666.545242
CATEGORY							
1.000000	102.574382	101	1.01558794	.869262	163.3385706	.76918961	59.165265
2.000000	-1.903871	103	-.01848418	-.164810	45.3519946	.67385926	46.316803
3.000000	7.881510	103	.07652049	-.069805	55.1048476	.73097935	54.501743
4.000000	-18.015350	99	-.18197324	-.328299	78.0310710	.87337464	74.752759
5.000000	16.375851	97	.16882321	.022497	43.5146932	.69733944	46.750069
6.000000	8.378122	100	.08378122	-.062545	113.3796755	1.06684537	112.677746
7.000000	-12.716303	98	-.12975819	-.276084	175.8336854	1.34034016	174.183641

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(54) LCV
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		98.19721533	6	16.36620256	19.98449	<0.0005
LINEAR	35.12504508		1	35.12504508	42.89059	<0.0005
OTHER	63.07217026		5	12.61443405	15.40327	<0.0005
WITHIN CATEGORIES		568.34802677	694	.81894528		
TOTAL		666.54524210	700			

MULTIPLE CORRELATION COEFFICIENT
R	SQUARED (R2) = ETA
.383826	.147323

IF RESTRICTED TO A LINEAR TERM ONLY,[X(54)=+ .59079422- .11195555*X(3)]

SIMPLE CORRELATION COEFFICIENT
R	SQUARED (R2)
-.2295	.0527

REGRESSION SUM OF SQUARES
35.12504508

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.59079422				
PERIOD	3	-.11195555	.01795386	-6.2357	38.8844	<0.0005

The following three printouts show the analysis of variance for MAD relative to heuristic LDR's taken across time. In each case it is evaluated on the composite data set. The order is composite price, marketing and volume LDR's.

The subsequent three printouts show the analysis of variance for MAD relative to the method 3 composite LDR's across time. They are evaluated on the composite data set and have the same order as the preceding tests.

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(34)   ACP
CATEGORY VARIABLE IS X(3)   PERIOD

(OVERALL) MINIMUM VALUE- .00260 MAXIMUM VALUE- .6679

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	73.600427	701	.10499348		15.7624619	.10713741	8.034897
CATEGORY							
1.000000	29.734306	101	.29439907	.189436	9.5658469	.09011632	.812095
2.000000	5.955473	103	.05782012	-.037173	.8672395	.06211027	.393484
3.000000	7.036191	103	.06831253	-.036691	.7859269	.05469764	.305167
4.000000	7.035136	99	.07106249	-.033931	.7656004	.05206575	.265663
5.000000	6.387745	97	.06585306	-.039140	.7401319	.05768903	.319479
6.000000	8.511584	100	.08511534	-.013873	1.3163750	.07732291	.591904
7.000000	7.900941	98	.08071369	-.024230	1.7214414	.10566436	1.083001

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(34)   ACP
CATEGORY VARIABLE IS X(3)   PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		4.26410433	6	.71068406	130.79868	<0.0005
LINEAR	1.32190980		1	1.32190980	243.29244	<0.0005
OTHER	2.94219454		5	.58843891	108.29993	<0.0005
WITHIN CATEGORIES		3.77079285	694	.00543342		
TOTAL		8.03489718	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.728490	.530698

IF RESTRICTED TO A LINEAR TERM ONLY, [X(34)=+ .19121849- .02171891*X(3)]

SIMPLE CORRELATION COEFFICIENT R	SQUARED (R2)	REGRESSION SUM OF SQUARES
-.4056	.1645	1.32190980

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.19121849				
PERIOD	3	-.02171891	.00185121	-11.7323	137.6459	<0.0005

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(36) ACM
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- .000454 MAXIMUM VALUE- 4.3331

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	333.557883	701	.47583150		353.0800138	.52693543	194.362665
CATEGORY							
1.000000	35.651078	101	.35298097	-.122851	32.5584336	.44692596	19.974282
2.000000	50.784735	103	.49305539	.017224	51.6533050	.51077251	26.610633
3.000000	48.700683	103	.47282217	-.003009	45.4878494	.46926190	22.461087
4.000000	49.750111	99	.50252637	.026695	49.5899102	.50090904	24.589167
5.000000	50.481119	97	.52042391	.044592	56.2676674	.55898053	29.996086
6.000000	48.144910	100	.48144910	.005618	58.2514466	.59520070	35.072123
7.000000	50.045277	98	.51066610	.034835	59.2744017	.58958290	33.717975

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(36) ACM
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE	SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
[illegible]TWEEN CATEGORIES	1.94131219	6	.32355203	1.16694	.322
[illegible]ITHIN CATEGORIES	192.42135326	694	.27726420		
[illegible]TAL	194.36266545	700			

MULTIPLE CORRELATION COEFFICIENT

R	SQUARED (R2) = ETA
.099940	.009988

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(38) ACV
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- .002963 MAXIMUM VALUE- 9.2262

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	454.079958	701	.64776030		661.5132117	.72444979	367.378237
CATEGORY							
1.000000	49.003757	101	.48518571	-.162575	60.9804901	.60995547	37.204567
2.000000	54.140333	103	.52563430	-.122126	55.2836785	.51283234	26.825694
3.000000	[illegible]	103	.60281812	-.044942	72.3409248	.58503970	34.911688
4.000000	61.578027	99	.62200027	-.025760	77.9293626	.63589735	39.627813
5.000000	52.352192	97	.53971332	-.108047	51.9703872	.49702984	23.715712
6.000000	87.608373	100	.87608373	.228320	145.1765106	.83135988	68.424766
7.000000	87.307351	98	.89089133	.243131	197.8314579	1.11248814	120.050096

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(38) ACV
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		16.61790050	6	2.76965008	5.47992	<0.0005
LINEAR	12.30695586		1	12.30695586	24.35004	<0.0005
OTHER	4.31094464		5	.86218893	1.70589	.131
WITHIN CATEGORIES		350.76033666	694	.50541835		
TOTAL		367.37823716	700			

MULTIPLE CORRELATION COEFFICIENT
R .212692
SQUARED (R2) = ETA .045234

IF RESTRICTED TO A LINEAR TERM ONLY,[X(38)=+ .38466826+ .06626932*X(3)]

SIMPLE CORRELATION COEFFICIENT
R .1830
SQUARED (R2) .0335

REGRESSION SUM OF SQUARES
12.30695586

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.38466826				
PERIOD	3	.06626932	.01346345	4.9222	24.2277	<0.0005

S T A T I S T I C S   F O R   E A C H   C A T E G O R Y

DEPENDENT VARIABLE IS X(61) ALCP
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- .000158 MAXIMUM VALUE- .7320

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	85.883612	701	.12252298		27.3247854	.15492605	16.801456
CATEGORY							
1.000000	46.604933	101	.46143498	.338912	22.2741467	.08769267	.769000
2.000000	6.975652	103	.06772478	-.054798	.8022869	.05686779	.329862
3.000000	6.125299	103	.05946892	-.063054	.6031571	.04839505	.238892
4.000000	5.552006	99	.05608087	-.066442	.5481069	.04915050	.236746
5.000000	5.206863	97	.05367900	-.068844	.4640992	.04385107	.184600
6.000000	7.946264	100	.07946264	-.043060	1.1466602	.07214107	.515229
7.000000	7.477595	98	.07630199	-.046221	1.4863283	.09716459	.915773

A N A L Y S I S   O F   V A R I A N C E   T A B L E   (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(61) ALCP
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		13.61135361	6	2.26855893	493.52014	<0.0005
LINEAR	4.62012687		1	4.62012687	1005.09870	<0.0005
OTHER	8.99122674		5	1.79824535	391.20442	<0.0005
WITHIN CATEGORIES		3.19010265	694	.00459669		
TOTAL		16.80145626	700			

MULTIPLE CORRELATION COEFFICIENT
R .900072 SQUARED (R2) = ETA .810129

IF RESTRICTED TO A LINEAR TERM ONLY,[X(61)=+ .28372087- .04060356*X(3)]

SIMPLE CORRELATION COEFFICIENT
R -.5244 SQUARED (R2) .2750

REGRESSION SUM OF SQUARES
4.62012687

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.28372087				
PERIOD	3	-.04060356	.00249371	-16.2824	265.1163	<0.0005

STATISTICS FOR EACH CATEGORY

DEPENDENT VARIABLE IS X(62) ALCM
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- .002733 MAXIMUM VALUE- 3.2937

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	310.690070	701	.44320980		292.7459533	.47063038	155.045070
CATEGORY							
1.000000	47.725284	101	.47252756	.029318	39.2866820	.40908642	16.735170
2.000000	44.045604	103	.42762722	-.015583	46.5070146	.52085822	27.671915
3.000000	41.063982	103	.39867944	-.044530	34.3846476	.42023899	18.013282
4.000000	46.080913	99	.46546377	.022254	44.0157361	.47986755	22.566741
5.000000	44.345372	97	.45716878	.013959	46.3187708	.52087118	26.045451
6.000000	42.438470	100	.42438470	-.018825	38.5254304	.45521882	20.515193
7.000000	44.990445	98	.45908617	.015876	43.7076717	.48750555	23.053181

ANALYSIS OF VARIANCE TABLE (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(62) ALCM
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
BETWEEN CATEGORIES		.44413660	6	.07402277	.33229	.920
LINEAR	.00048849		1	.00048849	.00219	.963
OTHER	.44364811		5	.08872962	.39831	.850
WITHIN CATEGORIES		154.60093323	694	.22276792		
TOTAL		155.04506983	700			

MULTIPLE CORRELATION COEFFICIENT
R .053522
SQUARED (R2) = ETA .002865

IF RESTRICTED TO A LINEAR TERM ONLY,[X(62)=+ .44155228+ .00041751*X(3)]

SIMPLE CORRELATION COEFFICIENT
R .0018
SQUARED (R2) .0000

REGRESSION SUM OF SQUARES .00048849

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.44155228				
PERIOD	3	.00041751	.00889666	.0469	.0022	.963

STATISTICS FOR EACH CATEGORY

DEPENDENT VARIABLE IS X(63) ALCV
CATEGORY VARIABLE IS X(3) PERIOD

(OVERALL) MINIMUM VALUE- .000721 MAXIMUM VALUE- 9.0610

	SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	STANDARD DEVIATION	SUM OF SQUARED DEVIATIONS FROM THE MEAN
	470.973927	701	.67186010		681.5545377	.72222469	365.125950
CATEGORY							
1.000000	107.364282	101	1.06301270	.391153	163.3385706	.70149109	49.208975
2.000000	52.128147	103	.50609852	-.165762	46.3519946	.44247539	19.970016
3.000000	51.653234	103	.50148771	-.170372	55.1548476	.53505896	29.201385
4.000000	58.142327	99	.58730128	-.084559	73.0310710	.66917337	43.883714
5.000000	50.930401	97	.52505568	-.146804	49.5146932	.48705532	22.773397
6.000000	71.200343	100	.71200343	.040143	113.3796755	.79572588	62.684788
7.000000	79.554692	98	.81178257	.139922	175.8336854	1.07094992	111.252572

ANALYSIS OF VARIANCE TABLE (ALLOWS A SEPARATE MEAN FOR EACH CATEGORY)

DEPENDENT VARIABLE IS X(63) ALCV
CATEGORY VARIABLE IS X(3) PERIOD

SOURCE OF VARIANCE		SUM OF SQUARES	DEGS. OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
ETWEEN CATEGORIES		26.15110223	6	4.35851704	8.92341	<0.0005
LINEAR	.36308258		1	.36308258	.74336	.389
OTHER	25.78801965		5	5.15760393	10.55942	<0.0005
ITHIN CATEGORIES		338.97484749	694	.48843638		
OTAL		365.12594972	700			

MULTIPLE CORRELATION COEFFICIENT
R .267623 SQUARED (R2) = ETA .071622

IF RESTRICTED TO A LINEAR TERM ONLY,[X(63)=+ .71704934- .01138256*X(3)]

SIMPLE CORRELATION COEFFICIENT
R -.0315 SQUARED (R2) .0010

REGRESSION SUM OF SQUARES .36308258

	VAR	COEFFICIENT	STANDARD ERROR	TB	FB	APPROX. SIGNIFICANCE PROBABILITY OF F STAT.
CONSTANT	0	.71704934				
PERIOD	3	-.01138256	.01364595	-.8341	.6958	.404