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TIME SERIES PROPERTIES OF ALTERNATIVE METHODS OF INCOME MEASUREMENT

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I) INTRODUCTION

The time series properties of accounting earnings represent a topic of considerable interest to accounting and related disciplines which has been the subject of several previous studies. Beaver (1970), for example, through the use of both empirical and simulated data found that much of the behavior of deflated accounting income streams is consistent with measurements derived from a moving average model. Ball and Watts (1972), on the other hand, state their findings suggest either a submartingale or very similar process. In an effort to further delve into this issue, and to clarify such earlier findings, this study seeks to identify the basic properties of a series of income streams via utilization of the Box-Jenkins (1970) method of time series analysis. As an extension of these previous works, a simulation model is employed to generate income streams under a series of alternative income concepts--specifically, historical cost, business profit, current operating profit and net realizable value.

II) BACKGROUND

A) Rationale

A fundamental question which must be addressed at the initial stage of this study relates to its rationale. That is, why should accounting researchers b concerned with the time series behavior of earnings? Beaver (1970) offers a series of observations which provide the basic foundation. Borrowing from his earlier work (and hopefully not over-condensing), these can be summarized as follows:

(1) Three accounting issues have, as a common denominator, the time series properties of accounting earnings. These are: (a) income smoothing, (b) the relative forecast ability of alternative income measurements, and (c) interim reporting. (1970, p. 62).

(2) A series of studies have utilized accounting earnings data in a predictive context.[1] However, generally speaking, the primary purpose of such studies was not to examine the accounting earnings *per se*. Hence, assumptions regarding the process were never made explicit, or only a relatively narrow range of possible models were tested. The critical point raised by Beaver (1970, p. 65) is that a forecasting process cannot proceed very far without the additional knowledge of the underlying process generating the earnings observations--since such information is a prerequisite to the optimal construction of a forecasting system.

(3) A substantial component of accounting research is concerned with potential measurement errors-particularly with respect to accounting earnings. Beaver (1970, p. 64) contends it is inconceivable such insight can be gained without a knowledge of the process generating the data.

(4) Finally, after briefly discussing the linkage between the statistical behavior of security returns and the efficiency of the valuation process of security markets, Beaver (1970, p. 65) suggests very little is known about the statistical properties of accounting earnings, and in what ways (if any) they differ from the statistical properties of security returns.

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[1]For example, Miller and Modigliani (1966) discuss predictive ability within the context of a firm valuation model; Graham, Dodd and Cottle (1962) with respect to valuation of the firm's securities; Fama and Babiak (1969) and Brittain (1966) considered the dividend policies of the firm; and Little (1962), Lintner and Glauber (1965), and Cragg and Malkiel (1968) were concerned specifically with earnings growth rate forecasts.

Clearly, Beaver's (1970) study and that of Ball and Watts (1972) provide a great deal of insight with respect to these observations. However, due to the conflicting conclusions each paper reported, this study seeks to reexamine the question from a somewhat different perspective (i.e., simulation), apply a more sophisticated methodology (i.e., Box-Jenkins) in examining the time series behavior of income streams, and finally, examine not only streams generated by historical cost but extend the analysis to several alternative income schemes. Since these modifications represent substantial extensions from the earlier works in the time series literature, each will be briefly considered in the following sections.

B) Why Simulation?

While Beaver employed simulation as an integral part of his research design, two noteworthy differences exist between his simulation process and the model utilized in this study. First, Beaver empirically found parameters relating solely to the earnings streams themselves. Then, while not actually simulating a firm's operations, he randomly generated a series of accounting earnings. In contrast, this study simulated the actual operations of a firm (including resource allocations, production and sale of products) and then determined the earnings streams. As a second differentiating factor, this analysis extends beyond historical cost to consider a series of alternative income measurement concepts. It should be noted that these observations are not meant as criticism of Beaver's methodology (which was primarily utilized as support for the empirical data employed within his study), but rather as justification for an alternative approach addressed to the broader question of identifying the basic time series properties of competing income concepts discussed in the literature.

In addition, several specific factors provide support for the simulation

approach employed herein. Simmons and Gray (1969, p. 758) offer a general rationale for the use of simulation. They suggest previously unanswerable questions of accounting theory can be resolved by the use of simulation. In this particular instance, the fundamental "stumbling block" which has impeded empirical research revolves about the existence of the requisite data base. That is, if one seeks to utilize the Box-Jenkins technique to study the time series properties of alternative concepts of income measurement, several pragmatic problems must be broached. First, Box-Jenkins require at least fifty observations in order to identify the underlying model implicit in the time series. Second, and potentially a more significant problem, no "real world" data base exists which contain the necessary accounting streams. That is, while McKeown (1974) and Revsine (1974) have demonstrated (through a case study) the <u>feasibility</u> of implementing net realizable value and replacement cost methods of income measurement, no data base yet exists to empirically analyze the time series properties of such alternatives--particularly with respect to Box-Jenkins' requirement of fifty observations. Accordingly, the use of a simulation model is a natural outgrowth of such pragmatic considerations.

C) Why Box-Jenkins?

A major extension from earlier works in this area relates to the nature of the analysis technique employed. That is, Beaver's (1970) and Ball and Watts' (1972) studies both drew inferences regarding the basic properties of the earnings streams from an examination of descriptive statistics which characterized their data. This study employs the Box-Jenkins technique to analyze the various streams of earnings generated by a simulation model. The selection of the Box-Jenkins methodology was motivated by the following considerations:

1) The Box-Jenkins "family" of models incorporates <u>both</u> the "mean

reverting" model and the "random walk" model which have previously been applied in the accounting literature. In this fashion, the findings of the current study may build upon previously reported results regarding the time series properties of earnings.

2) The Box-Jenkins technique provides a thorough and structured approach to the selection of the most appropriate statistical model through its three iterative stages--i.e., identification, estimation and diagnostic checking.

3) Finally, more complex models are subsumed under the Box-Jenkins "family" of models than the pure random walk or mean reverting models. This feature enhances the descriptive validity of this study while providing a more rigorous examination of the time series properties of earnings than previous studies.

D) Why Undeflated Earnings?

This study examines the time series properties of undeflated earnings rather than rates of return (deflated earnings). Since the time series properties of earnings are largely unspecified and the reported results are somewhat conflicting in nature (Beaver, 1970 and Ball and Watts, 1972), the impact of this study will be to extend knowledge in this area via a more sophisticated approach.

In his discussion of Beaver's (1970) study, Jensen (1970) offers support for the use of the undeflated earnings streams. He suggests:

> "...It would seem to me that by far the most important issue is the behavior of the income series itself and not the various rate of return series that we suspect on _a priori_ grounds to be of relatively little usefulness anyway." (1970, p. 103)

Beaver (1970, p. 72), on the other hand, argues that the utilization of deflated earnings renders the data more tractable analytically and empirically. He views the possible heteroscedastic nature of an undeflated earnings series coupled with a possible drift or trend in the series as the major problems associated with an analysis based upon undeflated earnings. In the context of the present study, these potential problems are overcome by the utilization of consecutive differencing (d) of the earnings data and/or the introduction of a deterministic trend parameter (θ_o) where necessary.[2] Furthermore, the factors suggested by Beaver may be subsumed under the stationarity concept utilized in the Box-Jenkins methodology. Essentially, a time series is stationary if the underlying stochastic process is in statistical equilibrum over a constant mean.[3]

III) THE SIMULATION MODEL

This study employed a simulation model 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 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 provide an entire spectrum of operating performances and were implemented with the objective of generalizing the results

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[2] These features of the Box-Jenkins technique will be fully described in Section V.

[3] A process is strictly stationary if we require that the joint distribution be invariant with regard to displacement in time such that $p(z_t, \ldots z_{t+m}) = p(z_{t+k}, \ldots z_{t+k+m})$ for all t, k, and m.

of this study to a large class of firms.

Each firm (j) began operations at time period zero (t=o) at which time the values of the stochastic parameters were randomly selected. At the other end of the spectrum, each firm was permitted to liquidate at any point in time (T_j) depending upon the results of their decision making process.[4] 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 meet this minimum criterion and were included.

Two separate time horizons were employed in the model--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 <u>beginning</u> of the decision period and this decision holds <u>throughout</u> that decision period. An accounting period (a.p.) begins exactly at the <u>midpoint</u> 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.

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[4]The decision making process resulted in one of four decisions: (1) expand, (2) contract, (3) remain constant and (4) liquidate. The first three decisions relate to the plant capacity the firm required for the next period's production.

Insert Figure One here

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 a primary issuance of shares.[5]

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:

[5]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 include the gross cash proceeds from the primary issuance of bonds.

FIGURE ONE -

0 — Production decision as to d.p.1

Purchase labor, materials and plant at time 0 prices

Production Moment 1.1

Receive contribution from owners to defray cash deficit

Accounting period one (a.p.1) begins

Input prices change from time 0 values to time 0.5 values (for accounting valuation purposes only)

0.5 — Accounting period one (a.p.1) begins

Input prices change from time 0.5 to time 1 values and demand parameter change from time 0 values to time 1 values

Purchase materials (if necessary) and labor at time 1 prices

Production moment 1.2

1 — Production decision as to d.p.2

Purchase materials and labor, buy or sell plant, all at time 1 prices

Production moment 2.1

Sales of B_t widgets at price p_1

If cash deficit, receive contribution from owners to defray; if cash surplus, distribute it to owners

Input prices change from time 1 values to time 1.5 values (for accounting valuation purposes only)

1.5 — a.p.1 ends

Input prices change from time 1.5 to time 2 values and demand parameters change from time 1 to time 2 values

Purchase materials (if necessary) and labor at time 2 prices

Production moment 2.2

2 — Production decision as to d.p.3

Purchase materials and labor, buy or sell plant, all at time 2 prices

Production moment 3.1

Sale of B_t widgets at price p_2

If cash deficit, receive contribution from owners to defray; if cash surplus, distribute it to owners

$$p_t = \alpha_t + \beta_t \cdot Z_t \qquad \text{For } \alpha_t > 0 \text{ and } \beta_t < 0 \qquad (1)$$

where: t = time period
p = selling price
α = intercept parameter
β = slope parameter
Z = quantity sold

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. Similarly, to produce Z_t widgets the firm must have n_t units of plant capacity (where $n_t > Z_t$) available immediately <u>following</u> the production decision.[6] 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 pre-specified 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 remains $(1 - \delta)n_t$ 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, 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 (Z_t) it must manufacture one half of that quantity ($\frac{Z_t}{2}$) at p.m.t_1 and an equal quantity at p.m.t_2.

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

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

purchase and inventory Z_t units of raw material immediately preceding p.m.t_1; alternatively, it can acquire $Z_t/2$ units immediately before p.m.t_1, and a like quantity before p.m.t_2. This choice is a result of expected input prices at d.p.t. vis a vis the known prices at d.p.t-1. This decision process is described in Section E--"Decision Making."

D) Model Paramaters

1) 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

2) Stochastic Features and Parameters

While each of the 70 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 each 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=o 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%.[7] These stochastic parameters primarily relate to the price

[7] This value, while somewhat arbitrary, is roughly in accord with values observed among "real-world" firms--see Greenball (1966, p. 67).

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

of inputs and the α intercept of the demand function. The parameters and their ranges are summarized in Table Two.[8]

Insert Table Two here

E) 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, <u>or</u>
  (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:

$$C_{t-1}(t) + (\bar{C}_t(t) + \bar{V}_t) \;/\; (1 + \rho) \qquad (2)$$

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.

[8] See Greenball (1966, pp. 68-75) for a complete description of these stochastic parameters.

TABLE TWO

STOCHASTIC PARAMETERS

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

$\overline{C}_t(t)$ 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 $\overline{p}_t$.

$\overline{V}_t$ is the expected liquidation value of the firm at the end of decision period t. Since no receivables, payables, retained earnings, or inventory[9] is maintained at the end of decision period t (i.e., all transactions are solely for cash), then $\overline{V}_t$ simply represents the liquidation value of the plant at the end of the decision period. Symbolically,

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

$$\text{where:} \quad \overline{p}_t^{\,d} = \quad \cdot \, \bar{\tilde{p}}_t^{\,f}$$

ρ 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 employs the expected values of these parameters as certainty equivalents for the true values in order to derive a solution to equation 2. The expected values utilized by each firm are dependent upon: (1) the firm's forecasting ability with respect to parameter changes[10] and (2) the parameter values at the beginning of d.p.t. which are known to the firm.

IV) INCOME METHODS

In this study eight alternative methods of accounting earnings (i = 1,2,...,8) were evaluated with respect to their time series properties.[11] These methods include the following:

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[9] 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.)

[10] 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.

[11] It should be noted that all earnings measures basically 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 independently.

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

where: H = historical cost
B = business profit
C = current operating profit
N = net realizable value (unadjusted)[12]
N+ = net realizable value (adjusted)[13]
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:

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

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 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

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[12]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 tiem of their severance.

[13]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.

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 ($P_{a,i}$) were measured. For methods 1 through 4 and 7 this process can be summarized as follows:

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

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

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

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

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 "a-1" asset groupings valued at time "a" prices. Finally, the adjusted net realizable value earnings (method 8) were calculated as follows:

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

where: "acq" represents the units of plant acquired during accounting period 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 widgets inventory. That is, 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.

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.

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

$$\phi_p (B) \nabla^d Z_t = \theta_0 + \theta_q (B) a_t \quad (8)$$[14]

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_0 = 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

[14] 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.

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

By defining $\phi_p(B)$, $\theta_q(B)$ and ∇^d as above, we may utilize the term "pdq" as a specification of the identified time series model where:

p = number of terms in the autoregressive polynomial $\phi_p(B)$

d = order of consecutive differencing utilized

q = number of terms in the moving-average polynomial $\theta_q(B)$

VI) FINDINGS

Tables Three through Ten present the particular time series models identified for each of the fifty sample firms across the eight alternative methods of income measurement. Specifically, the first column of these tables identifies the pdq representation of the time series model while the remaining columns provide the specific parameter values and their respective orders.[15]

It should be emphasized that specification of solely the pdq values will not identify a unique time series model. For example, firm 4 in Table Three is represented by a pdq of "012." There is no autoregressive parameter in the model (p=0), first order consecutive differencing was utilized (d=1), and there are two moving average parameters (q=2). However, Table Three must be referenced to determine the appropriate order of the moving average parameters. In this case we have $\theta_3 = .34$ and $\theta_4 = -.71$. The purpose of this example is to emphasize that the pdq notation will provide the correct number of the parameters in the identified model, but that the specific order of the moving average parameter must also be determined in order to fully describe the series. This information is provided in the remaining columns of Tables Three through Ten.

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[15] The procedure for identifying the generating process and its parameters is essentially an iterative one wherein the parameters are selected to minimize Σa_t^2. Thus, the a_t may be interpreted as random shocks.

Table Three summarizes the findings with respect to the historical cost absorption measurement method (HA). Among the 50 time series models summarized in this table, there are three pure autoregressive models (models which have a non-zero value for the p parameter and a zero value for the q parameter), 34 pure moving average models (models which have non-zero values for the q parameter and zero values for the p parameter), and finally, there are 13 mixed models (models containing non-zero values for p and q). Tables Four through Ten can be similarly interpreted for the other seven income methods. Table Eleven summarizes the frequency of models identified for all eight measurement methods, the utilization of consecutive differencing and the deterministic trend parameter.

Insert Table Eleven here

From Table Eleven it can be observed that the pure moving average models dominate as the most frequently identified model across all methods of income measurement. In fact, 295 of the 400 possible models belong to the pure moving average class of models.[16] The mixed models were identified on 91 occasions while the pure autoregressive models were identified on only 14 occasions.[17]

With regard to the behavior of the undeflated earnings streams, it was necessary to utilize consecutive differencing on 273 occasions and a deter-

[16] It can be shown that the pure mean reverting process is a member of the pure moving average class of models. For example, a moving average process of order q--MA(q)--has a "memory" q periods long and then reverts to the mean of the process. Since the pure mean reverting process reverts immediately to the mean of that process, it can be described as an MA model where $q = 0$.

[17] It should be noted that the random walk model is simply a pure autoregressive model in which the ϕ_1 parameter is equal to one. In pdq fashion it could be represented in either of two manners: (100) or (010).

TABLE ELEVEN

FREQUENCY OF IDENTIFIED MODELS AND SELECTED PARAMETERS

Income Method	PA	PMA	M	d	θ_0
HA	3	34	13	36	24
HD	3	37	10	34	24
BA	2	42	6	38	31
BD	3	35	12	31	27
CA	0	31	19	31	22
CD	0	33	17	31	22
N	2	39	9	33	24
N+	1	44	5	39	31
	14	295	91	273	205

PA = pure autoregressive
PMA = pure moving-average
M = mixed
d = consecutive differencing
θ_0 = deterministic trend parameter

ministic trend parameter on 205 occasions. Thus, in 68% of the identified models (273 out of 400) the undeflated earnings stream was determined to be non-stationary. This finding is consistent with Beaver's commentary (1970, p. 72) regarding undeflated earnings.

VII) RELATIONSHIP TO PREVIOUS TIME SERIES RESEARCH

To place the results of the present study in perspective, a brief summary of the results of Ball and Watts and Beaver's papers will be undertaken. First, Ball and Watts (p. 680) explicitly state that they are not interested - within the context of their study - in the income time series properties of individual firms. Therefore, their analysis was necessarily based on mean and median results without an investigation of any outliers. Given these conditions, they conclude that measured accounting income is well represented by a submartingale[18] or some very similar process.

Beaver conducted both a simulation and an empirical analysis on actual earnings data. His analysis examined rate of return measures as well as total dollars of net income. He concluded, with respect to the empirical data, that rate of return, defined in terms of dividends and price changes, appears to be well approximated by a pure mean reversion process; whereas accounting rates of return are consistent with the behavior of a moving average process. (Beaver, p. 86) Beaver did not offer an interpretation of his results concerning actual net income. However, in his discussion of Beaver's paper, Jensen (1970, p. 103) does conclude that Beaver's findings, with respect to the undeflated income series, are consistent with the random walk process.

Jensen evidently reached this conclusion by examining Table 6 of Beaver's study, (1970, p. 94), which reported a first order serial correlation of .68 for net income

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[18] Essentially, a submartingale includes the random walk model as well as the random walk model with a drift or trend.

and .10 for the first differences of net income. Regarding Jensen's inference, the following observations can be made. First, the correlation coefficients previously referenced, are mean statistics generated across the 57 firms in Beaver's sample. Thus, no individual firm by firm analysis was conducted to determine the extent to which outliers deviate from the random walk model. Second, it is impossible to differentiate between various autoregressive and moving average models by simple reference to the first order serial correlation coefficient.

In order to expand upon this critical point, a hypothetical example will be presented. Assume, as in Beaver's paper, that the first order correlation coefficient is .68. If the second, third, fourth, etc. correlation coefficients were oscillating about zero, the appropriate time series model would be a moving average model (001). If the correlation coefficients declined exponentially i.e., $(.68)^2$ for the second order, $(.68)^3$ for the third etc.--then a first order autoregressive model (100) would be appropriate.[19] Thus, Beaver's results may also be interpreted as being consistent with a moving average process. As such, this paper has employed a more sophisticated approach --the Box-Jenkins methodology--in the hope of resolving this issue.

VIII) SPECIFIC HYPOTHESES TESTED

The statistical analyses reported herein were performed on individual firm earnings data rather than an aggregation (mean or median data) of same. If there is indeed diversity in the time series behavior of income (however measured), any analysis performed on aggregate data would have a tendency to

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[19] The random walk model is simply one type of autoregressive model where $_1 = 1$. For an in depth discussion of the techniques used in model identification ee Nelson, (1973, pp. 69-89).

minimize or "average it out." The question of whether a single simple process (i.e., a submartingale) characterizes the behavior of income appears to be better approached on an individual basis. In this manner, the most appropriate time series model may be identified for each sample firm.

Since the present study does analyze the income time series properties of firms on an individual basis--in contrast to previous research--these findings are employed to test the hypotheses that undeflated earnings follow either: (1) a pure random walk--with or without drift, or (2) a pure mean reversion process. These hypotheses can be formally stated as follows:

H_1: The income pattern generated by a given accounting method for a a given firm, is best identified by a model which can <u>not</u> be distinguished from one with a pdq representation of 100 where $\phi_1 = 1$ or, alternatively, 010 utilizing one consecutive difference.

H_2: The income pattern, generated by a given accounting method for a given firm, is best identified by a model which can <u>not</u> be distinguished from one with a pdq representation of 000 where no parameter differs from zero except the mean of the series.

The test of each hypothesis was conducted in two phases. First, through use of the Box-Jenkins' identification and estimation stages, parameter values and confidence intervals around each value were determined. Second, the identified model and its parameters were then compared to the prototypes as expressed in H_1 and H_2. Specifically, for any parameter value which had less than a 5% probablility (as evidenced by the confidence interval) of being equal to the prototype's counterpart, the hypothesis was rejected. A summary of the results of these tests is contained in Table Twelve. For H_1--the income pattern is represented by a random walk (with or without drift)--the findings indicate the hypothesis is overwhelmingly rejected. However, there is some variation across income methods in that for HA the hypothesis

was rejected for 43 of the 50 firms while all other methods indicated even a greater rejection rate. Alternatively, H_2--the income pattern is represented by a mean reverting process--is uniformly rejected for all 50 firms, irrespective of accounting method.

Insert Table Twelve here

IX) COMPARISON OF ALTERNATIVE METHODS OF INCOME MEASUREMENT

Table Thirteen provides a capsule summary of the frequency of various parameters presented in detail in Tables Three to Ten. The "number of parameters" column indicates the total number of autoregressive (ϕ_p) and moving average (θ_q) parameters utilized in the models across all 50 firms for each income method. In a very general way, the number of parameters utilized may be viewed as a surrogate for model complexity. That is, ceteris-paribus, time series models with more parameters are more complex than time series models with less parameters.[20]

Insert Table Thirteen here

Analyzing the findings in Table Thirteen, remarkable consistency is found across six of the income methods (i.e., HA, HD, BA, BD, N, N+) with the total number of

[20] It is recognized that this particular surrogate for complexity is not perfect. For example, there is an interaction effect present in a time series model when both autoregressive and moving average parameters are present (ϕ_p and θ_q). That is, very complex patterns of behavior may be identified by a mixed model.

TABLE TWELVE

Summary of Tests of Hypotheses
($\alpha = .05$)

Income Method	Number of Firms	
	H_1 Rejected	H_2 Rejected
HA	43	50
HD	45	50
BA	46	50
BD	45	50
CA	48	50
CD	49	50
N	48	50
N+	47	50

TABLE THIRTEEN

SUMMARY OF THE FREQUENCY OF TIME SERIES PARAMETERS

Income Method	# of parameters	ϕ_1	θ_1	θ_2	θ_3	$\geq\theta_4$
HA	125	16	28	12	13	56
HD	120	14	40	13	8	45
BA	122	8	38	20	8	48
BD	120	15	32	20	11	42
CA	135	19	38	16	15	47
CD	134	17	43	18	16	40
N	119	11	41	10	13	44
N+	122	6	45	16	14	41

parameters ranging from 119 to 125. CA and CD, the two remaining income measurement methods, utilize 135 and 134 parameters respectively. Thus, somewhat more complex time series models were employed to describe the behavior of current operating profit income numbers (absorption and direct).

The distribution across autoregressive and moving average parameters reveals the fact that the serial correlation of the HA income numbers is spread out over a wider time frame. Specifically, there are 56 moving average parameters of order four or greater in the HA time series models while the other measurement models range from 41-48. This result is consistent with Beaver's discussion concerning the averaging process induced by a historical cost measurement scheme.[21]

Finally, the utilization of direct costing results in no apparent pattern with respect to the type of model identified. (See Table Eleven.) That is, while differences do result between absorption and direct costing, these differences vary in both direction and magnitude across measurement methods. The same comment also applies to the number of parameters identified (See Table Thirteen). However, HD results in eleven fewer moving average parameters being identified--for lags greater than four--than HA (45 to 56). Evidently, the utilization of HD obviates the impact of serial correlation upon an income stream relative to HA.

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[21] From a different perspective, these results tend to validate the simulation model utilized in this paper. That is, the accounting procedures inherent in historical cost income measurement (i.e., depreciation, amortization, accruals and deferrals) have a marked tendency to induce serial correlation upon the income stream over a longer time frame than other measurement methods. This result is borne out by Table Thirteen. Additionally, Lorek (1975) utilized the Box-Jenkins technique in examining the time series properties of reported quarterly earnings for a sample of 30 New York Stock exchange firms. Ignoring seasonality factors, the findings were similar to the models identified in HA.

X) LIMITATIONS AND POSSIBLE EXTENSIONS

Although the application of simulation offers several specific advantages (discussed earlier), an identification of the simulation's limitations is desirable to properly interpet the results reported herein. Accordingly, the following limitations are set forth:

1) The use of the expected cash flow maximization criterion can be attacked on the grounds of experimental reality.

2) The simulation model employed but one product and one production decision per period.

3) The simulation model represented a relatively simplistic situation in terms of income reporting.

As a possible extension of the present study, the identified time series models may be utilized in a predictive context. That is, which measurement scheme provides the best prediction of itself in future periods? Alternatively, which measurement scheme provides the best prediction of economic income (however defined) in future periods?

Additionally, future research may be directed toward the possibility of applying the Box-Jenkins technique on data bases containing less than 50 observations. If the model parameters prove relatively insensitive to the use of smaller data bases, actual (rather than simulated) annual earnings data could then be analyzed.

XI) SUMMARY AND IMPLICATIONS

Very little support was found for the random walk model (with or without drift) across all alternative methods of income measurement. This finding has important implications with respect to the cross sectional valuation models developed in the finance and accounting literatures. That is, the last net income number in a time series should not be utilized as the best estimate of next period's income. In addition, no support was found for the pure mean reversion

model across all alternative methods of income measurement.

In terms of the complexity of the identified models, 6 of the 8 alternative income methods provide remarkably similar results. The CA and CD methods provide somewhat more complex models yet the distribution of these model's parameters is similar to the other measurement methods. This result suggests that the consistent utilization of alternative measurement methods will not materially affect the time series properties of the resultant income streams. Perhaps accountants must look to other characteristics and/or rationale for the utilization of alternative income measurement methods.[22]

Finally, the results indicate that the pure moving-average class of models was the most frequently identified time series model, followed by the mixed models and then the purely autoregressive models. Yet, inspection of Tables Three to Ten reveals a wide range in the order of the parameters reported. This finding emphasizes the heterogeneous nature of the time series behavior of net income across firms. Thus the utilization of a single simplistic model as a descriptive device for all firms appears suboptimal.

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[22] One such consideration would be cost. Non-zero data transformation costs are incurred when moving from an historical cost system to a market based system.

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TABLE THREE
TIME SERIES MODELS - HISTORICAL COST - ABSORPTION

Firm	(pdq)	ϕ_1	u	θ_0	θ_1	θ_2	θ_3	θ_q	θ_q	θ_q
1	(101)	1.10	30.09		.73					
2	(011)				-.28					
3	(022)			.83	1.03	.21				
4	(012)						.34	15 -.71		
5	(012)			11.44	.79			4 -1.01		
6	(012)			11.79	.42			6 -.66		
7	(013)			3.72	-.16	-.21	-.47			
8	(012)					-.31		10 .59		
9	(016)				-.03			4 -.23 9 .27	10 -.51 12 .08	13 -.62
10	(013)			1.01			.27	6 .18	11 -.29	
11	(013)					.27		4 .29	5 -.30	
12	(013)				-.31			4 .27	5 .33	
13	(011)			7.32				5 -.26		
14	(013)			4.08	.68		.60	14 .24		
15	(023)				1.21			4 -.31	5 .09	
16	(122)	-.89		1.22		1.07		16 -.87		
17	(102)	1.04	-804.18		.34			4 .25		
18	(103)	1.07	-6.44					4 .21	8 -.04	12 .95
19	(012)					.15		5 .30		
20	(102)	1.03	-499.59			.19	-.73			
21	(021)			.07	1.15					
22	(103)	.97	351.39				.79	5 .67	12 -.69	
23	(024)			.95	1.32			4 -1.10	5 .70	6 .34
24	(101)	.92	77.89					4 -.39		
25	(021)			.54	1.14					
26	(011)			5.34				4 .58		
27	(011)			4.07		.47				
28	(102)	1.21	38.75				.61	5 2.03		
29	(102)	.87	72.67		-.40		.30			
30	(011)			6.07	.57					
31	(023)			.16	1.02			7 -.15	8 .44	
32	(102)	1.05	-9.90			1.03		5 .33		
33	(024)			1.61	1.34		-.08	7 -1.50	8 1.37	
34	(124)	-.63		1.17	.50	1.08	-.47	7 .30		
35	(021)			.31	1.13					
36	(023)			1.86	1.09		-.59	8 .56		
37	(022)				1.01			9 .06		
38	(100)	.93	114.34							
39	(100)	.85	57.03							
40	(012)							7 -.33	10 -.28	
41	(012)			3.76	-.40	-.30				
42	(023)			.41	1.09		-.43	4 .60		
43	(103)	.92	57.93				-.11	12 .22	16 .24	
44	(013)			4.31				5 .24	8 .59	11 .46
45	(103)	.97	96.34		.33			6 .60	7 .58	
46	(011)							6 -.27		
47	(021)			.01	1.14					
48	(023)				.74			7 .22	14 -1.30	
49	(100)	1.01	-393.93							
50	(024)			.11	.63	.65		8 -.18	10 .25	

TABLE FOUR

TIME SERIES MODELS - HISTORICAL COST - DIRECT

Firm	(pdq)	ϕ_1	μ	θ_0	θ_1	θ_2	θ_3	θ_q	θ_q	θ_q
1	(101)	1.08	-64.93		1.14					
2	(022)				.99			5 -.03		
3	(021)			1.24	1.14					
4	(012)				.43			15 -.32		
5	(012)			11.03	.87			4 -.97		
6	(012)			14.39	.52			6 -.61		
7	(022)			.59	.94			4 .28		
8	(013)				.29	-.26		10 .33		
9	(007)		24.75		-.61	-.52	-.27	5 -.13		
								10 .52	12 .28	13 -.33
10	(013)			1.02	.32			6 .17	11 -.25	
11	(012)			1.07	.72			4 .13		
12	(004)		10.27		-.84	-1.02	-.78	10 -.14		
13	(011)			7.72				5 -.29		
14	(013)			4.36	.75		.44	14 .18		
15	(011)			6.61	1.12					
16	(015)			7.57	.30			4 -.33	8 -.15	9 .58
								7 .11		
17	(102)	1.06	-137.94		.79			4 .31		
18	(102)	1.06	-11.32		.33			12 .70		
19	(102)	.82	27.81					4 -.27	5 .44	
20	(013)			27.68	.51		-.95	7 .09		
21	(102)	.84	77.53		.32			16 .38		
22	(014)			10.13	.58			5 .35	6 -.25	12 -.60
23	(102)	1.00	13889.0		.36			4 -1.36		
24	(023)			.58	1.74	-1.07		5 .48		
25	(021)			-.16	1.15					
26	(012)			3.88	.45	.71				
27	(012)			4.27	.30	.41				
28	(102)	1.21	27.83			.45	1.12			
29	(011)						.29			
30	(012)			5.15	.83	.19				
31	(023)			-.03	1.12			7 -.17	8 .44	
32	(102)	1.05	-7.43		.89			5 .49		
33	(023)			5.91	.11			6 -.39	10 1.59	
34	(124)	.48			.77	.85	-.60	7 .27		
35	(011)				.33					
36	(102)	1.00	1062.80		.72			8 1.44		
37	(101)	1.02	-300.49		.47					
38	(012)					.32		7 -.30		
39	(011)			1.22	.31					
40	(014)				.15			7 -.35	10 -.30	11 .17
41	(100)	1.07	-13.88							
42	(013)			6.04	.46		-.42	4 .44		
43	(100)	.90	54.18							
44	(011)							6 -.30		
45	(100)	.91	77.20							
46	(002)		10.48		-.18	-.62				
47	(011)			1.06	.61					
48	(012)			35.47	.54	-.50				
49	(021)				1.02					
50	(012)			.57		.27		10 .32		

TABLE FIVE

TIME SERIES MODELS - BUSINESS PROFIT - ABSORPTION

Firm	(pdq)	ϕ_1	u	θ_0	θ_1	θ_2	θ_3	θ_q	θ_q	θ_q
1	(101)	1.11	73.44		.87					
2	(013)			4.99	1.12			8 .54	11 -.26	
3	(012)			20.15	.41	.25				
4	(013)				.42	.29		4 -.38		
5	(012)			13.20		.47		4 -.72		
6	(013)			16.67	.38	-.07		6 -.92		
7	(013)			4.73	.02	-.46		14 .94		
8	(008)		31.54		-.55	-.51	-.38	4 -.55; 10 .15	11 .13; 12 -.07	13 .18
9	(004)		29.64		-.54	-.31	-.35	4 -.38		
10	(011)			.90	.33					
11	(001)		56.62		-.34					
12	(002)		11.97		-.88	-.49				
13	(100)	.99	1245.40							
14	(013)			4.55	.77	.36		10 .45		
15	(012)			7.17	.69		.58			
16	(011)			7.48	.58					
17	(011)			69.46	.61					
18	(015)			4.10	.37		.09	4 .27	6 -.32	8 -.31
19	(014)				.37	.29		4 -.27	18 -.30	
20	(011)			20.93	.45					
21	(101)	.46	71.67					4 -.37		
22	(102)	.97	335.53		1.07			7 .18		
23	(012)			15.79	.46	.37				
24	(025)			.58	1.21			4 -.49; 5 .43	10 .09	15 .52
25	(012)			29.01	.70		-.35			
26	(014)			5.78	.85			5 .17	6 -.19	7 .84
27	(014)			2.76	.51			4 .57	5 .14	8 -.82
28	(021)			.16	1.23					
29	(101)	.89	71.48			.43				
30	(013)			4.58		.76		7 -.18	12 -.51	
31	(013)				.27	.19		4 -.35		
32	(011)			5.38	.63					
33	(013)			-6.51				4 -.84	8 -.18	11 -1.11
34	(012)			22.95	.30			4 -.21		
35	(021)			.30	1.20					
36	(013)			-2.83		.85	-.63	4 -1.08		
37	(023)				1.10			11 -.68	12 .65	
38	(021)			.18	1.15					
39	(012)			1.50	.23			15 .25		
40	(014)				.13	.38		8 .38	12 -.47	
41	(100)	.95	128.31							
42	(011)			6.49	.44					
43	(102)	.79	54.05				-.34	10 .30		
44	(101)	.88	154.87			.57				
45	(011)							6 .28		
46	(021)			.01	1.14					
47	(022)			.21	1.20	.02				
48	(022)			2.27	1.66	-.70				
49	(013)					.38		6 -.85	9 .67	
50	(013)			.97	.78		.29	9 .49		

TABLE SIX
TIME SERIES - BUSINESS PROFIT - DIRECT

Firm	(pdq)	ϕ_1	α	θ_0	θ_1	θ_2	θ_3	θ_q	θ_q	θ_q
1	(103)	1.13	-76.55		.40			4 -.51	12 -1.06	
2	(013)			4.50	1.03			8 .54	11 -.19	
3	(013)			17.88	.35	.16		5 -.64		
4	(101)	.53	28.19					4 -.38		
5	(013)			11.03	.67	.18		4 -1.21		
6	(012)			6.43				6 -.22	10 .54	
7	(012)			4.30	.29	-.27				
8	(006)		32.06		-.80	-.47	-.29	10 .12	11 .49	12 .48
9	(004)		29.22		-.54	-.30	-.41	4 -.39		
10	(011)			.93	.39					
11	(012)			1.25	.68		.22			
12	(002)		11.72		-1.07	-.39				
13	(012)			7.51				8 -.21	13 .84	
14	(011)			4.17	.82					
15	(013)			6.84	.77		1.05	4 -.76		
16	(102)	1.00	87114.0		.38			16 -.38		
17	(012)			28.04	.73			7 -.70		
18	(014)			5.04	.27		.19	4 .17	8 -.33	
19	(101)	.57	26.16					4 -.36		
20	(013)			18.01	.44		-.36	10 .57		
21	(100)	.57	72.35							
22	(101)	.95	275.27			.55				
23	(013)			2.95	.62	.42		6 .51		
24	(101)	.84	75.35					4 -.38		
25	(011)			25.14	.58					
26	(011)			5.16	.82					
27	(011)			3.94	.78					
28	(022)			.36	1.32	-.12				
29	(101)	.88	67.50			.34				
30	(014)			3.01	.47	.67		6 .28	7 -.20	
31	(012)				.27	.13				
32	(014)			5.36	.26	.52	-.47	4 .23		
33	(105)	1.07	-126.05			.52	.53	4 -.41	6 -.22	8 -.81
34	(011)			23.11				4 -.48		
35	(021)			.47	1.13					
36	(104)	1.11	-15.83		.36	-.16		6 -.60	8 1.27	
37	(012)			4.50			.48	11 -.75		
38	(100)	.76	94.49							
39	(012)			1.54	.30			15 .20		
40	(012)				.24	.34				
41	(100)	.99	346.10							
42	(011)			6.93	.32					
43	(103)	.81	54.98				-.23	10 .18	13 .30	
44	(101)	.90	158.73			.62				
45	(011)							6 .24		
46	(002)		10.56		-.29	-.47				
47	(012)			1.00	.39	.27				
48	(102)	1.09	-20.90		1.01			6 .24		
49	(013)			5.76		.35		6 -.31	9 .64	
50	(012)						.06	9 .32		

TABLE SEVEN

TIME SERIES MODELS - CURRENT OPERATING PROFIT - ABSORPTION

Firm	(pdq)	ϕ_1	u	θ_0	θ_1	θ_2	θ_3	θ_q	θ_q	θ_q
1	(103)	1.10	-51.04		1.34		-.33	6 .19		
2	(001)		82.10					5 -.42		
3	(102)	1.07	2.57		.56	.84				
4	(012)				.57			6 -.34		
5	(102)	.80	78.24		.59			5 -1.08		
6	(013)			9.55	.34			4 .01	6 -.65	
7	(012)			4.71		-.40	-.21			
8	(011)				.30					
9	(101)	.52	29.29				-.43			
10	(011)			1.09	.37					
11	(012)				.61			9 .01		
12	(003)		10.83		-.09	-.42	-.23			
13	(011)			7.31				5 -.25		
14	(012)			3.99	.65			16 .14		
15	(011)			6.67				5 .45		
16	(012)			8.05				4 -.21	7 .36	
17	(102)	1.03	-1683.73		1.26	-.73				
18	(102)	1.00	11770.44		.92			4 -.62		
19	(101)	.76	26.19				-.34			
20	(105)	1.06	-148.0		.80			4 -.04	6 .59	11 .60
								5 .31		
21	(024)				2.00	-1.08	-.79	4 .85		
22	(014)			7.90	.82		.52	10 -.27	12 -.89	
23	(122)	-1.12		.06		1.46		7 -.26		
24	(102)	.93	88.56		.97	-.36				
25	(021)			.69	1.16					
26	(014)				.64		-.27	5 1.11	6 -1.04	
27	(011)			3.90		.46				
28	(025)				1.06	.07		5 .41	6 .19	7 -1.03
29	(012)				.81			5 -.19		
30	(012)			4.53	.98			8 .20		
31	(014)				.61		-.22	5 -.23	6 .51	
32	(102)	1.04	-15.63			1.01		5 .41		
33	(021)			1.42	1.16					
34	(104)	.74	170.64		.42		-.46	6 -.18	9 -1.07	
35	(024)			.11	1.38		-.33	4 .08	8 -.24	
36	(013)			28.68	1.20	-.58	-.22			
37	(101)	1.02	-259.96		.57					
38	(101)	.94	130.18		.52					
39	(102)	.84	56.49		.72	-.29				
40	(024)			.02	1.48	-.54		5 .14	11 .22	
41	(022)			.48	1.64	-.61				
42	(011)			5.70	.35					
43	(104)	.85	59.07		.26		-.47	12 .46	14 .16	
44	(013)			5.78	1.10			10 -.19	11 .77	
45	(013)			.71	.75			4 -.15	5 .92	
46	(011)							6 -.24		
47	(011)			1.09	.53					
48	(124)	-.75		3.24	1.36	-.91	.25	4 .58		
49	(103)	.92	160.54		1.06	-.70		6 -.29		
50	(102)	.28	30.47				-.38	6 -.43		

TABLE EIGHT
TIME SERIES MODELS - CURRENT OPERATING PROFIT - DIRECT

Firm	(pdq)	ϕ_1	u	θ_0	θ_1	θ_2	θ_3	θ_q		θ_q		θ_q	
1	(102)	1.10	-10.71		1.38		-.86						
2	(002)		78.49			-.42		5	-.50				
3	(102)	1.08	15.49		.66	.59							
4	(012)				.63			6	-.30				
5	(013)			4.03	.98			4	-.40	6	.99		
6	(012)			10.43	.54			6	-.47				
7	(011)			4.75		-.32							
8	(011)				.37								
9	(014)				.44	.17	-.29	13	-.30				
10	(011)			1.10	.51								
11	(011)			.83	.82								
12	(001)		11.06			-.42							
13	(011)			7.72				5	-.28				
14	(011)			3.97	.75								
15	(101)	.99	912.73		1.12								
16	(104)	1.03	-92.53		.74			4	.12	7	.52	9	.50
17	(012)			74.79	1.10	-.64							
18	(103)	1.03	-103.58		.85		.28	4	-.87				
19	(101)	.68	26.68				-.48						
20	(102)	1.05	-104.05		.68			11	.81				
21	(012)				.94		-.42						
22	(014)			9.25	.79	-.14	.32	12	-.58				
23	(124)	-.94			.67	.35		6	-.41	8	1.07		
24	(102)	.93	90.96		1.07	-.46							
25	(011)			22.56			.60						
26	(014)			4.33	1.36		-.62	5	.68	6	-.08		
27	(012)			4.09	.37	.38							
28	(013)			-25.48	.15			7	-1.22	8	-.65		
29	(013				.76			4	.25	5	-.44		
30	(103)	1.00	3944.0		.91		-.41	7	-.57				
31	(014)				.67		-.50	5	-.21	6	.57		
32	(103)	1.05	-6.31		.99			5	.39	8	.19		
33	(022)			2.13	.90	.32							
34	(013)			5.16	1.31		-.71	6	-.15				
35	(021)			.19	1.18								
36	(012)			27.86	.94		-.55						
37	(013)			10.03	.45			14	.36	15	-.39		
38	(014)				.69		-.22	5	.07	6	-.53		
39	(104)	.84	56.70		.77	-.21		10	.40	15	.03		
40	(103)	.86	82.36		.55	-.49		10	-.29				
41	(012)			4.18	.58	-.32							
42	(011)			5.72	.54								
43	(102)	.90	58.15		.32			12	.48				
44	(012)			5.10	1.07			11	.46				
45	(104)	.61	9.97		-.65	-.52	.18	4	-1.31				
46	(002)		10.20		-.21	-.51							
47	(012)				.45			16	-.46				
48	(013)			35.41	.92	-.89	.36						
49	(103)	.91	167.04		1.07	-.78		6	-.28				
50	(102)	.31	25.75				-.29	6	-.94				

TABLE NINE
TIME SERIES MODELS - NET REALIZABLE VALUE (UNADJUSTED)

Firm	(pdq)	ϕ_1	u	θ_0	θ_1	θ_2	θ_3	θ_q	θ_q	θ_q
1	(013)			91.59	.86		-.82	4 .55		
2	(002)		82.17			-.51	-.26			
3	(104)	1.05	-24.05		.72		.26	4 .66	8 -.20	
4	(102)	.48	27.35					4 -.30	7 -.39	
5	(011)			11.21	.63					
6	(011)							6 -.52		
7	(012)			4.12	.32	-.37				
8	(007)		33.28		-.38	-.27	-.20	10 .20	12 .11	14 .33
								11 .31		
9	(003)		29.30		-.42	-.45	-.26			
10	(100)	.98	72.51							
11	(012)			1.12	.89			5 .03		
12	(002)		11.73		-.41	-.36				
13	(024)				.98			8 -.25	11 .85	12 -.58
14	(013)			5.38	1.02			10 .34	14 .12	
15	(012)			7.06			.56	4 -.17		
16	(012)			7.21	.41			16 -.31		
17	(103)	1.04	-315.36		1.33	-1.38	1.26			
18	(011)			4.70	.76					
19	(012)				.61			4 -.11		
20	(011)			21.57	.51					
21	(003)		66.25			-.13	-.25	5 -.40		
22	(102)	.97	323.84		1.17			7 -.08		
23	(012)			4.91	.93			6 .37		
24	(013)				.43			4 -.42	5 .37	
25	(012)			28.50	.85		-.54			
26	(012)			4.88	1.08			6 .10		
27	(022)				1.21			5 -.30		
28	(101)	1.19	38.28		1.13					
29	(023)			.35	1.33		-.34	4 .08		
30	(012)			3.79	1.11			4 .01		
31	(103)	.86	36.48		.75		-.57	5 -.65		
32	(101)	1.03	-63.89		.68					
33	(022)				1.22			4 -.42		
34	(014)			21.29	.90		-.34	5 .55	6 -.43	
35	(011)							4 .37		
36	(012)			28.13	.54			5 -.32		
37	(012)			6.94	.61			11 -.34		
38	(011)			2.53	.79					
39	(011)			1.18	.64					
40	(014)				.01		.68	5 -.18	7 -.43	
41	(100)	.98	289.78							
42	(011)			6.55	.51					
43	(104)	.85	49.10		.69			5 -.05	12 .20	14 .48
44	(011)			3.15	.89					
45	(101)	.58	66.86					4 .42		
46	(002)		10.60		-.59	-.27				
47	(011)			1.18	.71					
48	(022)			.10	1.80	-.70				
49	(014)			1.69	.73			4 .41	6 -.18	9 .92
50	(012)				.43	.24				

TABLE TEN

TIME SERIES MODELS - NET REALIZABLE VALUE (ADJUSTED)

Firm	(pdq)	ϕ_1	u	θ_0	θ_1	θ_2	θ_3	θ_q		θ_q		θ_q	
1	(013)			101.38	.93		-.80	4	.44				
2	(002)		86.86			-.45	-.26						
3	(013)			23.48	.44			4	.45	5	-.46		
4	(014)				.45	.30		4	-.22	7	-.44		
5	(011)			13.37	.56								
6	(013)			18.40	.37	.01		6	-.84				
7	(012)			4.67	.30	-.33							
8	(007)		36.57		-.28	-.33	-.19	10	.22	12	.12	14	.35
								11	.27				
9	(013)			.53	.84			4	.54	17	.31		
10	(011)			.84			.26						
11	(011)			1.15	.91								
12	(002)		13.11		-.35	-.41							
13	(024)				1.04		-.45	4	.15	11	.37		
14	(012)			4.07	.75			17	-.16				
15	(011)			6.92	1.08								
16	(011)			7.98	.49								
17	(014)			38.57	1.18	-.93	.54	7	-.73				
18	(013)				.05		.28	8	-.76				
19	(101)	.57	28.24					4	-.28				
20	(011)			22.44	.49								
21	(003)		72.35			-.09	-.26	5	-.38				
22	(103)	.97	332.89		1.16	.03		7	-.09				
23	(013)			12.56	.54	-.08		10	.70				
24	(012)				.69	-.46							
25	(012)			29.24	.74		-.44						
26	(015)			6.23	.96		-.16	5	.47	6	-.51	7	.83
27	(104)	1.00	915.68		.41			4	.60	5	.18	8	.89
28	(013)			-13.11	.71			5	-1.07	8	-.94		
29	(003)		69.04		-.67	-.41	-.35						
30	(011)			4.91	1.10								
31	(102)	.91	45.77		.68		-.41						
32	(101)	1.03	-70.53		.71								
33	(021)			1.60	1.13								
34	(014)			22.26	.87		-.34	5	.58	6	-.47		
35	(021)			.33	1.15								
36	(011)			34.09	.51								
37	(022)				1.90	-1.00							
38	(011)			2.80	.77								
39	(011)			1.16	.63								
40	(013)			6.74	.45		.48	9	.77				
41	(100)	.97	201.03										
42	(011)			6.71	.54								
43	(014)			1.31	.72			12	.58	13	-.56	14	.69
44	(012)			3.20	.84			4	-.04				
45	(013)				.39			4	-.39	10	-.35		
46	(023)			.14	.71	.37		4	.22				
47	(011)			1.42	.56								
48	(022)			.43	1.61	-.51							
49	(013)				.35			6	-.47	9	.49		
50	(012)				.43	.23							