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## Faculty Working Papers

EVALUATION OF ALTERNATIVE METHODS OF EARNINGS  
MEASUREMENT VIA A CRITERION OF MANAGERIAL ABILITY

Ronald D. Picur and James C. McKeown

#258

**College of Commerce and Business Administration**  
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FACULTY WORKING PAPERS

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VIA A CRITERION OF MANAGERIAL ABILITY

I) OVERVIEW

A spectrum of alternative methods of earnings measurement has long been the subject of continual debate among accounting theoreticians.<sup>1</sup> Historical cost, business profit, current operating profit and net realizable value all have been championed in the literature--although primarily at the conceptual level.<sup>2</sup> Moreover, the feasibility of implementing such alternatives has been demonstrated in a recent study commissioned by the AICPA.<sup>3</sup> In a similar vein, the ability of these measurement schemes to surrogate economic income (in a Hicksian sense) has been indirectly evaluated in several simulation studies.<sup>4</sup> Nevertheless, such efforts have been generally hampered by the lack of a mutually agreeable reference point (and evaluation criterion)--specifically, the lack of a "user model."

This study seeks to address such issues, albeit in somewhat indirect fashion, by offering an evaluation criterion whose theoretical merits have been discussed in the literature, but which has not been empirically measured or tested. Specifically, this study evaluates alternative methods of income measure via a criterion of how well they facilitate an analysis of management performance. That is, which method of income measurement can most quickly and consistently identify differing managerial ability?

Such a criterion has been previously alluded to by several authors. The 1966 ASOBAT Committee suggested, "The prediction of such (management) effectiveness would appear to be highly important to virtually all groups of external users of accounting information..."<sup>5</sup> From the standpoint of "informed" users, Brummet states:



"Security analysts, searching for key criteria for use in predicting business success, are interested, of course, in measured profit and statements of financial condition. Yet they usually give even greater recognition to management capability and human technical know-how."<sup>6</sup>

With respect to statement users in general, Anderson asserts, "...The (financial and other) information ought to enable a competent person to judge the abilities of the corporate management."<sup>7</sup> A final example of the interest in measuring management ability can be drawn from the recently released report of the Trueblood Study Group on the Objectives of Financial Statements:

"An objective of financial statements is to supply information useful in judging management's ability to utilize enterprise resources effectively in achieving the primary enterprise goal."<sup>8</sup> (emphasis added).

It is noteworthy that no uniform list of information requirements emerges from these writings, but all indicate an interest in accounting information which contributes to the external user's attempt to judge the effectiveness and efficiency of management. Since management's utilization of assets entrusted them is an essential component of the actual success or failure of a firm, it appears an examination of alternative income measurement methods in light of such a criterion is particularly appropriate.

With the above suppositions as a foundation, this study attempts such an evaluation. While an empirical study would provide the best environment, in order to implement such a study two major conditions must be fulfilled. First, a data base must exist which incorporates historical cost, replacement cost and net realizable value methods of earnings measurement for a set of firms. Second, an independently determined set of management performance indices would have to be collected. Unfortunately, the requisite data bases simply do not exist in the "real world" such that one could longitudinally evaluate alternative earnings measurement schemes.

Accordingly, this study has employed simulation as one method to address



the data base problems. Briefly summarized, the simulation model involved a pair of firms which varied with respect to managerial ability. "Managerial ability" consists of both forecasting ability and management's selection of the proper decision based on the forecast. In this study the emphasis was placed on forecasting abilities. Hence, the simulation model varied only the forecasting ability of the two firms. Each firm estimates a series of market parameters which impact upon the determination of production level and resulting asset acquisition or disposal decisions. Thus, by altering forecasting ability, different levels of managerial efficiency were effected. Performance of the firm (and the "management") was then measured by eight different methods of accounting measurement. Finally, the eight earnings streams were analyzed in order to address the question of which method most quickly and consistently discriminates differing managerial abilities.

## II) THE SIMULATION MODEL

As the basic simulation model, this study employed one first developed by Greenball and later extended by McKeown and Picur.<sup>9</sup> These models, while addressing the same basic question (i.e., evaluation of alternative methods of income measurement) utilized, as a criterion, the degree to which such alternatives surrogated a concept of economic income termed "permanent earnings." While this study pursues a similar objective, the managerial ability criterion clearly differentiates the approach utilized and, more importantly, attempts to analyze such alternatives in a manner which has been of general interest to accounting theoreticians. In order to provide a description of the attributes embedded within the simulation model, a brief overview of its fundamental features will be identified.

### A) The Firms

The simulation model consisted of two independent firms (A and B) initially identical in all respects except for their management's forecasting abilities.<sup>10</sup> Two hundred separate pairs of firms were encompassed within



the model--each pair representing a separate "industry".<sup>11</sup> While the two hundred industries were homogeneous with respect to product and requisite inputs, a heterogeneous grouping of variable attributes were employed within each industry. These stochastic features provided a range of operating performances and were implemented in order to allow the results of this study to be generalized over a large class of firms. During the initialization stage of each of the two hundred computer runs, the stochastic parameters were randomly selected for each industry. These values remained constant over the "life" of the two firms within that industry. However, in order to achieve the goal of surrogating differing managerial abilities, firm A uniformly made better predictions of market parameters (which affected performance) than firm B. The relationship between forecasts and performance is described in section E.

Within each industry, firms A and B began operations (i.e., stochastic parameters were randomly selected) at time period zero ( $t=0$ ). At the other end of the spectrum, either firm was allowed to liquidate at any point in time ( $T_j$ ).<sup>12</sup> However, two qualifications were attached to this liquidation option. First, since the two firms within each industry independently reach decisions as to expand, contract, continue or liquidate, a decision rule must be defined when one firm liquidates. Given the emphasis of this study on evaluation between firms, it was decided that once either firm A or B decides to liquidate, the other firm is required to do likewise. Second, as a somewhat arbitrary limitation, both firms must be liquidated by the end of period 60 (i.e.,  $T_j \leq 60$ ).

In the model two separate time horizons were employed within each industry-- a "decision period" and an "accounting period." Decision period 1 (d.p.1) begins at time 0 and ends at time 1. The production decision for each firm in the industry is made instantaneously at the beginning of the decision period





and this decision holds throughout that decision period. An accounting period (a.p.) begins exactly at the midpoint of one decision period and ends exactly at the midpoint of the next decision period. Hence, each accounting period is exactly equal in length to a decision period. Thus, for a given firm  $j$  in industry  $k$ , it has  $T_{j,k} - 1$  accounting periods. That is, neither the first half of the first decision period nor the last half of the last decision period are included in the respective accounting periods. (These time relationships are shown in Figure One.)

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Insert Figure One here

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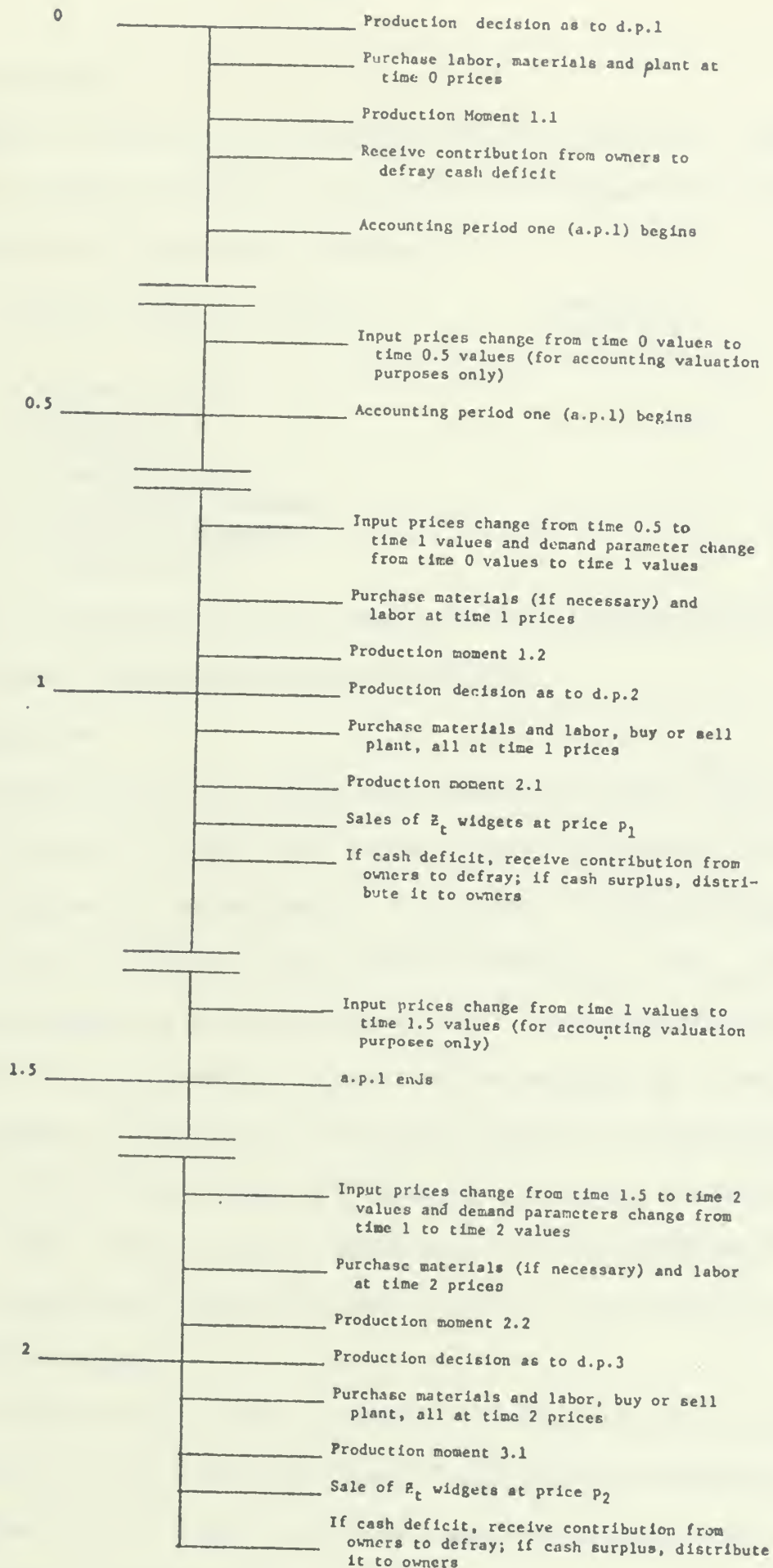
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This overlap of accounting periods upon decision periods is crucial to the simulation model. By straddling the decision period each firm is assured of maintaining a finished goods inventory (and possibly a raw materials inventory) at the beginning and end of each accounting period. This feature impacts upon the different methods of accounting earnings measurement in that both physical plant and inventory must be valued under alternative valuation schemes.

A final attribute of the accounting process relates to the transactions in which each firm engages. As a simplifying assumption all transactions are solely for cash. Further, cash flows occur between the firm and its owners in such a manner that cash balances (be they positive or negative) are held for no longer than an instant of time. Such flows take several forms: (1) a series of flows from a firm to its owners,  $(D_t)$ , which is composed of dividends or cash payments for shares reacquired by the firm, and (2) a series of flows from the owners to the firm,  $(F_t)$ , which represents gross cash proceeds from the primary issuance of shares.<sup>13</sup>



FIGURE ONE





## B) The Product

Again as a simplifying assumption all firms have but a single product-- a "widget." The price received by each firm is determined from a market demand function which can be expressed as follows:

$$p_{t,j,k} = \alpha_{t,j,k} + \beta_{t,j,k} \cdot z_{t,j,k} \quad \text{For } \alpha > 0 \quad (1) \\ \text{and } \beta < 0$$

where:  $t$  = time period  
 $j$  = firm  
 $k$  = "industry"  
 $p$  = selling price  
 $\alpha$  = intercept parameter  
 $\beta$  = slope parameter  
 $z$  = quantity sold

Note that it is parameters such as  $\alpha$  that each firm forecasts and which leads to the situation of differing managerial abilities.

## C) Production

The production of one widget requires direct input of one unit of raw material and one unit of labor, where prices during time period  $t$  are given by the sequences  $p_t^m$  and  $p_t^l$  respectively.<sup>14</sup> Similarly, to produce  $z_{t,j,k}$  widgets, firm  $j$  must have  $n_{t,j,k}$  units of plant capacity (where  $n_{t,j,k} > z_{t,j,k}$ ) available immediately following the production decision.<sup>15</sup> The price of a single unit of plant input ( $n = 1$ ) for period  $t$  is given by the sequence  $p_t^f$ . When a firm decides to dispose of a portion of its plant capacity it receives  $p_t^d$  per unit, where  $p_t^d$  is a prespecified fraction  $\gamma$  (where  $\gamma < 1$ ) of the prevailing price-- i.e.,  $p_t^d = \gamma \cdot p_t^f$ . Further, plant depreciates at a predetermined rate of  $\delta$  per decision period such that at the end of d.p.t. there remains  $(1 - \delta)n_{t,j,k}$  units of plant capacity.

In the model production takes place twice during a decision period. Production moment one (p.m.t<sub>1</sub>) occurs immediately following the beginning of each decision period, d.p.t., while production moment two (p.m.t<sub>2</sub>) takes place immediately before the end of that decision period. Once a firm has decided



the quantity of widgets it will sell ( $z_{t,j,k}$ ) it must manufacture one half of that quantity ( $\frac{z_{t,j,k}}{2}$ ) at p.m.t<sub>1</sub> and an equal quantity at p.m.t<sub>2</sub>.

While the firm may not vary its production schedule (once  $Z$  is determined), it does have two options with respect to raw material purchases. It can purchase and inventory  $z_{t,j,k}$  units of raw material immediately preceding p.m.t<sub>1</sub>; alternatively, it can acquire  $z_{t,j,k}/2$  units immediately before p.m.t<sub>1</sub>, and a like quantity before p.m.t<sub>2</sub>. This choice is a result of expected input prices (and forecasting ability) at d.p.t. vis a vis the known prices at d.p.t-1. This decision process is described in a later section E of this paper

#### D) Model Parameters

##### 1) Constant Parameters

As stated earlier the simulation process encompassed 200 industries each composed of two firms. Embedded within the model are several parameters which are constant across all industries. These values are summarized in Table One.

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Insert Table One here

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##### 2) Stochastic Features and Parameters

While each of the 200 industries simulated utilized the same inputs and produced the same product, several stochastic features were built into the model in order to generalize the findings of this study. For every pair of firms in a given industry, the value of each of the stochastic attributes were chosen at random from a population of values uniformly distributed over a specified range. These values were selected at  $t=0$  and hold until  $T_{j,k}$ . The demand function parameters were then adjusted in such a manner as to generate an expected rate





TABLE ONE  
CONSTANT PARAMETERS

Symbol	Parameter	Value
T	Maximum life of firm (in d.p.'s) . . . . .	60
$\rho$	Interest rate used in decision-making . . . . .	.06
$\gamma$	Ratio of plant selling price to plant buying price. .	.85
	Standard deviation of relative change in demand parameter . . . . .	.01



of return for accounting period one (a.p.<sub>1</sub>) of 20%. These randomly selected stochastic parameters primarily relate to the price of inputs and the  $\alpha$  intercept of the demand function. The parameters and their ranges are summarized in Table Two.<sup>16</sup>

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Insert Table Two here

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#### E) Decision Making

At the beginning of every decision period, each firm  $j$  (within industry  $k$ ) must determine the following:

- 1)  $z_{t,j,k}$ : sales for decision period  $t$
- 2)  $n_{t,j,k}$ : plant capacity for decision period  $t$
- 3) Raw material purchase option:
  - a)  $z_{t,j,k}$  units of raw material before production moment  $t_1$ , or
  - b)  $z_{t,j,k}$  units of raw material before production moment  $t_1$  and a like quantity before production moment  $t_2$ .

Each firm  $j$  selects these quantities by maximizing the expected value criterion:

$$C_{t-1,j,k}(t) + \{ \bar{C}_{t,j,k}(t) + \bar{V}_{t,j,k} \} / (1 + \rho) \quad (2)$$

where:

$C_{t-1,j,k}$  is the net cash flow to firm  $j$  associated with:

- (1) the purchase of either:
  - (a)  $z_{t,j,k}$  units of raw material, or
  - (b)  $z_{t,j,k}/2$  units of raw material,
- (2) the purchase of  $z_{t,j,k}/2$  units of labor, and
- (3) the purchase or disposal of plant--

where all events occur just prior to production moment  $t_1$ .



TABLE TWO  
STOCHASTIC PARAMETERS

Parameter	Range
Depreciation rate per period (S) . . . . .	.125 to .250
Systematic growth rate (g) . . . . .	.0 to .1
Standard deviation of relative change in input prices . . . . .	.02 to .06
Correlation in coefficient between relative change in demand parameter and relative changes in input prices. . . . .	.0 to .5



$\bar{C}_{t,j,k}$  the expected net cash flow to firm  $j$  associated with:

- (1) the purchase of  $Z_{t,j,k}/2$  units of raw material--if purchase option 1b (from above) is selected,
- (2) the purchase of  $Z_{t,j,k}/2$  units of labor, and
- (3) the sale of  $Z_{t,j,k}$  widgets at the expected price of  $\bar{P}_{t,j,k}$ .

$\bar{V}_{t,j,k}$  is the expected liquidation value of firm  $j$  at the end of decision period  $t$ . Since no receivables, payables, inventory, or retained earnings are maintained at the end of decision period  $t$  (i.e., all transactions are for cash), then  $\bar{V}_{t,j,k}$  represents the expected liquidation value of the plant at the end of decision period  $t$ .

Symbolically,

$$\bar{V}_t = \bar{p}_t^d \cdot n_{t,j,k} (1 - \delta)$$

$$\text{where: } \bar{p}_t^d = \rho \cdot \bar{p}_t^f$$

$\rho$  is the interest rate used by the firm for decision making purposes.

Given the uncertain nature of the stochastic parameters found in the time  $t$  values, each firm  $j$  employs the expected values of these parameters as certainty equivalents for the true values in order to derive a solution to equation 2. It is at this stage of the simulation model that the differing managerial abilities arise. That is, in determining these expected values each firm depends upon: (1) its forecasting ability with respect to the stochastic parameter changes, and (2) the parameter values at the beginning of decision period  $t$  which are known to each firm. Within each industry  $k$ , firm  $A$  is provided with perfect foresight. That is, it can perfectly predict parameter values which will be in effect at production moment  $t_2$  and therefore determine exact values, rather than expected amounts for  $\bar{C}_{t,A,k}(t)$  and  $\bar{V}_{t,A,k}$ . Hence, firm  $A$  continually performs at the theoretical maximum (for its industry)





given the one period decision model utilized. Alternatively, firm B uniformly has zero foresight. Accordingly, it employs current period's stochastic parameter values as best estimates for production moment  $t_2$  values since firm B knows the mean change in such values is zero. As such, firm B's decisions are uniformly inferior to firm A--except for those situations where parameter values do not change.

One final point should be noted with respect to the market situations facing each firm. While both firms purchase inputs from the same markets, and therefore face identical price sequences, their output is sold to "independent" markets. That is, while they face the same demand function their production schedules determine separate prices. Thus, each firm faces exactly the same market situation--unaffected by the actions of the other firm. Hence, the differences in the two firms within each industry is solely caused by the differing managerial actions.

### III) ACCOUNTING METHODS EVALUATED

In this study eight accounting methods were evaluated,  $i = 1, 2, \dots, 8$ :

<u>i</u>	<u>Symbol</u>
1	HA
2	HD
3	BA
4	BD
5	CA
6	CD
7	N
8	N+



where H represents historical cost, B is business profit, C is current operating profit, N is net realizable value (unadjusted), N+ is net realizable value adjusted for the excess of cost over net realizable value (at time of purchase) of any new plant purchased during the period, A is absorption costing for the widgets inventory, and D is direct costing.

For each method  $i$  and firm  $j$  (in industry  $k$ ) a measure of capital ( $K_{i,j}$ ) at the end of the accounting period ( $a$ ) was determined as follows:

$$K_{a,i,j,k} = M_{a,i,j,k} + W_{a,i,j,k} + F_{a,i,j,k} \quad (3)$$

where:  $M$  is the book value of raw materials inventory. (note: a raw materials inventory will exist only if the first purchase option is selected--i.e.,  $Z_{t,j,k}$  units purchased at the beginning of d.p.t.)

$W$  is the book-value of completed widgets

$F$  is the book-value of plant.

Historical cost capital (methods 1 and 2) was determined by valuing  $F$  at historical cost while  $M$  and  $W$  were valued at moving average historical cost. Business profit capital (methods 3 and 4) and current operating profit capital (methods 5 and 6) were determined by valuing  $M$ ,  $W$  and  $F$  in terms of the replacement (entry) prices for raw materials, labor, and plant as of the valuation date. Finally, net realizable value capital (methods 7 and 8) was found by valuing  $M$ ,  $W$  and  $F$  in terms of the disposal (exit value) prices as of the valuation date.

Similarly, for each method, accounting period  $a$ 's earnings ( $P_{a,i,j,k}$ ) were measured. For methods 1 through 4 and 7 this process can be summarized as follows:

$$P_{a,i,j,k} = K_{a,i,j,k} - K_{a-1,i,j,k} + C_{j,k}^{(a)} \text{ for: } i=1, \dots, 4 \text{ and } 7 \quad j = A, B \quad (4)$$



where:  $C_{j,k}^{(a)}$  cash flow from firm  $j$  to its owners during a.p.a.--  
 i.e.,  $C_{j,k}^{(a)} = D_{j,k}^{(a)} - F_{j,k}^{(a)}$

Since the current operating profit methods differ from the business profit methods by excluding holding gains (or losses), the earnings expressions for methods 5 and 6 may be stated as follows:

$$P_{a,5,j,k} = P_{a,3,j,k} - ({}^aK_{a-1,3,j,k} - K_{a-1,3,j,k}) \quad (5)$$

$$P_{a,6,j,k} = P_{a,4,j,k} - ({}^aK_{a-1,4,j,k} - K_{a-1,4,j,k}) \quad (6)$$

where the quantities  $({}^aK_{a-1,3,j,k} - K_{a-1,3,j,k})$  and  $({}^aK_{a-1,4,j,k} - K_{a-1,4,j,k})$  represents the holding gains (or losses) during accounting period  $a$ . That is  ${}^aK_{a-1,3,j,k}$  and  ${}^aK_{a-1,4,j,k}$  represent the capital of the "a-1" asset groupings valued at time "a" prices. Finally, the adjusted net realizable value earnings (method 8) were calculated as follows:<sup>17</sup>

$$P_{a,8,j,k} = P_{a,7,j,k} + (acq_{j,k}) (p_{a-\frac{1}{2},j,k}^f - p_{a-\frac{1}{2},j,k}^d) \quad (7)$$

where: "acq" represents the units of plant acquired during a.p.a.

The absorption costing (A) earnings measurement (methods 1, 3, and 5) differ from their direct costing (D) counterparts (methods 2, 4, 6) only with respect to the valuation of the widgets inventory. While all methods include material and labor components in the valuation of  $W$ , the absorption methods also included a fixed overhead component. Given the structure of the simulated firms, the only fixed overhead component is depreciation. For the absorption methods the overhead charge per unit was determined by taking the ratio of depreciation in the accounting period in which the widget is manufactured to the normal production volume in that period--where the latter is a weighted average of past period production volume.

#### IV) METHOD OF COMPARISON

In addressing the basic question of this study--which method of income measurement most quickly and consistently identifies differing managerial



abilities--a multi-stage methodology was employed. First, a procedure for identifying differences was determined. Next, measures of the quickness and consistency by which such differences occur were operationalized. Finally, tests of whether or not the measured differences are statistically significant were made. Accordingly, a three stage procedure was utilized within the study.

#### A) Stage One: Identification

The purpose of this stage was to identify differences between the two firms. Referring to the simulation model, it should be remembered that eight streams of accounting income were generated for both firms within each of the two hundred industries.<sup>18</sup> As such, the identification method required a comparison of each income method to determine if differences could be found. Hence, cumulative t tests of the ratio of firm B's accounting income to firm A's were utilized. The basic statistic calculated can be expressed as follows:

$$\text{STAT}_{i,k,t^*} = \frac{\left( \sum_t \frac{\text{Ratio}_{i,k,t}}{t^*} - 1 \right) \sqrt{t^*}}{\frac{\sum_t \text{Ratio}_{i,k,t}^2 - \left( \frac{\sum_t \text{Ratio}_{i,k,t}}{t^*} \right)^2}{t^*-1}} \quad (8)$$

for:  $i=1,8$   
 $k=1,200$   
 $t=1, T_k$   
 $t^*=6, T_k$

where:  $\text{Ratio}_{i,k,t} = \frac{P_{i,2,k,t}}{P_{i,1,k,t}}$

In calculating the t test value (i.e., STAT), a ratio was used as a scaling device.

#### B) Stage Two: Measurement

The second stage required the development of a measurement scheme to evaluate the consistency and quickness by which alternative income methods





identified the differing managerial abilities. The  $t$  values computed via equation 8 were compared to table values of the  $t$  statistic at various levels of significance. The surrogation procedure employed to measure the differences was based on the concept of an investment decision. That is, this procedure viewed the entire process from the perspective of an investor. On a period-by-period basis he evaluates the two firms, through any of the eight different streams of accounting earnings, with the objective of investing in the firm with the superior managerial ability. The comparison of the test  $t$  value (STAT) to the table  $t$  value leads him to one of three decisions:

- 1) If no significant difference exists between  $t$  values, he invests equally between firms A and B.
- 2) If significant differences exist between the  $t$  values, he then invests his entire current period investment amount in either:
  - a) Firm A if the significant difference favors A, or
  - b) Firm B, in the converse holds.

For purposes of this study, the investor is provided two utiles per period per accounting method.<sup>19</sup> Therefore, he can invest zero, one or two utiles in either firm depending upon: (1) the existence of a significant difference between the test  $t$  value and table  $t$  value, and (2) the direction of the significant difference. At the end of the life of each industry ( $T_k$ ), two values were calculated for each accounting method:

- 1)  $I_{i,k}$ : the average amount per period invested in firm B.
- 2)  $I_{i,k}^*$ : the discounted present value of the average amount invested per period in firm B.<sup>20</sup>

In addition, these values were ranked (from lowest to highest). It should be noted that these values are taken from the perspective of the investor investing in the wrong firm. Thus, the better the discrimination, the lower the  $I$  or  $I^*$  value will be.



### C) Stage Three: Analysis

Having completed the measurement stage, sixteen investment figures (simple average and discounted present value) for each of two hundred "industries" were generated. The analysis stage sought to determine if significant differences existed between accounting methods when viewed from the aggregate of the multi-industry environment. This analysis was made in three steps.

Step one utilized a standard analysis of variance (ANOVA) package for repeated measures. Given the non-homogeneity of the covariance matrix, an adjustment (originally proposed by Box) to the degrees of freedom used in determining the "F" statistic was made--representing step 2.<sup>21</sup> Finally, the third step involved paired comparisons of one income method versus another. In order to make paired comparisons between all possible pairs, Scheffè's procedure for an a posteriori test was employed.<sup>22</sup> It should be noted the Scheffè method for testing differences is highly conservative with respect to a type I error.

## V) RESULTS AND ANALYSIS

### A) Results

Upon completion of the simulation run, eight streams of accounting income for both firms in each of two hundred industries had been generated. For each accounting method within each industry a period by period t test comparison was made using significance levels of .10 and .25.<sup>23</sup> That is, the test value  $STAT_{i,k,t^*}$  was compared to a table t value for  $t^* = 6, T_k$ . If the difference was not significant, one utile was invested in each firm. If the difference



was significant, two utilities were invested in the appropriate firm. A series of performance indices were then computed--the general form of which can be found in Table Three.

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Insert Table Three here

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The computed values of the performance indices were then input into a standard ANOVA package to test for an overall difference between accounting methods. Tables Four and Five summarize the results of this analysis. Again, it should be noted that since two separate sets of eight accounting streams were generated--raw earnings and earnings adjusted for economic rent--the presentations in Tables Four and Five are appropriately categorized. Similarly, the degrees of freedom, resulting from Box's adjustments (necessitated by the non-homogeneity of the covariance matrix), has been included parenthetically. As can be seen, for both sets of earning streams all performance indices suggest significant differences do exist between the eight accounting methods. That is, at the aggregate level the alternative income methods did differ with respect to the quickness and consistency which they identified differing managerial abilities.

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Insert Table Four here

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Insert Table Five here

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TABLE THREE  
PERFORMANCE INDICES

Index	Symbol	Definition
Average Investment	$I_{i,k}$	$\frac{\sum_{t=6}^{T_k} \text{Investment}_{i,k,t}}{T_{k-5}}$
Discounted Present Value of Investment	$I^*_{i,k}$	$\frac{\sum_{t=6}^{T_k} \text{Investment}_{i,k,t}}{(1 + .06)^t}$
Ranking of Average Investment by Accounting Method	$R_{i,k}$	$R_{i,k}$ is the absolute ranking (from lowest to highest) of accounting methods based on $I_{i,k}$ --where R assumes values from 1 to 8
Ranking of D.P.V. of Investment by Accounting Method	$R^*_{i,k}$	$R^*_{i,k}$ is the absolute ranking (from lowest to highest) of accounting methods based on $I^*_{i,k}$ --where $R^*$ assumes values from 1 to 8.

where:  $i$  = accounting method (1,2,...,8).  
 $k$  = industry identification (1,2,...,200).  
 $T_k$  = length in periods of industry k.  
Investment = number of utiles invested in firm B  
(0, 1, or 2).

Note: In case of ties (with respect to I or  $I^*$  values) the appropriate R values are summed and the average value is assigned each tied method. For example, if accounting methods 3 and 5 tied for third lowest, then each is assigned an R of 3.5.





TABLE FOUR  
RESULTS OF ANOVA TEST  
(Stage I Difference: .10 Level)

Set	Index	F Ratio	Probability (Degrees of Freedom)
Raw Accounting Earnings ("Income")	I	123.3	0.0 (4.0,794)
	I*	108.2	0.0 (3.6,710)
	R	159.1	0.0 (4.7,933)
	R*	150.1	0.0 (4.6,905)
Adjusted Accounting Earnings: ("Adjusted Income")	I	147.1	0.0 (4.5,888)
	I*	119.5	0.0 (4.0,788)
	R	143.5	0.0 (5.6,1114)
	R*	140.5	0.0 (5.6,1100)



TABLE FIVE  
 RESULTS OF ANOVA TEST  
 (Stage I Difference: .25 Level)

Set	Index	F Ratio	Probability (Degrees of Freedom)
Raw Accounting Earnings: ("Income")	I	145.50	0.0 (4.2,848)
	I*	126.9	0.0 (4.4,875)
	R	162.2	0.0 (4.6,918)
	R*	144.5	0.0 (4.5,901)
Adjusted Accounting Earnings: ("Adjusted Income")	I	139.8	0.0 (4.7,930)
	I*	112.5	0.0 (4.7,936)
	R	139.7	0.0 (5.6,1108)
	R*	119.0	0.0 (5.3,1048)



Upon determination that significant differences did exist at the aggregate level, pairwise comparisons were made between all possible combinations of accounting methods. As previously noted, Scheffe' post-hoc test, adjusted for the non-homogeneity of covariance by Box's procedure, was used at this point of the analysis. Rather than presenting sixteen tables (i.e., 4 performances indices for 2 stage I levels of significance for both "income" and "adjusted income"), this myriad of data has been condensed to two tables. Specifically, Tables Six and Seven present the findings determined from the pairwise comparisons of the "adjusted income" discounted present value indices at the .25 stage I significance level. It was felt the "adjusted income" (adjusted for the cost of capital change) presents the most representative picture of the "true" income (regardless of accounting method) of the firms. Similarly, the use of the discounted present value indices (I\* and R\*) provide the best measure of the quickness by which the alternative income methods were able to discriminate the differing managerial abilities between Firms A and B. However, since minor discrepancies did exist across the sixteen possible tables, the interpretation of the findings will identify the range over which the generalized results hold.

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Insert Table Six here

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Insert Table Seven here

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TABLE SIX  
 PAIRED COMPARISONS OF ADJUSTED INCOME  
 PERFORMANCE INDEX: I\*  
 (Stage I Difference: .25 level)

Method (Mean)	HD (.82825)	BA (.45305)	BD (.74760)	CA (.81872)	CD (.95117)	N (1.0006)	N+ (.91745)
HA (.41718)	HA***	HA	HA***	HA***	HA***	HA***	HA***
HD (.82825)		BA***	BD	CA	HD*	HD***	HD
BA (.45305)			BA***	BA***	BA***	BA***	BA***
BD (.74760)				BD	BD***	BD***	BD***
CA (.81872)					CA**	CA***	CA
CD (.95117)						CD	N+
N (1.0006)							N+

Interpretation: \*\*\* = Significant at .01 level  
 \*\* = Significant at .05 level  
 \* = Significant at .10 level  
 (No Mark) = Not Significant





TABLE SEVEN  
 PAIRED COMPARISONS OF ADJUSTED INCOME  
 PERFORMANCE INDEX: R\*  
 (Stage I Difference: .25 level)

Method (Mean)	HD (4.8700)	BA (2.5325)	BD (4.2600)	CA (4.8300)	CD (5.8350)	N (6.0675)	N+ (5.4075)
HA (2.1975)	HA***	HA	HA***	HA***	HA***	HA***	HA***
HD (4.8700)		BA***	BD	CA	HD***	HD***	HD***
BA (2.5325)			BA***	BA***	BA***	BA***	BA***
BD (4.2600)				BD	BD***	BD***	BD***
CA (4.8300)					CA***	CA***	CA
CD (5.8350)						CD	N+
N (6.0675)							N+

Interpretation: \*\*\* = Significant at .01 level  
 \*\* = Significant at .05 level  
 \* = Significant at .10 level  
 (No Mark) = Not Significant



## B) Interpretation of Findings

### 1) General Findings

For purposes of interpreting the findings of this study, a summarized table of paired comparisons has been included as Table Eight. Again, it should be noted that the results included within Table Eight relate to the following attributes:

- 1) .25 difference at the identification stage,
- 2) Adjusted (for cost of capital) accounting earnings,
- 3) I\* performance index, and
- 4) "Logical" paired comparisons.<sup>24</sup>

Turning to Table Eight, the first situation evaluated was the capacity of absorption versus direct costing to discriminate differing managerial abilities. In all cases, regardless of accounting method and performance index, absorption costing methods uniformly and significantly outperformed their direct costing counterparts.

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Insert Table Eight here

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Considering individual accounting methods, historical cost significantly outperformed current operating profit and net realizable values.<sup>25</sup> However, the findings regarding business profit were somewhat mixed. That is, while HA better discriminates the differing managerial ability than BA, this difference was not significant even at the .10 level. Moreover, with respect to the direct costing methods, the findings were reversed. BD outperformed HD, though once again, these results were not significant at even the .10 level.

The next method evaluated, business profit, uniformly and significantly provided a better method of discriminating managerial ability than either current operating profit or net realizable value. However, as noted above, this superiority did not uniformly hold with respect to the historical costing methods.



TABLE EIGHT  
SUMMARY OF RESULTS  
(Stage I Difference of .25 and Adjusted Income)

Pairwise Comparison	Index	I*
Absorption vs. Direct		
HA vs. HD		HA***
BA vs. BD		BA***
CA vs. CD		CA**
HC vs. BP		
HA vs. BA		HA
HD vs. BD		BD
HC vs. COP		
HA vs. CA		HA***
HD vs. CD		HD**
HCA vs. NRV		
HA vs. N		HA***
HA vs. N+		HA***
BP vs. COP		
BA vs. CA		BA***
BD vs. CD		BD***
BPA vs. NRV		
BA vs. N		BA***
BA vs. N+		BA***
COPA vs. NRV		
CA vs. N		CA***
CA vs. N+		CA

Interpretation: \*\*\* = Significant at .01 level  
 \*\* = Significant at .05 level  
 \* = Significant at .10 level  
 (No mark) = not significant



Current operating profit absorption outperformed only the net realizable value methods and even then the comparison to the adjusted NRV method (CA vs. N+) was not significant. Finally, the net realizable value methods were significantly inferior to all but current operating profit in the CA versus N+ comparison.

## 2) Sensitivity of Results

As previously discussed, the vast range of paired comparisons have been condensed down to Table Eight. However, since discrepancies did exist across the various alternative presentations (e.g., Stage I significance level, performance index, and "income" or "adjusted income"), it was deemed appropriate to identify the range over which the generalized results hold. Accordingly, Table Nine summarizes such ranges for each of the generalized paired comparisons discussed above. Only major discrepancies will be considered.

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Insert Table Nine here

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In the comparison of absorption versus direct costing methods, the total range of results indicated that while CA always outperformed CD the levels of significance varied from the .01 level to not significant at all. However, for the historical cost and business profit alternatives the absorption methods uniformly outperformed their direct counterpart at the .01 level.

Considering individual paired comparisons, the total range of results basically support the findings reported earlier. That is, HA and BA were not significantly different. Similarly, while BD outperformed HD the difference was insignificant but for two cases--the R and R\* indices of "raw income" at the





TABLE NINE  
SENSITIVITY OF RESULTS

Pairwise Comparison	Range of Results
Absorption vs. Direct	
HA vs. HD	HA***
BA vs. BD	BA***
CA vs. CD	CA to CA***
HC vs. BP	
HA vs. BA	HA to BA
HD vs. BD	BD to BD*
HC vs. COP	
HA vs. CA	HA***
HD vs. CD	HD to HD***
HCA vs. NRV	
HA vs. N	HA***
HA vs. N+	HA***
BP vs. COP	
BA vs. CA	BA***
BD vs. CD	BA***
BPA vs. NRV	
BA vs. N	BA***
BA vs. N+	BA***
COPA vs. NRV	
CA vs. N	CA to CA***
CA vs. N+	N+ to CA***

Interpretation: \*\*\* = Significant at .01 level  
 \*\* = Significant at .05 level  
 \* = Significant at .10 level  
 (No mark) = Not significant



.25 Stage I level. The only other case in which historical cost was involved that varied from Table Eight's results were found in the HD versus CD comparison. That is, while HD uniformly outperformed CD the significance level of the difference varied from .01 to not significant at even the .10 level.

Finally, the only situation in which the findings varied greatly depending upon the nature of the evaluation method was with regard to the current operating profit absorption versus net realizable value comparison. CA uniformly outperformed N but this comparison was highly sensitive to the method of comparison. Similarly, in the comparison of CA versus N+, the findings ranged from favoring N+ (although insignificantly) to favoring CA at the .01 level. Since, these findings were highly sensitive to the performance index, the Stage I significance level and the method of earnings measurement ("raw" or "adjusted"), no firm conclusions can be drawn from these comparisons.

#### VII) LIMITATIONS AND EXTENSIONS

No research study is free from limitations imposed by the methodology-- particularly when a simulation approach is utilized. As such, any research effort should set forth these limitations with two goals in mind. First, a specification of the limitations demarcate the boundaries within which the findings can be applied. Second, the designation and appreciation of these limitations can serve as a foundation for future research. Accordingly, the following limitations and possible extensions are offered:

- 1) Decision Functions--The use of the expected cash flow maximization criterion can be attacked on the grounds of experimental reality. That is, while theoretically such a criterion should be utilized to insure long run profit maximization, various authors have suggested other criteria are employed in the "real-world."<sup>26</sup> Further, the sensitivity of the decision model (to the forecasted parameters) could affect the results. That is,



the use of different decision models could change the findings.

- 2) Single Production Decision and Single Product--The simulation model used had but one production decision per period and one product per firm. While it can be argued the time dimension of the production decision would not impact upon the results, the effect of multi-product firms is unknown.<sup>27</sup>
- 3) "Simplicity" of Income Statement--The simulation model represented a fairly simplistic situation with respect to income reporting. That is, depreciation was the only form of "deferred charge" amortized over time. As such, the effect of alternative accounting principles or "income smoothing" could not be determined.
- 4) Managerial Capability Surrogate--The simulation model utilized dichotomous degrees of forecasting ability to create the situation of differing managerial abilities. One possible extension would allow forecasting capability to randomly vary (from none to perfect) between the two firms and employ different decision functions to generate the differing levels of managerial ability.

In summary, while several limitations are inherent in the simulation model, it should nevertheless be noted that the findings reported provide significant insight. That is, by demonstrating via a somewhat simplistic situation that alternative methods of income measurement can discriminate firms varying only with respect to managerial ability, this study points out the necessity of future research in this area. The development of more complex simulation models or the collection of sufficient "real world" data bases to longitudinally evaluate alternative accounting methods, are but two possible extensions from this basic study.



## VIII) POLICY IMPLICATIONS AND SUMMARY

As a framework within which the policy implications of these findings will be analyzed, the objectives of this study will be briefly reiterated. First, this paper sought to evaluate various proposed alternative concepts of income measurement. Second, the criterion employed for this evaluation--the ability of an income method to discriminate similar firms on the basis of differing managerial abilities--sought to determine if the product of the accounting process can be used to evaluate the management of a firm. Subject to the constraints implicit in the simulation model, both objectives have been achieved.

Two major findings (and resulting policy implications) follow from the results of this study. First, the seemingly unrelenting criticism directed towards historical cost based valuations systems may well be unwarranted. A recent example can be found in the Trueblood Report, which suggested current values should be disclosed when they differ significantly from historical costs.<sup>28</sup>

In a similar vein, the SEC has recently made overtures that replacement costs of fixed assets and inventories would be required as supplemental information appended to the income statement.<sup>29</sup> While the SEC's proposal is couched in terms of partially disclosing the impact of inflation, the lack of a user model as a reference point somewhat clouds any theoretical justification of such a requirement. In both cases, if one assumes a requirement of income measurement is to evaluate the effectiveness of management, it is clear the findings of this study suggest historical cost does meet such a requirement.<sup>30</sup> Moreover, proposals such as the Trueblood Report and the SEC's inclusion of current values have little "pseudo-empirical" support--based on the results of this simulation model.

The second major finding relates to the Trueblood Report's objective of "... supplying information useful in judging management's ability to utilize enter-





prise resources effectively..."<sup>31</sup> It has been shown that the use of the accounting earnings can discriminate between firms varying only with respect to their managerial ability--within the constraints of the simulation model. Further, the historical cost absorption income method identifies this difference earlier and more consistently than other conceptual alternatives which have been offered in the literature. While the methodology utilized did a priori know which firm was performing consistently better, this fact does not detract from the findings. That is, the firms were differentiated solely on the basis of accounting earnings. Hence these results suggest that continued research in this area is well-warranted.



## FOOTNOTES

<sup>1</sup>For example, see: R. R. Sterling, ed. Asset Valuation and Income Determination, (Scholars Book Company: Lawrence, Kansas, 1971); and Norton M. Bedford and James C. McKeown, "Comparative Analysis of Net Realizable Value and Replacement Costing," The Accounting Review, (April, 1972), pp. 333-338.

<sup>2</sup>For example see:

Edgar O. Edwards and Phillip W. Bell, The Theory and Measurement of Business Income, (University of California Press: Berkeley and Los Angeles, 1967; Raymond J. Chambers, Accounting Evaluation and Economic Behavior, Prentice-Hall, Inc.: Englewood Cliffs, NJ, 1966; and Lawrence S. Revsine, Replacement Cost Accounting, (Prentice-Hall, Inc.: Englewood Cliffs, NJ 1973).

<sup>3</sup>For example, see

James C. McKeown, "A Test of the Feasibility of Preparing Exit Value Accounting Statements" and Lawrence S. Revsine, "A Test of the Feasibility of Preparing Replacement Cost Accounting Statements;" both can be found in Objectives of Financial Statements - Volume II, (American Institute of Certified Public Accountants, New York, NY, 1974), pp. 213-228 and pp. 229-244.

<sup>4</sup>For example, see

Melvin N. Greenball, "The Accuracy of Different Methods of Accounting for Earnings--A Simulation Approach," Journal of Accounting Research, (Spring, 1968), pp. 114-129; and "The Concept, Relevance and Estimation of the Permanent Earnings of the Firm," (unpublished Ph.D. dissertation, University of Chicago, 1966).

James C. McKeown and Ronald D. Picur, "A Simulator Approach to the Evaluation of Alternative Methods of Earnings Measurement," (University of Illinois, College of Commerce and Business Administration, Working Paper #219, November, 1974)

<sup>5</sup>Committee to Prepare a Statement of Basic Accounting Theory, A Statement of Basic Accounting Theory (American Accounting Association, 1966), p. 25.

<sup>6</sup>R. Lee Brummet, "Accounting for Human Resources," Journal of Accountancy, December 1970, pp. 62-63.

<sup>7</sup>Corliss Anderson, "The Financial Analyst's Needs," Berkeley Symposium on the Foundations of Financial Accounting (School of Business Administration, University of California, Berkeley, 1967), p. 100.

<sup>8</sup>Objectives of Financial Statements - Volume I, (American Institute of Certified Public Accountants: New York, NY, 1973), p. 26.

<sup>9</sup>See footnote #4.

<sup>10</sup>At  $t=0$  both firms have exactly the same configuration of assets. All future production decisions utilize different forecasts such that for  $t>1$  the operating results and corresponding profits will vary.



<sup>11</sup>"Industry" will be used throughout this paper to differentiate each of the two hundred separate pairs of firms. In fact, while every pair does have attributes similar to an industry (e.g., same product, same input markets, etc.), each firm sells its product in basically independent output markets. (This point is fully explored in a later section of this paper.)

<sup>12</sup>The phrase "allowed to liquidate at any point in time" should not be misconstrued. Each firm within an industry makes a periodic decision to expand, contract, liquidate or maintain constant production. Hence the term "allowed" suggests that capability of liquidation during any period. The actual outcome is the result of a decision model used by both firms, varying with respect to the accuracy of forecasts utilized as input.

<sup>13</sup>As Greenball suggests (1968, pp. 115-116), if the definition of owners is expanded to encompass bondholders, then D also includes (1) the cash interest payments and (2) the cash payments for bond retirement. Similarly, the flow F would consist of the gross cash proceeds from the primary issuance of bonds.

<sup>14</sup>Note that both firms within an industry face the same input prices.

<sup>15</sup>This relationship assumes the firm can acquire sufficient capacity in a short time period to make up any deficiency--i.e., if  $n_{t-1,j} < z_{t,j}$  then the firm must purchase at least  $z_{t,j} - n_{t-1,j}$  units of capacity prior to production.

<sup>16</sup>See Greenball, "The Concept, Relevance and Estimation of the Permanent Earnings of the Firm," (unpublished Ph.D. dissertation, University of Chicago, 1966, pp. 68-75) for a complete description of the stochastic parameters.

<sup>17</sup>This adjustment is for the market differential created by "friction" in the marketplace. That is, at the moment of acquisition purchase price differs from exit value. An adjustment is made to the basic NRV earnings to account for this "friction."

<sup>18</sup>Since the firms operated within basically independent output markets, situations arose where considerable differences could arise with respect to the size of the firm, and more importantly, to the size of accounting income (however defined). In order to eliminate this problem of differing magnitude, two sets of eight earnings streams were generated for each firm. The second set charged each income stream for a cost of capital--termed an "economic rent." A 6% charge for cost of capital provided this second stream of earnings -- a stream closely aligned with the economic concept of "pure profit." This cost of capital charge was based on beginning capital balance.

Symbolically, the second set of accounting income was basically calculated as follows:

$$P'_{i,j,k,t} = P_{i,j,k,t} - ER(K_{t-1})$$

where: P' = accounting income adjusted for economic rent charge  
 P = unadjusted accounting income  
 ER = rate.

<sup>19</sup>Each period the investor invests an additional portion of his wealth --i.e., there are no dis-investment or re-investment opportunities. This simplifying assumption was encompassed within the simulation model due to the non-existence of a securities market. That is, lacking such a market no value could be placed upon the "shares" already acquired by the investor--be they in firm A or B.



<sup>20</sup> The discounted present value amounts were generated in order to address the question of how quickly individual accounting methods differentiated between the firms.

<sup>21</sup> G. E. P. Box, "Some Theorems on Quadratic Forms Applied in the Study of Analysis of Variance Problems, I. Effect of Inequality of Variance in the One-Way Classification," Annals of Mathematical Statistics (June, 1954), p. 300.

<sup>22</sup> See R. J. Winer, Statistical Principles in Experimental Design, (McGraw-Hill: New York, 1971), pp. 196-199. Also, the adjustment proposed by Box was also applied to the degrees of freedom of the F statistics in the Scheffe' test.

<sup>23</sup> At the identification stage of analysis both the .10 and .25 levels of significance were used to discriminate between the two firms. While no theoretical justification can be offered for the utilization of the .25 level (nor for that matter, any particular level) it was felt that an investor would employ a more "liberal" significance level than is typically found in research studies. That is, an investor would be willing to accept a 25% chance of selecting the improper firm--or, alternatively, a 75% chance of selecting the better managed firm.

<sup>24</sup> "'Logical' paired comparisons" implies elimination of absorption versus direct costing comparisons of different methods--e.g., HA vs. BD.

<sup>25</sup> All comparisons in which net realizable value are concerned utilize only the absorption method of the alternative. That is, since both NRV variations (N and N+) do not treat overhead as a period cost, comparisons are limited only to absorption methods.

<sup>26</sup> For example, see Eugene M. Lerner and Alfred Rappaport, "Limit DCF in Capital Budgeting," Harvard Business Review, (September-October, 1968), pp. 133-139.

<sup>27</sup> The length of a decision period was not specified other than being equal (overall) to a single accounting period. A decision period could represent any reasonable length of time--i.e., a year, quarter, etc. The point being, that since up to sixty decision periods were employed the results truly represent a longitudinal study.

<sup>28</sup> Objectives of Financial Statements - Volume I, op. cit., p. 36.

<sup>29</sup> Wall Street Journal, (May 8, 1975), p. 8.

<sup>30</sup> It should be noted that in comparisons with business profit historical cost did not significantly outperform business profit. In fact, for the direct costing methods of each, BD outperformed HD--although the difference was not significant. However, given the additional data transformation costs associated with a business profit measurement scheme, a crude cost/benefit analysis (since benefits are equal) would not seem to justify a movement to the business profit alternative.

<sup>31</sup> Objectives of Financial Statements - Volume I, op. cit., p. 26.











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