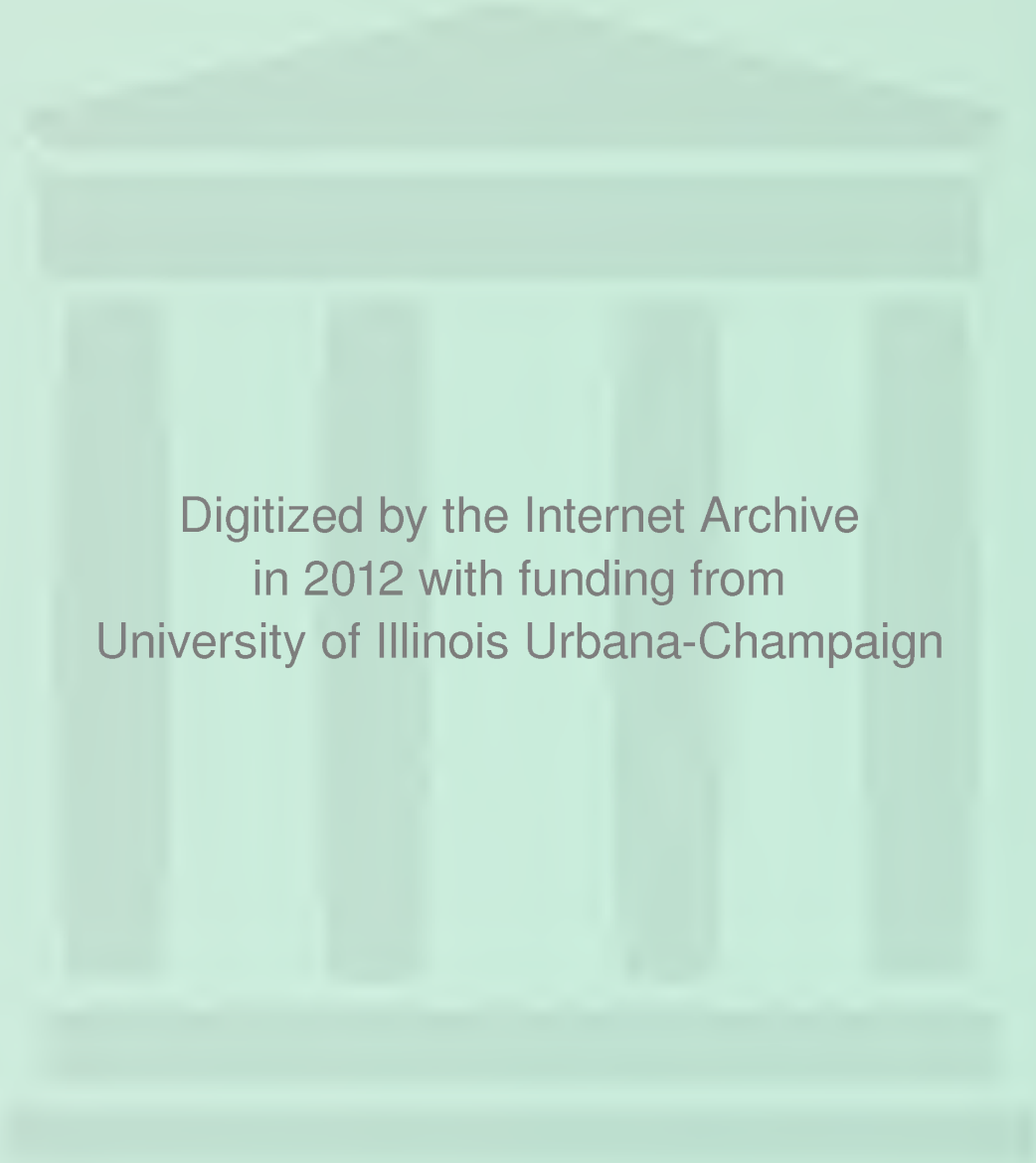

Faculty Working Papers

PREDICTIVE ABILITY OF ALTERNATIVE INCOME CONCEPTS

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Ronald D. Picur
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#268

College of Commerce and Business Administration
University of Illinois at Urbana-Champaign

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PREDICTIVE ABILITY OF ALTERNATIVE INCOME CONCEPTS

I) INTRODUCTION

A topic of considerable interest to accounting research is the selection of a user-oriented information system given alternative methods of income measurement. A wealth of literature appears which addresses this issue. Such literature can be broadly classified into three categories: (1) conceptual articles which debate the merits of alternative measurement schemes, (2) articles which consider predictive ability as a criterion to evaluate such alternatives, and (3) articles which, in fact, evaluate alternative methods of income measurement via the predictive ability criterion. This study seeks to extend earlier research related to the all-encompassing third category. That is, alternative methods of income measurement are evaluated on the basis of their predictive ability. Two vehicles are employed in order to approach this research question. First, a simulation model is utilized to generate a series of accounting earnings under alternative income concepts. Second, predictions of future earnings are generated through application of the forecasting feature found in the Box-Jenkins time series analysis technique.

II) FOUNDATIONAL STUDIES

Three areas of related research have been identified above. The first--conceptual merits of alternative methods of income measurement--has been the subject of much discussion and will not be re-traversed here. The reader is referred to Edwards and Bell (1967), Revsine (1973) and Chambers (1966) for in-depth discussions of several frequently cited alternatives which are evaluated herein.

The predictability criterion is one which has found both institutional and individual support. The 1966 ASOBAT committee of the American Accounting Association (1966, p.) alluded to this criterion as follows:

> "The past earnings of the firm are considered to be the most important single item of information relevant to the prediction of future earnings."

Beaver, Kennelly and Voss (1968) provide perhaps the most basic description of the criterion and the rationale for its use. Their interpretation (p. 675) of the predictability criterion suggests:

> "...alternative accounting measurements are evaluated in terms of their ability to predict events of interest to decision-makers. The measure with the greatest predictive power with respect to a given event is considered to be the 'best' method for that purpose." (emphasis added)

Moreover, Beaver, et al, offer (p. 676) as rationale the observation that, "The criterion is well established in the social and natural sciences as a method for choosing among competing hypotheses."

However, predictability has not been universally championed as a method of evaluation. Louderback (1971), for example, attacks the operationalization of this criterion. He finds that various studies - such as Frank (1969) and Simmons and Gray (1969) - employ the criterion in predicting future accounting earnings. Louderback criticizes these and related studies on the basis of the object of the prediction--i.e., accounting earnings. The foundation for such criticism relates to the lack of articulation between accounting earnings and what Louderback terms information relevant to investor decisions -- although he does not identify what information falls into this "relevance" category. In a similar vein, Revsine (1971) also questions the results of such predictability studies--i.e., Frank (1969) and Simmons and Gray (1969)--on the grounds that a theoretical base, for suggesting income forecasts are useful in their own right, is unspecified. That is, Revsine claims income is simply an artifact for some other phenomena the investor deems relevant.[1]

The final category of research relevant to this study encompasses several studies which employed the predictive abilitive criterion (with respect to future

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[1]Revsine (1971) also offers a set of testable hypotheses (see the "assertion" and "sub-assertions on p. 483) which are clearly addressed in this study. These will be explicitly identified in Section III.

earnings) to evaluate alternative methods of income measurement. Frank (1969) employed empirical data relating to six industries (derived from COMPUSTAT) to determine the error magnitude, which resulted from using one year's current operating profit (COP) to predict succeeding years' measures of the same income concept. Frank found the error rate of COP forecasts exceeded those of historical cost. In addition, Frank's findings suggest that historical cost generally outperformed COP in forecastin, suceeding year's historical cost earnings. In a related study, Simmons and Gray (1969) utilized a simulation approach in considering the predictive ability of alternative income measurement methods. They found that historical cost and price level adjusted historical cost both yielded better predictions of their own future values than did current operating profit in predicting future current operating profit.

III) RELATIONSHIP OF THIS STUDY TO PREVIOUS RESEARCH

In light of previous research, the study attacks the issue of the predictability of alternative income methods by employing a methodology which seeks to eliminate deficiencies of previous studies and to address the questions surrounding the predictability criterion. Accordingly, each of the deficiencies or questions raised by the previous studies will be identified and the methodology this study employed to circumvent same will be described.

Frank's (1969) study, while utilizing empirical data, had to generate current operating profit earnings via a series of transformation functions. As a result, the accuracy of fixed asset and inventory valuations are suspect. Moreover, other income measurement alternatives--such as net realizable value--were not evaluated. Hence, while empirical data did permit Frank a greater degree of experimental reality (as opposed to simulation), the "cost" of this reality is necessarily that of limi scope. This study seeks to expand on Frank's findings by considering four major income measurement methods--i.e., historical cost price level adjusted, business profit, current operating profit and net realizable value.

Simmons and Gray's (1969) study, while also employing simulation, had several conditions which limited the scope and therefore the findings, of their study. First, the simulation model they used generated earnings streams for only one firm.[2] This study, by way of a series of stochastic parameters, generates operating results for approximately 50 different firms. Second, Simmons and Gray did not evaluate either the business profit or the net realizable value methods of income measurement which are included within this study. Finally, as Revsine (1971, p. 486) points out, Simmons and Gray utilized a straight-line extrapolation technique to forecast future earnings. This study, by employing Box-Jenkins, significantly extends the time series analysis methodology employed in their study.

The relevance of the object of the predictive ability criterion being the forecast of future accounting earnings--raised by both Louderback (1971) and Revsine (1971)--is also addressed in this study. While Louderback declined to define "relevance" (p. 299), Revsine does offer an alternative to the estimation of future income (however defined) which both Frank and Simmons and Gray employed as their predictability criterion. Revsine (1971, p. 483) states:

> "It would then follow that earnings projections themselves are not of primary interest to the user; rather it is the relationship between projected income and <u>future distributable operating flows</u> that is important." (emphasis added).

Accordingly, this study will evaluate the ability of the alternative income measures to predict a flow called the "permanent earnings" of the form.[3,4] In addition, since

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[2]Other differences - such as the actual decision making function of the simulated firm - will be identified in Section IV.

[3]This concept, as defined by Greenball (1966, pp. and 196 , pp) is employed in this study. This concept is defined in Section IV.

[4]It should be noted that Revsine explicitly states such a study should be undertaken. Specifically,

> "...where distributable operating flows are assumed to be the appropriate object of prediction, a relevant test of these predictability assertions would require a determination of the relative ability of various income concepts in predicting future operating flows." (1971, p. 486)

various authors[5] have suggested that the predictive ability criterion of forecasting future accounting earnings (however defined) by past accounting earnings (similarily defined) may be relevant, this study will consider the relative efficiency by which each method of income measurement predicts itself.

In summary, this study seeks to evaluate a series of alternative income methods on the basis of a predictive ability criterion--where such a criterion is either the future "permanent earnings" or future accounting earnings of the firm. A simulated firm is employed to generate the alternative earnings streams and the forecasting component of the Box-Jenkins time series analysis technique is used to generate future period's projections.

IV) THE SIMULATION MODEL

With these objectives as a foundation, this study sought to achieve such goals by use (in part) of a simulated set of firms. The basic simulation model was first developed by Greenball (1966 and 1968) and later extended by McKeown and Picur (1974). In order to provide a description of the attributes embedded within the model, a brief overview of its fundamental features will be identified.

A) The Permanent Earnings Concept

Given this study's major objective of evaluating alternative methods of earnings measurement via the predictability criterion (of economic income), a concept of economic income must first be postulated and then operationalized in order to perform such evaluations. The one employed within this study is the "permanent earnings concept" as defined by Greenball. Rather than simply restating the underlying axioms which uniquely define this concept the reader is referred to Greenball (1968, pp. 115-119) for a complete derivation of the permanent earnings concept and the justification for its use.

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[5] For example, both Louderback (1971, p. 298) and Revsine (1971, p. 483) suggest the earnings predictions might be useful as surrogates for decisions about the relative merits of common stocks and/or future distributable operating flows.

However, this concept can be briefly defined by the following three step procedure:

1) Determine the permanent rate of return: (PROR is implicitly defined in terms of net cash flow.)

$$\sum_{t=o}^{T} C_t (1 + PROR)^{-t} = 0 \qquad (1)$$

Where: C_t is the net cash flow during period t
PROR is the permanent rate of return
T represents the period in which the firm liquidates.

2) Determine the permanent capital:

$$K_t = \sum_{v=t+1}^{T} C_v (1 + PROR)^{t-v} \qquad (2)$$

Where: K_t is the permanent capital at the end of period t

3) Determine the permanent earnings:

$$PE_t = K_t - K_{t-1} + C_t \qquad (3)$$

Where: PE_t is the permanent earnings of the firm during period t

B) Model of Simulated Firms

Needless to say a simulation of any process represents a complex computer program. Hence, this discussion will be restricted to solely a review of the fundamental features of the simulated firms. Since the basic model employed within this study is founded upon Greenball's work, much of the following discussion will parallel his description.[6]

1) The Firms

The basic simulation model employed was used to generate operating results for approximately 70 firms. These firms were homogeneous with respect to product and requisite inputs but represented a heterogeneous grouping of variable parameters which affected actual performance. The inclusion of stochastic features sought to

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[6]For a complete description of Greenball's model the reader is referred to Chapter 6, "The Model of Class H Firms," of his dissertation (1966).

provide an entire spectrum of operating performances and were implemented with the objective of generalizing the results of this study to a large class of firms.

Each firm j began operations at time period zero (t=o) and was permitted to liquidate at any point in time (T_j) with the sole constraint all firms must be liquidated no later than at the end of period 55 ($T_j \leq 55$).[7] This forced liquidation feature was necessary to allow calculation of the permanent earnings (PE_j) for each firm j. However, in light of the Box-Jenkins requirement of fifty observations, any firm liquidating prior to the completion of the 50th period was excluded from the sample. As such, only 50 of the 70 firms originally simulated met this minimum criterion and were included.

In the model two separate time horizons were employed--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 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 it has $T_j - 1$ 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.

Insert Figure One Here

[7] In fact, each firm j made a decision each period as to expand, contract, liquidate or maintain constant production level. Hence, the term "permitted" suggests the capability of liquidation during any period. The actual outcome is a result of a decision model employed by all firms.

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 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 represent the gross cash proceeds from a primary issuance of shares.[8]

2) The Product

Again as a simplifying assumption a l 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:

$$p_t = \alpha_t + \beta_t \cdot \bar{x}_t \qquad \text{for } \alpha_t > 0 \text{ and } \beta_t < 0 \tag{4}$$

where: t = time period
p = selling price
α = intercept parameter
β = slope parameter
$\bar{x}$ = quantity sold

[8] As Greenball suggest (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 include of the gross cash proceeds from the primary issuance of bonds.

3) 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. Similarly, to produce $\bar{z}_t$ widgets the firm must have n_t units of plant capacity (where $n_t \geq \bar{z}_t$) available immediately following the production decision.[9] 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 γ (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 δ per decision period such that at the end of d.p.t. there remain $(1 - \delta)n_t$ units of plant capacity.

In the model production takes place twice during a decision period. Production moment one (p.m.t_1) occurs immediately following the beginning of each decision period (d.p.t.), while production moment two (p.m.t_2) takes place immediately before the end of that decision period. Once a firm has decided the quantity of widgets it will sell ($\bar{z}_t$) it must manufacture one half of that quantity ($\frac{\bar{z}_t}{2}$) at p.m.t_1 and an equal quantity at p.m.t_2.

Once the firm has made its decision as to its production level ($\bar{z}_t$), it has two options with respect to raw material purchases. It can purchase and inventory $\bar{z}_t$ units of raw material immediately preceding p.m.t_1; alternatively, it can acquire $\bar{z}_t/2$ units immediately before p.m.t_1, and a like quantity before p.m.t_2. This decision is made based upon expected input price at d.p.t. with respect to the known prices at d.p.t-1.

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[9] This relationship assumes the firm can acquire sufficient capacity in a short time period to make up any deficiency--i.e., if $n_{t-1} < \bar{z}_t$ then the firm must purchase at least $\bar{z}_t - n_{t-1}$ units of capacity prior to production.

4) Model Parameters

a) Constant Parameters

As stated earlier the simulation process encompassed 70 firms. Embedded within the model are several parameters which are constant across all such firms. These values are summarized in Table One.

Insert Table One here

b) Stochastic Features and Parameters

While each of the 200 firms simulated utilized the same inputs and produced the same product, several stochastic features were built into the model in order to generalize the results of this study. For every firm the value of each of the stochastic attributes was chosen at random from a population of values uniformly distributed over a specified range. These values were selected at t=0 and the demand function parameters and input prices were then adjusted in such a manner as to generate an expected rate of return for accounting period one ($a.p._1$) of 20%. These stochastic parameters primarily relate to the price of inputs and the α intercept of the demand function. The parameters and their ranges are summarized in Table Two.[10]

Insert Table Two here

[10] See Greenball (1968, pp. 68-75) for a complete description of these stochastic parameters.

TABLE ONE

CONSTANT PARAMETERS

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

5) Decision Making

At the beginning of every decision period each firm must determine the following:

(1) z_t: Sales for decision period t
(2) n_t: Plant capacity for decision period t.
(3) Raw material purchase option:
    (a) z_t units of raw material before production moment t_1, or
    (b) $z_t/2$ units of raw material before production moment t_1 and a like quantity before production moment t_2.

Each firm selects these quantities, and thereby sets production levels and determines resource requirements, by maximizing the expected value criterion:

$$C_{t-1}(t) + (\bar{C}_t(t) + \bar{V}_t) / (1 + \rho)$$

where:

$C_{t-1}(t)$ is the net cash flow associated with

(1) the purchase of either:
    (a) z_t units of raw material, or
    (b) $z_t/2$ units of raw material,
(2) the purchase of $z_t/2$ units of labor, and
(3) the purchase or disposal of plant--

where all events occur just prior to production moment t_1.

$\bar{C}_t(t)$ is the expected net cash flow associated with:

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

$\bar{V}_t$ is the expected liquidation value of the firm at the end of decision period t. Since no receivables, payables, retained earnings, or inventory[11] is maintained at the end of decision period t (i.e., all transactions are solely for cash), then $\bar{V}_t$ simply represents the liquidation value of the plant at the end of the decision period.
Symbolically,

$$\bar{V}_t = \bar{p}_t^{\,d} \cdot n_t (1 - \delta)$$

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

ρ is the interest rate used by the firm for decision making purposes.

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[11] No inventory is maintained at the end of a decision period due to the fact the firm sells its entire output at the prevailing market price. That is, since the firm's decision function is solely a one period time horizon, inventory "build-ups" (in anticipation of changing prices) are not permitted. Note that this does not affect accounting measurements since the firm does maintain an inventory at the end of each accounting period. (Remember that accounting periods "straddle" decision periods.)

TABLE TWO

VARIABLE PARAMETERS

Mnemonic	Parameter	Range
DEPR	Depreciation rate per period (S)	.125 to .250
GROW	Systematic growth rate (g)	.0 to .1
FRST	Ability to forecast next period changes in stochastic parameters.	none to perfect
CVAR	Standard deviation of relative change in input prices	.02 to .06
ALCR	Correlation coefficient between relative change in demand parameter and relative changes in input prices	.0 to .5

Given the uncertain nature of the stochastic parameters found in the time t values each firm employs the expected values of these parameters as certainty equivalents for the true values in order to derive a solution to equation 5. The expected values utilized by each firm are dependant upon: (1) the firm's forecasting ability with respect to parameter changes[12] and (2) the parameter values at the beginning of d.p.c. which are known to the firm.

IV) ACCOUNTING METHODS EVALUATED

In this study eight accounting methods were evaluated, $i = 1,2,\ldots,8$: were evaluated with respect to their time series properties. These methods include the following:[13]

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

[12] For those firms with no forecasting ability it utilizes the $t-1$ value for its expected time t value since it knows the mean change in these values is zero.

[13] It should be noted that all examined measures initially represent price level adjusted amounts. Alternatively, this situation can be viewed as an environment with no change in the general price level. However, it should be remembered that specific price levels (i.e., fixed assets, labor and inventory) do vary.

where: H = historical cost

B = business profit

C = current operating profit

N = net realizable value (unadjusted)[14]

N+ = net realizable value (adjusted)[15]

A = absorption costing with respect to the widgets inventory

D = direct costing

For each method a measure of capital (K_I) at the end of the accounting period (a) was determined as follows:

$$K_{a,i} = M_{a,i} + W_{a,i} + F_{a,i} \qquad (6)$$

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 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 data. 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.

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[14]Net realizable value of an asset is defined as the maximum net amount which can be realized from the disposal of that asset within a short period of time--not a forced sale situation, but not long enough to allow disposal of fixed assets through ordinary use of services. Income, under this valuation scheme, is the excess of realized revenues over expired disposition values of assets at the time of their severance.

[15]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 net realizable value earnings to account for this friction.

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

$$P_{a,i} = K_{a,i} - K_{a-1,i} + C(a) \quad \text{for: } i=1,\ldots,4 \text{ and } 7 \tag{7}$$

where: C(a) is the net cash flow from the firm to its owners during a.p.a.--i.e., $C(a) = D(a) - F(a)$

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:

$$P_{a,5} = P_{a,3} - ({}^{a}K_{a-1,3} - K_{a-1,3}) \tag{8}$$

$$P_{a,6} = P_{a,4} - ({}^{a}K_{a-1,4} - K_{a-1,4}) \tag{9}$$

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

$$P_{a,8} = P_{a,7} + (acq) \cdot (p^{f}_{a-\frac{1}{2}} - p^{d}_{a-\frac{1}{2}}) \tag{10}$$

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 and 6) only with respect to the valuation of the widget inventory. While all methods include material and labor components in the valuation of W, the absorption methods also include 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.

V) OVERVIEW OF BOX-JENKINS TIME SERIES MODELS

Since the Box-Jenkins time series analysis technique has been described in varying degrees of detail elsewhere -- see Box and Jenkins (1971), Nelson (1973), Dopuch and Watts (1972), and Mabert and Radcliffe (1974)--discussion here will be limited to a brief overview of the particular form of the model utilized in the present study and a description of adaptive forecasting.

A) ARIMA Models

An important class of discrete linear time series models are the auto-regressive integrated moving-average (ARIMA) models. These models may represent a particularly wide range of time series behavior. A convenient notational representation follows:

$$\phi_p (B) \nabla^d z_t = \theta_o + \theta_q (B) a_t \quad (11)$$ [16]

where:

z_t = a correlated sequence of observations generated by the process to be identified.

$\phi_p (B) = 1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p$

B is a backward shift operator such that $Bz_t = z_{t-1}$

$\nabla^d z_t = (1 - B)^d z_t$ where d represents the level of consecutive differencing necessary to attain stationarity.

θ_o = deterministic trend constant

a_t = a sequence of independent and identically distributed random variables.

$E(a_t) = 0$ and σ_a^2 is a constant

$\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \ldots - \theta_q B^q$

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[16] It should be noted that when the consecutive differencing parameter is zero (d=0), z_t is replaced in the above equation by $(z_t - u)$ where u represents the mean of the series under examination.

B) Adaptive Forecasting

In this paper, the identified time series model for each sample firm is utilized to generate predictions of income for the next five periods. Due to the length of the forecast horizon (five periods), updated forecasts of income will also be generated through the utilization of adaptive forecasting. (See Nelson, 1973, pp. 157-159).

With this technique, the originally identified time series model for each firm remains unchanged. However, forecasts of income for periods greater than one are updated given the forecast error of the first period forecast. Specifically, the actual income number for the first forecast period is compared to the forecast generated from the original time series model. The comparison of these two numbers results in a forecast error. A set of factors which are dependent upon the parameters of the original model are used to update future period forecasts in accordance with the following rule:

forecast at origin T + 1 = forecast at origin T + (factor) X (forecast error)

The factor term stated above is a model specific value (a function of the parameters of the original model); the forecast error term is the difference between the actual income figure - (Z_t) and the forecast of that income figure at period t-1 - ($\hat{Z}_{t-1}(1)$). An example will serve to provide a better understanding of this updating process.

Assume an autoregressive process of order one [AR(1)] as follows:

$$\hat{Z}_t(m) - \hat{Z}_{t-1}(m+1) = \phi_1^m (Z_t - \hat{Z}_{t-1}(1)) \quad m = 1,2, \ldots$$

where: $\hat{Z}_t(m)$ = the forecast of Z_{t+m} at period t

ϕ_1^m = first order autoregressive parameter raised to the exponent m.

Z_t = current observation (new observation in adaptive forecasting)

$\hat{Z}_{t-1}(1)$ = the forecast of Z_t at period t-1

Thus, as the forecast horizon "m" increases, the current error term ($Z_t - \hat{Z}_{t-1}(1)$) provides less information providing $\phi_1^m < 1$.

The purpose of employing adaptive forecasting can be identified in terms of a supplementary method of evaluating predictive ability. That is, by utilizing adaptive forecasting, the predictive ability of the alternative income measures is better assessed because the forecasts are updated as actual income results are appended to the respective data bases.

VI) METHOD OF ANALYSIS AND FINDINGS

Upon completion of the simulation runs, a series of 8 accounting streams, of 55 periods each, for 50 firms had been generated.[17] Each time series was then analyzed, utilizing the Box-Jenkins technique, to derive forecasts for the following situations:

1) Forecasts of accounting earnings predicting:
   a) future period's accounting earnings, and
   b) future period's permanent earnings
2) Adaptive forecasts of accounting earnings predicting:
   a) future period's accounting earnings, and
   b) future period's permanent earnings.[18]

In order to assess the relative predictive ability of each accounting method vis a vis the other alternatives, a three stage analysis was employed. The first stage entailed a determination of the forecast error between the predicted and actual values. Accordingly, Thiel's (1961, p. 32) "U" coefficient

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[17] Fifty-five accounting periods were simulated in order to utilize the first 50 periods as input to the Box-Jenkins model and then compare the forecasts from Box-Jenkins to the actual results of the next 5 accounting periods.

[18] Since permanent earnings are not available until after liquidation, the adaptive forecasts used only the actual accounting earnings (from periods 51 through 54) in deriving the predictions.

was calculated for each of the four cases described above. The general formulations of these are summarized in Table Three. In addition, rank values were calculated for each measure and labeled as UAR, UPER, UAR' and UPER'. Values of 1 to 8 were assigned to each measure based on a ranking (from lowest to highest) of the corresponding "U" value.

Insert Table Three here

The second stage comprised an analysis of variance of the various U statistics (including the rank scores). In all cases, the income method represented the independent variable; correspondingly, the U coefficients and ranks were utilized as the dependent variable. In addition, for any case where the covariance matrix was found to be non-homogeneous, an adjustment (originally proposed by Box) was made to the degrees of freedom used in calculating probabilities of the "F" ratios.[19] The results of the ANOVA tests, which include the Box adjustment parenthetically, are contained in Tables Four and Five.

Insert Tables Four and Five here

The final stage of the analysis was contingent upon the results of the ANOVA test. That is, for all cases where significant "F" ratios were found, Scheffè's *a posteriori* test was employed in order to make paired comparisons between all possible methods of income measurement. Here also the results were adjusted by the Box procedure for those situations in which the covariance

[19]For a full explanation of this adjustment, and the rationale for its use, see Box (1954, p. 300).

TABLE THREE

FORECAST ERROR FORMULAS

Mnemonic	Description	Formulation
UA	Accounting earnings predicting accounting earnings	$UA_{i,j} = \frac{\sqrt{\sum_a (\hat{P}_{i,j,a} - P_{i,j,a})^2}}{\sqrt{\sum_a (\hat{P}_{i,j,a})^2} + \sqrt{\sum_a (P_{i,j,a})^2}}$
UPE	Accounting earnings predicting permanent earnings	$UPE_{i,j} = \frac{\sqrt{\sum_a (\hat{P}_{i,j,a} - PE_{j,a})^2}}{\sqrt{\sum_a (\hat{P}_{i,j,a})^2} + \sqrt{\sum_a (PE_{j,a})^2}}$
UA'	Adaptive forecast of accounting earnings predicting accounting earnings	$UA'_{i,j} = \frac{\sqrt{\sum_a (\hat{P}'_{i,j,a} - P_{i,j,a})^2}}{\sqrt{\sum_a (\hat{P}'_{i,j,a})^2} + \sqrt{\sum_a (P_{i,j,a})^2}}$
UPE'	Adaptive forecast of accounting earnings	$UPE'_{i,j} = \frac{\sqrt{\sum_a (\hat{P}'_{i,j,a} - PE_{j,a})^2}}{\sqrt{\sum_a (\hat{P}'_{i,j,a})} + \sqrt{\sum_a (PE_{j,a})^2}}$

WHERE:
- i = accounting method (1 to 8)
- j = firm (1 to 50)
- a = accounting period (50 to 55)
- P = accounting earnings (actual)
- PE = permanent earnings
- $\hat{P}$ = forecast accounting earnings
- $\hat{P}'$ = adaptive forecast of accounting earnings

TABLE FOUR

RESULTS OF ANOVA TEST
ON BOX-JENKINS FORECASTS

MEASURE	INDEX	F RATIO	PROBABILITY (DEGREES OF FREEDOM)
Accounting Income . Predicting Future Accounting Income.	UA	3.485	0.011 (3.74,183.2)
Rank of Accounting Income . Predicting Itself	UAR	4.691	0.000+ (5.2, 254.9)
Accounting Income . Predicting Future Permanent Earnings	UPE	1.578	0.177 (4.28, 209.6)
Rank of Accounting Income . Predicting Future Permanent Earnings	UPER	1.081	0.373 (5.59, 273.7)

TABLE FIVE

RESULTS OF ANOVA TEST
ON BOX-JENKINS ADAPTIVE FORECASTS

MEASURE	INDEX	F RATIO	PROBABILITY (Degrees of Freedom)
Accounting income · predicting future accounting income .	UA*	11.715	0.00 (4.03, 197.6)
Rank of accounting income · predicting itself	UAR*	13.587	0.00 (4.78, 234.3)
Accounting income . predicting future permanent earnings	UPE*	5.558	0.0002 (4.44, 217.6)
Rank of accounting income · predicting future permanent earnings	UPER*	5.015	0.0002 (4.93, 241.6)

matrix was non-homogeneous. The net result of the use of the Scheffé test adjusted by the Box procedure in this set of findings, highly conservative with respect to a Type I error, which can be found in Tables Six through Eleven.

Insert Tables Six through Eleven here

VII) INTERPRETATION OF FINDINGS

The findings in Tables Six through Eleven have been condensed into a simplified set of select paired comparisons which are summarized in Table Twelve. All comparisons in the table are limited to the U coefficients derived from the analysis of predicted versus actual numbers (i.e., no ranks are found in Table Twelve), and unusual or unlikely comparisons (e.g., comparisons of BA and BD, BA and CD, etc.) have been eliminated. The discussion of the findings will be considered in two categories: (1) accounting earnings used to predict future accounting earnings, and (2) accounting earnings used to predict future permanent earnings.

Insert Table Twelve here

A) Predictive Ability of Alternative Income Measures to Predict Themselves

As identified earlier, one of the basic research questions concerning alternate concepts of income measurement is their ability to predict their own future values. The findings of this study with regard to this question can

TABLE SIX

PAIRED COMPARISONS OF UA

Method (Mean)	HD (.21421)	BA (.21531)	BD (.22675)	CA (.24248)	CD (.26496)	N (.23843)	N+ (.23183)
HA (.19104)	HA	HA	HA	HA	HA**	HA	HA
HD (.21421)		HD	HD	HD	HD	HD	HD
BA (.21531)			BA	BA	BA	BA	BA
BD (.22675)				BD	BD	BD	BD
CA (.24248)					CA	N	N+
CD (.26496)						N	N+
N (.23843)							N+

CODE: *** = significant at .01 level
** = significant at .05 level
* = significant at .10 level
(no mark) = not significant

TABLE SEVEN

PAIRED COMPARISONS OF UAR

Method (Mean)	HD (3.94)	BA (4.42)	BD (4.64)	CA (4.52)	CD (5.40)	N (5.04)	N+ (4.96)
HA (3.08)	HA	HA	HA	HA	HA***	HA**	HA**
HD (3.94)		HD	HD	HD	HD	HD	HD
BA (4.42)			BA	BA	BA	BA	BA
BD (4.64)				CA	BD	BD	BD
CA (4.52)					CA	CA	CA
CD (5.40)						N	N+
N (5.04)							N+

CODE: *** = significant at .01 level
** = significant at .05 level
* = significant at .10 level
(no mark) = not significant

TABLE EIGHT

PAIRED COMPARISONS OF DA'

Method (Mean)	HD (.16332)	BA (.18597)	BD (.18552)	CA (.20071)	CD (.23699)	N (.23501)	N+ (.21080)
HA (.11327)	HA	HA**	HA**	HA***	HA***	HA***	HA***
HD (.16332)		HD	HD	HD	HD**	HD**	HD
BA (.18597)			BD	BA	BA	BA	BA
BD (.18552)				BD	BD	BD	BD
CA (.20071)					CA	CA	CA
CD (.23699)						N	N+
N (.23501)							N+

CODE: *** = significant at .01 level
** = significant at .05 level
* = significant at .1 level
(no mark) = not significant

TABLE NINE

PAIRED COMPARISONS OF MAR'

Method (Mean)	HD (3.74)	BA (4.60)	BD (4.32)	CA (4.48)	CD (5.36)	N (5.96)	N+ (5.28)
HA (2.26)	HA	HA***	HA***	HA***	HA***	HA***	HA***
HD (3.74)		HD	HD	HD	HD*	HD***	HD
BA (4.60)			BD	CA	BA	BA	BA
BD (4.32)				BD	BD	BD*	BD
CA (4.48)					CA	CA	CA
CD (5.36)						CD	N+
N (5.96)							N+

CODE: *** = significant at .01 level
** = significant at .05 level
* = significant at .10 level
(no mark) = not significant

TABLE TEN

PAIRED COMPARISONS OF DPI'

Method (Mean)	HD (.17250)	BA (.14856)	BD (.17003)	CA (.17259)	CD (.20602)	N (.18573)	N+ (.15023)
HA (.12626)	HA	HA	HA	HA	HA***	HA*	HA
HD (.17250)		BA	BD	HD	HD	HD	N+
BA (.14856)			BA	BA	BA*	BA	BA
BD (.17003)				BD	BD	BD	N+
CA (.17259)					CA	CA	N+
CD (.20602)						N	N+*
N (.18573)							N+

CODE: *** = significant at .01 level
** = significant at .05 level
* = significant at .10 level
(no mark) = not significant

TABLE ELEVEN

PAIRED COMPARISONS OF UPER'

Method (Mean)	HD (4.54)	BA (3.72)	BD (4.68)	CA (4.42)	CD (5.82)	N (5.00)	N+ (4.44)
HA (3.38)	HA	HA	HA	HA	HA**	HA	HA
HD (4.54)		BA	HD	CA	HD	HD	N+
BA (3.72)			BA	BA	BA**	BA	BA
BD (4.68)				CA	BD	BD	N+
CA (4.42)					CA	CA	CA
CD (5.82)						N	N+
N (5.00)							N+

CODE: *** = significant at .01 level
** = significant at .05 level
* = significant at .10 level
(no mark) = not significant

TABLE TWELVE
SELECT PAIRED COMPARISONS

Index / Comparison	UA	UA	UPE
Absorption vs. Direct			
HA vs. Hd	HA	HA	HA
BA vs. BD	BA	BD	BA
CA va. CD	CA	CA	CA
HC vs. BP			
HA vs. BA	HA	HA**	HA
HD vs. BD	HD	HD	BD
HC vs. COP			
HA vs. CA	HA	HA**	HA
HD vs. CD	HD	HD**	HD
HCA vs. NRV			
HA vs. N	HA	HA***	HA*
HA vs. N+	HA	HA***	HA
BP vs. COP			
BA vs. CA	BA	BA	BA
BD vs. CD	BD	BD	BD
BPA vs. NRV			
BA vs. N	BA	BA	BA
BA va. N+	BA	BA	BA
COPA vs. NRV			
CA va. N	N	CA	CA
CA vs. N+	N+	CA	N+

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

be found in the column labeled "UA" in Table Twelve. It should be pointed out that all inferences drawn from this table, based on the "UA" index, are not significant even at the .10 level. Nevertheless, some interesting observations can be made.

In all cases the absorption costing methods outperformed their direct costing counterparts in predicting future period values of themselves. This phenomenon may be attributable (in part) to the probably "smoother" stream produced t the absorption methods -- in contrast to the fluctuations found when the direct costing alternatives are employed. Perhaps the most interesting finding relates to the historical cost comparisons with the other income schemes. In all cases, both the absorption and direct versions of historical cost uniformly outperformed their business profit, current operating profit and net realizable value counterparts.[20] Business profit represented the next "best" predictor -- in a relative sense. That is, it provided better predictions of itself that did either the current operating profit or net realizable value methods. The unadjusted (N) and adjusted (N+) net realizable value methods outperformed only the CA alternative. Finally, the current operating profit method was found inferior to all the other alternatives.

As previously identified, due to the length of the forecast horizon (i.e., five periods), updated forecasts of income were also generated through the utilization of adaptive forecasting. The summary of these findings are contained in Table Twelve under the column labeled "UA'." In general these results coincided with the findings discussed above. However, several changes

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[20]Since the net realizable value concept of income measurement does not treat overhead as a period cost, all findings involving NRV are limited to comparisons involving the alternative income method's absorption costing counterpart.

did occur and are summarized below.

Undoubtedly, the most substantial change occurred with respect to the historical cost comparisons. That is, HA significantly outperformed all of its counterparts -- at the .05 level versus BA and the .01 level versus CA and the NRV methods. Similarly, HD was found to outperform CD at the .05 level though the comparison to BD was not significant even at the .10 level. The latter finding is consistent with the UA' results concerning absorption versus direct costing. Specifically, while HA and CA provided better predictions than their direct counterparts, BD outperformed BA. The only other difference from the UA results found CA providing better predictions of itself that either N or N+ -- although neither comparison was significant.

B) Predictive Ability of Alternative Income Measures to Predict Permanent Earnings

This analysis is primarily founded upon Revsine's (1971, p. 483) assertion that, "...it is the relationship between projected income and future distributable operating flows that is important." Revsine's (1971, p. 483) definition of operating flows as "...the amount of cash and other liquid resources generated by operating activities" appears to be in agreement with the permanent earnings concept previously identified. As such, this aspect of the study relates to the ability of each method of income measurement to predict future period's permanent earnings.

These findings are summarized in Table Twelve. It should be noted that since the ANOVA tests of the UPE index found insignificant differences (in the aggregate), the following discussion is limited to the adaptive forecasts of permanent earnings--i.e. UPE'. Once again, while the comparisons were generally not statistically significant, several interesting observations may nevertheless be made.

In all cases, the absorption methods uniformly outperformed their direct counterparts. Likewise, with the exception of the HD vs. BD comparison, the historical cost methods were found to be better predictors of permanent earnings that any of the other alternatives -- though only the HA vs. N comparison was significant at even the .10 level. Once again, the business profit measures provided the next best predictions of permanent earnings -- in a relative sense --since they outperformed both the current operating profit and net realizable value alternatives. Finally, the results regarding the CA and NRV comparisons were mixed. That is, CA outperformed only N; alternatively, N+ outperformed only CA in terms of predicting future permanent earnings.

VIII) LIMITATIONS

Although the application of simulation offers several specific advantages (discussed earlier), an identification of the limitations implicit in the model is desirable to properly interpret the results reported above. Perhaps the major limitation revolves around the use of a simulation model *per se*. That is, the dynamic properties of the various interactions do not permit an in-depth analysis of the findings other than at an intuitive level. Hence, while the findings can be reported, rationale for such phenomena occuring can not be identified. However, in defense of the simulation model, it should be noted that lacking empirical data and/or analytical solutions, simulation is the only feasible alternative.

Several specific limitations can also be found upon detailed examination of the model. First, the use of the expected cash flow maximization criterion (as the decision function) can be attacked on grounds of experimental reality. That is, while theoretically such a criterion should be utilized to insure

long run profit maximization, various authors (e.g., see Lerner and Rappaport) have suggested other criteria are employed in the real world. A second criticism can be raised regarding the utilization of a single production decision and single product. Finally, the income reporting situation represented a fairly simplistic environment. That is, depreciation and overhead represented the only form of deferred charge amortized over time. As such, the effect of alternative accounting principles or "income smoothing" in general could not be determined.

IX) IMPLICATIONS AND SUMMARY

The findings of this study have implications both with respect to past research and current and future policy making. Employing the Box-Jenkins time-series analysis technique to forecast future accounting earnings utilizing past accounting earnings, this study's results generally support the conclusions drawn by Simmons and Gray (1969) and Frank (1969). These studies found that historical cost provided better forecasts of itself than current operating profit did of itself. Moreover, the use of the adaptive forecasting feature of the Box-Jenkins technique found that the absorption method of historical cost significantly outperformed not only current operating profit but also business profit and net realizable value. Hence, the statistical significance (between historical cost and current operating profit forecasts errors) which was reported by Frank, was supported and extended to include several other income measurement alternatives offered in the literature. If one accepts Johnson's (1970, p. 653) position that "...since forecasting is prior to deciding, forecast accuracy should determine the system...," these findings lead to the conclusion that a historical cost based information system is better than other alternatives -- from the standpoint of a user-orientation.

In addition, the findings of this study shed some light on criticisms which have been directed toward the predictability criterion. Specifically, Revsine's (1971) criticism of Simmons and Gray's (1969) and Frank's (1969) studies revolves around Revsine's contention that the object of the prediction was improperly specified. That is, Revsine states that rather than examining the ability of current operating profit to predict future measures of itself, these studies should have tested the ability of current operating profit to predict future distributable operating flows. Revsine's assertion is based on his observation that proponents of replacement cost "...were really suggesting that future current operating profit is the appropriate object for prediction since this measure constitutes the best possible estimate of future distributable operating flows." (p. 483) Although Revsine's criticism of these previous studies may well be valid, the results of this study -- with respect to the adaptive forecasts (UPE') of accounting earnings predicting permanent earnings -- tend to refute this assertion. That is, historical cost outperformed current operating profit -- as well as the other alternatives -- in predicting future period's permanent earnings -- albeit at an insignificant level.

A final implication of this study relates to recent pronouncement of various authoritative bodies. For example, the Trueblood Report (1973, p. 36) stated that:

> "An objective is to provide a statement of the financial position useful for predicting, comparing and evaluating enterprise earning power." (emphasis added.)
> "Current values should also be reported when they differ significantly from historical costs."

In a similar vein, the Securities and Exchange Commission[21] has recently made overtures that replacement costs of fixed assets and inventories would be

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[21]For example, see the Wall Street Journal (1975, p. 8) for a discussion of this proposal.

required as supplemental information appended to the income statement. The rationale offered by the SEC was partially couched in terms of disclosing the impact of inflation. To the extent these bodies' recommendations are implicitly or explicitly based upon *a priori* expectations of predictive ability, then this study's findings provide additional information which should be weighed before movements to market based accounting systems are implemented. Moreover, the superiority of historical cost is of even greater importance when one considers that all income streams generated in the simulation, basically represented price level adjusted income statements. That is, the recent FASB (1975) exposure draft suggesting the adoption of price level adjusted statements, finds substantial support based on the results of this study.

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