Bias And Random Measurement Error In Accounting-Based Surrogates For Internal Rate Of Return

Dr. Steven R. Fritsche, Accounting, University of Baltimore
Dr. Michael T. Dugan, Accounting, Arthur Anderson Faculty Fellow, University of Alabama, Tuscaloosa

Abstract

Limitations inherent in alternative profitability measures as estimates of internal rate of return (IRR) often require that managers and researchers employ accounting-based profitability measures. Using published accounting and stock market data, this study models accounting rate of return (ARR) and conditional estimate of internal rate of return (CIRR) as functions of product market risk (β^{p}), growth (g), inventory cost flow assumption (INV), and depreciation method (DEP). The models support inferences about the bias and efficiency (i.e., systematic and random error) in the relationships between the two accounting-based profitability measures and IRR, as estimated by the bias and efficiency in their relationships with a factor that is suggested in the finance literature as a determinant of systematic risk (product market risk). The results indicate that ARR estimates IRR with bias attributable to g; however, ARR is unaffected by INV and DEP. Whether g, INV, or DEP affect CIRR's ability to estimate IRR depends on the interval over which CIRR is estimated and the assumed cash flow pattern. On the other hand, CIRR generally estimates IRR with significantly greater efficiency. These results have research design implications, as well as implications for both accounting policy formulation and anti-trust policies.

Introduction

The adequacy of accounting-based profitability measures as estimates of *ex post* firm profitability continues to be debated in the accounting and economics literature. Three factors appear to explain the longevity of this debate. First, profitability is important to interested parties in several contexts. Researchers, managers, and regulatory bodies continue to examine the relationship between observed profit rates and market structure (Weiss, 1974; Scherer, 1980; Mueller, 1986), mergers (Meeks, 1977), and financial accounting standards (Watts and Zimmerman, 1986).

Second, alternatives to accounting-based profitability measures, such as internal rates of return and stock returns, have practical limitations. Parties external to the firm are not able to access information about the amounts and timing of cash flows required to calculate the firm's internal rate of return (*IRR*), and stock returns cannot measure the amount or persistence of economic rents captured by firms because of rapid market adjustments (Schwert, 1981).

Finally, two widely discussed and used accounting-based profitability measures to which interested parties resort possess acknowledged deficiencies. The accounting rate of return (*ARR*) has been criticized for its sensitivity to accounting allocation methods and valuation bases, inflation, cash flow patterns, real growth rates, and length of asset lives (e.g., Harcourt, 1965; Solomon, 1966; Livingstone and Salamon, 1970; Stauffer, 1971; van Breda, 1981; Fisher and McGowan, 1983; and many others).[1] In response to these criticisms, Salamon (1982, 1985) extended the work of Ijiri (1978, 1979, 1980) and proposed the conditional *IRR* (*CIRR*) as an alternative to the *ARR*. *CIRR* has been criticized for its reliance on limiting assumptions of a constant cash recovery rate

(Ismail, 1987; Stark, 1989) and growth rate (Brief, 1985), a fixed cash flow parameter (Brief, 1985; Griner and Stark, 1991), assumed project lives (Brief, 1985; Hubbard and Jensen, 1991), and a definition of cash from operations based on working capital (Lee and Stark, 1987; Griner and Stark, 1988). In short, both of these IRR surrogates estimate *IRR* with error, the amount of which is unknown because *IRR* is unobservable.

More formally, both of the *IRR* surrogates possess two types of measurement error: systematic and random. The presence of systematic measurement error results in biased estimates. The presence of random measurement error results in inefficient estimates. It has been shown that both the *ARR* and *CIRR* contain growth-related bias. It has been conjectured that the *ARR* is contaminated by accounting policy choices, whereas *CIRR* is not. However, no previous studies have investigated the random measurement error in either surrogate.

The current study models each of the *IRR* surrogates as a function of the firm's product market risk, growth, and accounting policy variables to test for the presence of bias and random errors. Extant financial theory suggests that the *IRR* of a firm may be determined by the firm's risk characteristics, particularly its risk in its product market (e.g., Hamada, 1969; Rubenstein, 1972; Mandelker and Rhee, 1984; and others). If growth and accounting policy variables significantly influence *ARR* and *CIRR* after controlling for product market risk, the growth and accounting policy differences among firms may result in bias in the *IRR* surrogates. If, after controlling for product market risk, growth, and accounting policy differences, either of the *IRR* surrogates has more unexplained variation (random error) than the other, it represents a less efficient *IRR* estimator, and its usefulness as an *IRR* surrogate is open to question.

The main findings of the current study are: (1) consistent with results of previous studies, both *ARR* and *CIRR* are systematically biased by growth, (2) contrary to the accepted conjecture, the *CIRR* is biased by accounting policy choices, and *ARR* is not, and (3) *CIRR* estimates *IRR* with greater efficiency. The main implication is that when choosing a profitability measure, researchers face a trade-off between bias and efficiency similar to the trade-off that is forced by the presence of collinearity among independent variables in a multiple regression context (i.e., between an unbiased but inefficient OLS estimator and a biased by more efficient ridge estimator, as discussed by Greene (1990, pp. 263-270)).

The remainder of this paper is organized as follows. The next section presents models of the *IRR* surrogates as functions of product market risk (β^o), growth (g), inventory cost flow assumption (*INV*), and depreciation method (*DEP*). The models facilitate the development of the research hypotheses. Section 3 describes the methods for testing these hypotheses. Section 4 discusses the results of the hypothesis tests. The final sections summarize the contributions of the study and provide research and policy implications.

Research Hypotheses

The assumed importance of risk in deriving expected rates of return follows from the development of the Capital Asset Pricing Model (CAPM) (Sharpe, 1963, 1964; Lintner, 1965; Mossin, 1966). The expected return for an asset depends on its riskiness relative to the market portfolio, as reflected in its systematic risk (β). Salamon (1982, 1985) suggested that the collected assets of a firm be viewed as a composite project. If the firm's management incorporates an assessment of risk in its capital budgeting decisions, and (on average) its risk assessment is accurate, the return earned on the firm's composite project, or its *IRR*, is a function of the project's systematic risk.

A limitation of the traditional CAPM derivation of systematic risk is that it fails to identify the underlying sources of risk. This limitation is important in the context of the current study because the returns on a firm's equity securities are likely to be a function of different risk factors from those which determine the return on that same firm's composite project. Specifically, the riskiness of the firm's composite project is a function of the product market in which the firm competes.[2]

Several authors have developed theoretical models of the underlying determinants of systematic risk.[3] These models generally incorporate expressions of operating leverage, financial leverage, and the firm's intrinsic business risk (e.g., Gahlon and Gentry, 1982; Mandelker and Rhee, 1984). For example, the analytical model derived by Mandelker and Rhee (1984) expresses systematic risk (β) as a multiplicative function of degree of operating leverage (*DOL*), degree of financial leverage (*DFL*), and intrinsic business, or product market, risk (β^o), as follows:[4]

$$\beta_i = DOL_i \cdot DFL_i \cdot \beta_i^o \qquad (1)$$

Mandelker and Rhee's model allows the effect of a firm's product market risk (β^o) to be separated from the effects of alternative production mixes (*DOL*) and capital structures (*DFL*).

Assuming an additive (linear) functional relationship between *IRR* and β^o yields:

$$irr_i = \alpha_0 + \alpha_1\beta_i^o + \varepsilon_i, \quad (2)$$

where α_0 represents an estimate of the return on a product market risk free asset, α_1 represents an unknown parameter, and ε is an error term.

As noted earlier, both *ARR* and *CIRR* estimate *IRR* with error. One source of error results from their expression in nominal magnitudes. If *arr*, *cirr*, and *irr* represent the inflation-adjusted transformations of *ARR*, *CIRR*, and *IRR*, then the measurement error should be reduced, though not eliminated. A linear relationship between the *irr* surrogates and *irr* may be represented as follows:

$$arr_i = \gamma irr_i + u_i, \quad (3)$$

$$cirr_i = \gamma irr_i + v_i \quad (4)$$

where *u* and *v* are error terms.

The structures of the error terms in (3) and (4) are unknown. However, analytical models of the relationship between *arr* and *irr* suggest two sources of bias in the relationship between *arr* and *irr*. First, Salamon (1988) provided theoretical and empirical evidence of bias in the relationship between *arr* and *irr* attributable to growth in the firm's composite project (*g*). Griner and Stark (1991) and Stark, Thomas, and Watson (1992) provided evidence of a growth-related bias in the relationship between *cirr* and *irr*. In each case, growth produced a positively biased accounting-based profitability measure. Specifically,

$$(arr_i - g_i) = \lambda_1(irr_i - g_i) + u_i \quad (5)$$

$$(cirr_i - g_i) = \lambda_1(irr_i - g_i) + v_i \quad (6)$$

Second, research indicates that accounting policies relating to asset valuation and cost allocation represent an additional source of bias in the relationship between *arr* and *irr*. For example, inventory cost flow assumptions and depreciation methods are arbitrary techniques for allocating costs between income statement and balance sheet accounts.[5] Therefore, let *INV* and *DEP* represent inventory cost flow assumptions and depreciation methods, respectively, such that *INV* assumes the value of 1 for *LIFO*, and *DEP* assumes the value of 1 for accelerated depreciation methods. *INV* and *DEP* take on the value of 0 for any other inventory cost flow assumptions or depreciation methods.[6] Assuming *INV* and *DEP* affect λ_1, (5) and (6) become:

$$(arr_i - g_i) = (\lambda_1 + \lambda_2 INV_i + \lambda_3 DEP_i)(irr_i - g_i) + u_i^* \quad (7)$$

$$(cirr_i - g_i) = (\lambda_1 + \lambda_2 INV_i + \lambda_3 DEP_i)(irr_i - g_i) + v_i^* \quad (8)$$

or

$$arr_i = (1-\lambda_1)g_i + \lambda_1 irr_i + \lambda_2 irr_i INV_i + \lambda_3 irr_i DEP_i - \lambda_2 g_i INV_i - \lambda_3 g_i DEP_i + u_i^{**} \quad (9)$$

$$cirr_i = (1-\lambda_1)g_i + \lambda_1 irr_i + \lambda_2 irr_i INV_i + \lambda_3 irr_i DEP_i - \lambda_2 g_i INV_i - \lambda_3 g_i DEP_i + v_i^{**} \quad (10)$$

After combining terms, substituting (2) for *irr* in (9) and (10) yields:

$$arr_i = \delta_0 + \delta_1\beta_i^o + \delta_2 g_i + \delta_3\beta_i^o INV_i + \delta_4\beta_i^o DEP_i - \delta_5 g_i INV_i - \delta_6 g_i DEP_i + u_i^{**} \quad (11)$$

$$cirr_i = \delta_0 + \delta_1\beta_i^o + \delta_2 g_i + \delta_3\beta_i^o INV_i + \delta_4\beta_i^o DEP_i - \delta_5 g_i INV_i - \delta_6 g_i DEP_i + v_i^{**} \quad (12)$$

If (11) and (12) are properly specified, the following research hypotheses may be formulated.[7] First, assuming bias is adequately captured by *g*, *INV*, and *DEP*, a test for bias is a test of the significance of δ_2, δ_3, δ_4, δ_5, and δ_6 [8] Previous research (e.g., Griner and Stark (1991) and Stark, Thomas, and Watson (1992)) does not indicate the expected direction of the bias attributable to growth. Additionally, because the direction of the bias attributable to accounting policies will depend on the effect of an accounting policy choice on the reported income relative to its effect on reported asset values, and because the test used for this hypothesis is inherently a two-tailed test, the null hypothesis is tested against a non-directional (i.e., two-tailed) alternative.[9] Specifically, the following bias hypotheses are tested:

H_o1A: $\delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ for (11)

H_a1A: One or more of the five coefficients is significantly different from 0 for (11)

and

H_o1B: $\delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ for (12)

H_a1B: One or more of the five coefficients is significantly different from 0 for (12)

The bias hypothesis address the possibility that the accounting-based *irr* surrogates contain systematic error. These surrogates also contain random error (i.e., they estimate *irr* with less than perfect efficiency). Accordingly, the second research hypothesis tests whether one of the two surrogates estimates *irr* with greater efficiency than the other after growth and accounting policies are considered. If $\sigma^2_{u^{**}}$ and $\sigma^2_{v^{**}}$ represent the variances of u^{**}_i and v^{**}_i, respectively, the following hypothesis can be tested to determine whether one of the two surrogates estimates *irr* with significantly more efficiency:

$$H_o2: \quad \sigma^2_{u^{**}} = \sigma^2_{v^{**}}$$

$$H_a2: \quad \sigma^2_{u^{**}} \neq \sigma^2_{v^{**}}$$

The next section discusses the methodology used to test the research hypotheses and the specifications of (11) and (12).

Methodology

Sampling Procedures

The three samples used to test the research hypotheses included those firms with SIC codes between 2000 and 3999 (Manufacturing), and between 5000 and 5999 (Retailing), for which complete data were available for the seven-, eight-, and ten-year periods ending in 1987.[10] The appendix to this paper lists the required data items by data source. The firms in these industries were selected because they could be expected to carry inventory for sale as a normal part of their operations. Three sample periods were used to test the sensitivity of results to the number of years over which variables were calculated. The importance of the length of the estimation period is discussed further when *cirr* is defined in the next section. Data availability resulted in samples for the seven-, eight-, and ten-year periods of 138, 122, and 91 firms, respectively.[11]

Accounting-Based Profitability Measures

Conditional Estimate of Internal Rate of Return. Ijiri (1978, 1979, 1980) defined the firm's cash recovery rate (*CRR*) as the reciprocal of its payback period:

$$CRR_{it} = \frac{CFO_{it}}{GA_{it}} \tag{13}$$

where *CFO* is funds from operations, and *GA* is the average gross investment in assets during the period. In his formulation of *CRR*, Ijiri used a working capital definition of funds from operations. However, Lee and Stark (1987) suggested that a cash flow definition of funds from operations is more consistent with the concept of *irr* than a working capital definition. Furthermore, recent empirical and analytical research (e.g., Griner and Stark (1991)) employed a cash flow definition of funds from operations. As a result, the definition used by Griner and Stark (1991) is employed in the current study.

Under some additional assumptions, Salamon (1982) showed that the *CRR* and the firm's real *cirr* are related by:

$$CRR = \left[\frac{(1-pg)p^n g^n}{1-p^n g^n}\right] \cdot \left[\frac{g^n - b^n}{g^n(g-b)}\right] \cdot \left[\frac{r^n(r-b)}{r^n - b^n}\right] \tag{14}$$

where r is 1 plus *cirr*, p is 1 plus the inflation rate, g is 1 plus the real growth rate in investment, n is the useful life of the firm's composite project, and b is an assumed cash flow parameter.

Four comments about the calculation of *cirr* are appropriate. First, to derive his empirical estimates of *cirr*, Salamon (1982, 1985) calculated average values for the other variables (*CRR*, *g*, and *n*) over a period of 10 years and then performed cross-sectional analysis. This approach resulted from his assumption that *CRR*s are stable over time for mature firms. Ismail (1987) and Stark (1989) presented evidence inconsistent with this assumption. Recent studies have estimated *cirr* over shorter intervals (e.g., Salamon (1989) and Griner and Stark (1991)). Therefore, *cirr* estimates based on seven-, eight-, and ten-year periods were used to assess the sensitivity of the results to possible instability in the *CRR*s.

Second, inflation is explicitly modeled in (14). As a result, *cirr* represents a conditional estimate of the firm's real internal rate of return.[12]

Third, Salamon (1982) calculated the life of the firm's composite project, *n*, by first dividing gross property, plant, and equipment by depreciation expense for each period included in the sample period, and then calculating the average of those annual estimates. Using this approach assumes that straight-line depreciation provides a reasonable approximation of the firm's actual depreciation policy. The current study used the sum-of-the-years'-digits approach of Buijink and Jegers (1989) when the firm's depreciation expense was determined using an accelerated depreciation method. Salamon's (1982) approach was used in all other instances.[13]

Finally, Salamon's (1982) model assumes that the cash flows from the firm's composite project change at a constant rate over the project's life; that is, Salamon's model assumes a linear cash flow pattern.[14] Gordon and Hamer (1988) reported survey results indicating that a concave, or inverted U, pattern was the one most frequently produced by the composite projects held by the responding firms. Such projects produce low cash flows in early periods that gradually increase to a maximum and then gradually decline again. Gordon and Hamer derived an alternative form of (14) that incorporates such concave cash flow patterns:

$$CRR = \left[\frac{(1-pg)p^n g^n}{1-p^n g^n}\right] \cdot \left[\frac{r-b}{g-b}\right] \cdot \left[\frac{\frac{g^n - b^n}{g^{n-1}(g-b)} - \frac{nb^n}{g^n}}{\frac{r^n - b^n}{r^{n-1}(r-b)} - \frac{nb^n}{r^n}}\right] \quad (15)$$

The point in the project's life at which its cash flows are highest depends on the manner in which b is calculated. Gordon and Hamer (1988) compared three alternative formulas for b. Their analysis indicated a strong correlation between the *cirr* estimates reported by Salamon (1982) and their own estimates using a concave cash flow pattern parameter for the same sample of twenty firms.

The sensitivity of the results of the tests discussed below to the choice of the assumed cash flow parameter is assessed by using three values for b in (14) and the three formulas used by Gordon and Hamer (1988) in (15). Table 1 lists the values used for b, the equation in which they are used, and the variable label given to the resulting formulation of *cirr*.

Accounting Rate of Return. Researchers have used several different approaches to calculate *ARR*, including return on equity formulations. For example, Kay (1976) and Whittington (1979) used a return on equity formulation of *ARR* to demonstrate the ability of an average *ARR* to estimate a firm's *IRR*, net of financing and tax expenses. Kay and Mayer (1986) extended Kay's (1976) analysis to the case of replacement cost accounting information. Nevertheless, since the current study focuses on surrogates for a firm's *IRR*, rather than a return on equity, the definition of *ARR* emphasizes returns earned by the collected assets of a firm (i.e., an entity-based approach). The income measure used in the numerator excludes the effects of the firm's financing arrangements and income taxes, and the book value of the firm's total assets is used as the denominator.[15] Therefore, annual values for ARR are calculated as follows:

$$ARR_{it} = \frac{EBIT_{it}}{TA_{it}} \quad (16)$$

where *EBIT* is earnings before interest and taxes, and *TA* is book value of total assets at the end of the previous period.

Assuming that the relationship derived by Fisher (1930) holds, Beaver (1979) suggested transforming annual values of *ARR* to inflation-adjusted values, *arr*, by:

$$arr_{it} = \frac{[1 + ARR_{it}]}{[1 + I_{it}]} - 1 \quad (17)$$

where I is the annual inflation rate. The cross-sectional values of *arr* used as a basis for hypothesis tests in the current study were calculated by averaging annual values for each firm in the particular sample period.[16]

Product Market Risk

Next, β^o is estimated for each firm using the following definition derived analytically by Mandelker and Rhee (1984):[17]

$$\beta^o_{it} = \frac{COV\left[\frac{E_{it-1}}{S_{it-1}} \cdot \frac{S_{it}}{VE_{it-1}}, R_{mt}\right]}{\sigma^2_{R_{mt}}} \quad (18)$$

where E is earnings after interest and taxes, S is sales revenue, VE is the market value of the firm's equity securities, R_m is the return on the market, and σ^2_{Rm} is the variance of R_m. β^o captures the firm's product market risk in that it reflects the covariability between the firm's

Table 1
Values Used for b to Compute Alternative Formulations of *cirr*.

Values Used for b	Equation Number	Label Used for *cirr*
.8	(14)	$cirr_1$
1.0	(14)	$cirr_2$
1.2	(14)	$cirr_3$
$1/(e^{(1/(n/3))})$	(15)	$cirr_4$
$1/(e^{(1/(n/2))})$	(15)	$cirr_5$
$1/(e^{(2/(n/3))})$	(15)	$cirr_6$

demand (S), adjusted for its return on equity, and the returns realized on other investment opportunities in the market.

Statistical Model and Hypothesis Tests

Tests of the research hypotheses described above require estimates of the equations:

$$arr_i = \delta_0 + \delta_1\beta_i^o + \delta_2 g_i + \delta_3\beta_i^o INV_i + \delta_4\beta_i^o DEP_i - \delta_5 g_i INV_i - \delta_6 g_i DEP_i + u_i^{**} \quad (11)$$

$$cirr_i = \delta_0 + \delta_1\beta_i^o + \delta_2 g_i + \delta_3\beta_i^o INV_i + \delta_4\beta_i^o DEP_i - \delta_5 g_i INV_i - \delta_6 g_i DEP_i + v_i^{**} \quad (12)$$

Equations (11) and (12) are linear models based on the conventional assumptions of ordinary least squares regression (Greene, 1990, chs. 5 and 6).[18]

Under the null form of the bias hypotheses, δ_2, δ_3, δ_4, δ_5, and δ_6 are not significantly different from zero. Greene (1990, pp. 212-214) describes a test of the significance of a subset of regression model coefficients. Let R^2 represent the coefficient of determination for the model described in (11) or (12), and let R^2_r represent the coefficient of determination for a reduced form of the same model that excludes g and all of the interaction terms. Also, let n represent the number of observations used to estimate (11) and (12). Then the following F-test statistic can be used to test the first null hypothesis.

$$\frac{\left[\frac{R^2 - R_r^2}{5}\right]}{\left[\frac{1-R^2}{n-7}\right]} \sim F_{5,n-7} \quad (19)$$

Null hypotheses H_o1A and H_o1B are rejected for large values of this test statistic.

Table 2
Pearson Product Moment Correlations Among Profitability Measures

	arr	*cirr₁*	*cirr₂*	*cirr₃*	*cirr₄*	*cirr₅*
Panel A: 7-Year Sample Period, 138 Firms						
$cirr_1$	.275*					
$cirr_2$	.439*	.937*				
$cirr_3$	.620*	.711*	.902*			
$cirr_4$	.473*	.923*	.991*	.918*		
$cirr_5$	.532*	.876*	.981*	.959*	.992*	
$cirr_6$	.560*	.845*	.970*	.975*	.982*	.998*
Panel B: 8-Year Sample Period, 122 Firms						
$cirr_1$	.155∇					
$cirr_2$	.209◊	.896*				
$cirr_3$	.199◊	.712*	.946*			
$cirr_4$	.215◊	.877*	.997*	.959*		
$cirr_5$	.214◊	.822*	.987*	.984*	.994*	
$cirr_6$	.211◊	.794*	.978*	.992*	.987*	.999*
Panel C: 10-Year Sample Period, 91 Firms						
$cirr_1$	.113					
$cirr_2$	.338*	.930*				
$cirr_3$	.582*	.660*	.884*			
$cirr_4$	.369*	.922*	.996*	.891*		
$cirr_5$	.444*	.866*	.985*	.943*	.991*	
$cirr_6$	.482*	.830*	.973*	.964*	.979*	.997*

∇ $p < .10$ (Two-tailed), ◊ $p < .05$ (Two-tailed), * $p < .01$ (Two-tailed)

The second null hypothesis is that the efficiency associated with (11), as measured by $\sigma^2_{v^{**}}$, not significantly different from the efficiency associated with (12), as measured by $\sigma^2_{v^{**}}$. The adjusted mean squared errors (*MSE*s) from (11) and (12) are estimates of the error variances of their respective models. Let MSE_{11} and MSE_{12} represent the adjusted mean squared errors of (11) and (12), respectively, with associated degrees of freedom df_{11} and df_{12}. A test of the second null hypothesis involves calculating the ratio of the larger of the two *MSE*s to the smaller of the two. For example, if MSE_{11} is larger than MSE_{12}, then under the second null hypothesis:

$$\frac{MSE_{11}}{MSE_{12}} \sim F_{df_{11},df_{12}} \tag{20}$$

Null hypothesis H_o2 is rejected for large values of the *F*-test statistic.

Results

Pairwise correlations among alternative accounting profitability measures, reported in Table 2, differ somewhat from those reported by Salamon (1982, p. 297) and Gordon and Hamer (1988, p. 520). Salamon reported a correlation between $cirr_1$ and $cirr_2$ of .905, as compared to values that range from .896 to .937 in Table 2. Gordon and Hamer's correlation between $cirr_4$ and $cirr_5$ was .998, while in Table 2 the same correlations range from .991 to .994.[19] The correlations of $cirr_1$ and $cirr_2$ with *arr* reported by Salamon were .735 and .587, rather than values that range from .113 to .273 and from .209 to .439 in this study. Also, Gordon and Hamer reported correlations of $cirr_4$ and $cirr_5$ with *arr* of .752 and .759, while in Table 2 the same correlations ranged between .215 and .473 and between .214 and .532.

Table 3 summarizes the parameter estimates and *t*-statistics for each of the regression models. Panel A summarizes results for firms in the 7-year sample period. The coefficient for β^p is significant and positive in all models, as would be expected; however, when $cirr_3$, $cirr_4$, $cirr_5$, or $cirr_6$ is the dependent variable, the coefficient tends to be significantly smaller for firms that use accelerated depreciation methods (as reflected in the significant coefficient on the $\beta^p \bullet DEP$ interaction term). The coefficient for *g* is significant when *arr*, $cirr_3$, $cirr_4$, $cirr_5$, and $cirr_6$ are used as dependent variables. In each case, the sign of the coefficient is positive. Based on the lack of significance of the relevant interaction terms, the magnitude of the coefficient for growth does not differ according to the depreciation method or inventory cost flow assumption used by the sample firms.

In the models for the 8-year sample period summarized in Panel B of Table 3, the coefficient for β^p is significant and positive in all models, except for those involving *arr*. In all models where β^p contributes significantly to the model, the magnitude of its coefficient is significantly less for firms using a *LIFO* inventory cost flow assumption or an accelerated depreciation method (as reflected in the significant coefficients for the $\beta^p \bullet INV$ and $\beta^p \bullet DEP$ interaction terms). The coefficient for *g* is significant only in the models involving *arr* and $cirr_1$. Based on the lack of significance of the relevant interaction terms, the contribution of *g* to the models again is unaffected by the inventory cost flow assumptions and depreciation methods used by the sample firms.

β^p does not contribute significantly to any of the models for the 10-year sample period summarized in Panel C of Table 3. The sole potential exception is in the case of *arr*. Firms using a *LIFO* inventory cost flow assumption appear to demonstrate a negative association between *arr* and β^p (as reflected in the significant coefficient on the $\beta^p \bullet INV$ interaction). The coefficient for *g* is significant for models involving *arr*, $cirr_3$, $cirr_5$, and $cirr_6$. The relationship between the left-hand-side variable and *g* does not depend on the firm's accounting policy choices, as indicated by the lack of significance of the relevant interaction terms.

The differences in the results for the three samples of firms limit the number of general statements that may be made about the estimated relationships. The strength of the relationship between accounting-based profitability measures and β^p appears to diminish as the time interval over which variables are estimated lengthens. This result may reflect an equalization of risk or profit rates across firms over time. It also may reflect as yet unidentified differences in the samples of firms for which the models do not provide control.

The importance of *g* in the models varied according to the accounting-based profitability measure involved and the time interval over which the variables were estimated. Regardless of the time interval involved, *g* contributed significantly to models involving *arr* and did not contribute significantly to models involving $cirr_2$ and $cirr_4$. Thus, Salamon's (1988) analyses are supported with respect to growth as a source of bias in *arr*. The importance of *g* in some models involving *cirr* may reflect an association based on the inclusion of *g* in the formulas used to calculate *cirr*. alternatively, the importance of *g* may provide empirical support for the analytical results of Griner and Stark (1991). Again, no clear differences among the three samples existed that would explain the mixed results for *g*.

Table 3
Parameter Estimates and *T*-Statistics from Ordinary Least Squares Regressions

Dependent Variables	β^p	g	$\beta^p \bullet INV$	$\beta^p \bullet DEP$	$g \bullet INV$	$g \bullet DEP$	Adjusted R^2
Panel A: 7-Year Sample Period, 138 Firms							
arr	.725						.0641
	(3.223)*						
arr	.569	5.078	-.287	-.059	2.209	1.532	.2581
	(1.773)∇	(3.562)	(-.653)	(-.130)	(1.313)	(.788)	
$cirr_1$	.686						.0567
	(3.039)*						
$cirr_1$	.848	-2.276	.053	-.294	.625	.036	.0486
	(2.335)◊	(-1.410)	(.106)	(-.569)	(.328)	(.016)	
$cirr_2$	.802						.0801
	(3.597)*						
$cirr_2$	1.050	1.581	-.298	-.675	1.417	.073	.0822
	(2.944)*	(.997)	(-.609)	(-1.330)	(.757)	(.034)	
$cirr_3$	1.003						.1297
	(4.628)*						
$cirr_3$	1.374	6.168	-.722	-1.091	1.097	.240	.3347
	(4.522)*	(4.569)*	(-1.853)∇	(-2.524)◊	(.688)	(.131)	
$cirr_4$	.857						.0927
	(3.873)*						
$cirr_4$	1.259	1.218	-.508	-.863	1.132	.111	.0952
	(3.553)*	(.774)	(-1.045)	(-1.712)∇	(.609)	(.052)	
$cirr_5$	.928						.1099
	(4.232)*						
$cirr_5$	1.309	2.729	-.584	-.920	1.081	.333	.1489
	(3.809)*	(1.787)∇	(-1.240)	(-1.881)∇	(.600)	(.160)	
$cirr_6$	.960						.1182
	(4.401)*						
$cirr_6$	1.331	3.527	-.625	-.948	1.027	.426	.1850
	(3.959)*	(2.361)◊	(-1.354)	(-1.981)∇	(.582)	(.209)	

∇ $p < .10$ (Two-tailed), ◊ $p < .05$ (Two-tailed), * $p < .01$ (Two-tailed)

The results appear to be inconsistent with several implications of prior research concerning the importance of accounting policy variables. Except for the 10-year sample, the accounting policy variables do not contribute significantly to any of the models involving *arr*. Moreover, in the 10-year sample, only *INV* contributes significantly in an interaction with β^p and at $p < .10$. This finding does not support the suggestion in earlier studies (e.g., Solomon (1966), Harcourt (1965), and Fisher and McGowan (1983)) that *arr* is systematically influenced by the firm's choice of accounting policies. The importance of accounting policy variables in models involving *cirr* varies according to time period and the formula used to calculate *cirr*. Each accounting policy variable contributes significantly to at least on model for each formulation of *cirr*. This result appears not to support Salamon's (1982, 1985) suggestion that conditional estimates of internal rates of return are not biased by accounting policy choice. However, two alternative explanations exist for the importance of accounting policy variables in any of the regression models. Management may deliberately select accounting policies to accomplish objectives involving political costs, compensation agreements, and smoothing of reported earnings (Watts and Zimmerman, 1986). Also,

Table 3
(Continued)

Dependent Variables	β^p	g	$\beta^p \bullet INV$	$\beta^p \bullet DEP$	$g \bullet INV$	$g \bullet DEP$	Adjusted R^2
Panel B: 8-Year Sample Period, 122 Firms							
arr	.198						-.0058
	(.548)						
arr	.547	4.904	-.882	.362	2.262	3.060	.2426
	(.996)	(3.486)*	(-1.283)	(.439)	(1.245)	(1.435)	
$cirr_1$	1.488						.1336
	(4.434)*						
$cirr_1$	2.863	-2.532	-1.844	-2.036	.886	.700	.1855
	(5.030)*	(-1.736)	(-2.584)◊	(-2.378)◊	(.470)	(.317)	
$cirr_2$	1.604						.1567
	(4.846)*						
$cirr_2$	4.080	-.039	-3.462	-3.213	1.606	.757	.3430
	(7.981)*	(-.236)	(-5.403)*	(-4.178)*	(.949)	(.381)	
$cirr_3$	1.618						.1594
	(4.894)*						
$cirr_3$	4.570	.897	-4.181	-3.689	1.289	.805	.4454
	(9.731)*	(.746)	(-7.102)*	(-5.221)*	(.829)	(.442)	
$cirr_4$	1.630						.1620
	(4.939)						
$cirr_4$	4.220	-.623	-3.646	-3.323	1.388	.866	.3640
	(8.391)*	(-.484)	(-5.783)*	(-4.392)*	(.834)	(.443)	
$cirr_5$	1.645						.1653
	(4.995)*						
$cirr_5$	4.395	-.044	-3.886	-3.483	1.331	.937	.4001
	(8.999)*	(-.035)	(-6.347)*	(-4.740)*	(.823)*	(.494)	
$cirr_6$	1.647						.1656
	(5.002)*						
$cirr_6$	4.459	.209	-3.980	-3.543	1.288	.953	.4145
	(9.241)*	(.169)	(-6.579)*	(-4.880)*	(.806)	(.508)	

∇ $p < .10$ (Two-tailed), ◊ $p < .05$ (Two-tailed), * $p < .01$ (Two-tailed)

accounting policies may be associated with *irr*, as when tax benefits accrue to firms adopting a LIFO inventory cost flow assumption during inflationary time periods. It appears that the implications of some analytical research into the relationship between accounting-based profitability measures may be incomplete to the extent that they do not explicitly model tax consequences and management strategy. Finally, all of the adjusted R^2s indicate that the variables selected for inclusion in these models leave much variability in the models' dependent variables unexplained. This result appears to be more pronounced as the time interval over which the variables are calculated lengthens.

Tables 4 and 5 report the results of tests of the null hypotheses. The results of tests of the first null hypothesis, summarized in Table 4, confirm observations made earlier about the information in Table 3. Among models for the 7-year sample period, only those involving *arr*, $cirr_3$, $cirr_4$, and $cirr_5$ are significantly influenced by g, INV, and/or DEP. All accounting-based profitability measures exhibit significant influence from one or more of these variables

Table 3
(Concluded)

Dependent Variables	β^o	g	$\beta^o \bullet INV$	$\beta^o \bullet DEP$	$g \bullet INV$	$g \bullet DEP$	Adjusted R^2
Panel B: 10-Year Sample Period, 91 Firms							
arr	.404						-.0020
	(.904)						
arr	.820	6.342	-1.554	.699	.204	2.630	.2626
	(1.129)	(3.631)*	(-1.692)∇	(.785)	(.093)	(1.025)	
$cirr_1$	.671						.0142
	(1.514)						
$cirr_1$	.354	-1.660	.793	-.068	-.706	.276	-.0114
	(.416)	(-.811)	(.737)	(-.065)	(-.276)	(.091)	
$cirr_2$	.488						.0022
	(1.094)						
$cirr_2$	.368	2.967	.464	-.209	-.634	.650	-.0197
	(.431)	(1.445)	(.429)	(-.199)	(-.247)	(.216)	
$cirr_3$	.273						-.0071
	(.608)						
$cirr_3$	.177	8.958	.352	-.127	-1.086	.972	.2708
	(.245)	(5.158)*	.385)	(-.143)	(-.500)	(.381)	
$cirr_4$	.463						.0008
	(1.036)						
$cirr_4$	.333	2.811	.460	-.175	-1.010	.680	-.0274
	(.388)	(1.364)	(.425)	(-.167)	(-.391)	(.225)	
$cirr_5$	.429						-.0009
	(.961)						
$cirr_5$	.302	4.656	.429	-.141	-1.180	.977	.0256
	(.361)	(2.319)◊	(.407)	(-.138)	(-.470)	(.331)	
$cirr_6$	.408						-.0018
	(.913)						
$cirr_6$	.280	5.634	.415	-.121	-1.270	1.103	.0659
	(.343)	(2.866)*	(.401)	(-.120)	(-.516)	(.382)	

∇ $p < .10$ (Two-tailed), ◊ $p < .05$ (Two-tailed), * $p < .01$ (Two-tailed)

when the sample period is extended to 8 years. Models involving *arr*, $cirr_3$, and $cirr_6$ are significantly influenced by *g* and/or *INV* when the sample period is 10 years. H_o1A is rejected regardless of the time period over which variables are estimated. The implications for H_o1B are less clear. H_o1B is rejected consistently using the formula for $cirr_3$, and it is rejected for at least one sample period for each of the other formulations of *cirr*. In general, both *arr* and *cirr* estimate *irr* with bias attributable to *g*, *INV*, and/or *DEP*.

As indicated in Table 5, H_o2 would be rejected for all formulations of *cirr* when the test is based on data from the 7-year sample period. The only possible exception is $cirr_1$, for which the null hypothesis would be rejected based on a .10 significance level. Based on the 7-year sample period results for $cirr_2$, $cirr_3$, $cirr_4$, $cirr_5$, and $cirr_6$, it appears that *cirr* contains less unexplained variation than *arr*. The results for $cirr_1$ indicate the opposite relationship. When the sample period is extended to 8 years, H_o2 is rejected at the traditional .05 level for $cirr_3$,

Table 4
Results of Tests of H_o1: $\delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$

Dependent Variable	*F*-Statistic	*P*-Value
Panel A: 7-Year Sample Period, 138 Firms		
arr	8.420	.0000
$cirr_1$	.795	.5551
$cirr_2$	1.100	.3636
$cirr_3$	9.735	.0000
$cirr_4$	1.113	.3566
$cirr_5$	2.333	.0457
$cirr_6$	3.354	.0070
Panel B: 8-Year Sample Period, 122 Firms		
arr	9.414	.0000
$cirr_1$	2.682	.0249
$cirr_2$	8.281	.0000
$cirr_3$	14.188	.0000
$cirr_4$	9.146	.0000
$cirr_5$	11.029	.0000
$cirr_6$	11.889	.0000
Panel B: 10-Year Sample Period, 91 Firms		
arr	8.001	.0000
$cirr_1$	.596	.7031
$cirr_2$	.669	.6480
$cirr_3$	8.431	.0000
$cirr_4$	.554	.7349
$cirr_5$	1.605	.1677
$cirr_6$	2.480	.0381

Notes: The test statistics produced by the *F*-test for the 7-, 8-, and 10-year samples follow *F* distributions with 5 numerator degrees of freedom and 131, 115, and 84 denominator degrees of freedom, respectively.

and at a .10 significance level for $cirr_1$, but not for any other formulations of *cirr*. When the null hypothesis is rejected for the 8-year sample, *arr* appears to have exhibited more random variation than *cirr*. Finally, in the case of $cirr_1$, $cirr_2$, and $cirr_4$, H_o2 is rejected at the .10 significance level when the sample period is ten years. In each case, *cirr* exhibited more random error when the null hypothesis was rejected. Based on the results for all three sample periods, it appears that *cirr* represents a more efficient estimator of a firm's *irr* (i.e., it estimates a firm's *irr* with less random error) than does *arr* when data from shorter sample periods are used. This result changes when the sample time period lengthens.

It is difficult to determine whether this result should have been expected. A substantial amount of analytical research focuses on biases present in the relationships of *arr* and *cirr* with *irr*. This previous research makes no mention of either surrogate estimating *irr* with greater efficiency. Thus, the apparent hypothesis of previous researchers is that the two *irr* surrogates differed only with respect to systematic error or bias. Given that estimates of *cirr* incorporate information about inflation, growth, asset lives, and recovery rates, *cirr* may be a richer surrogate for *irr* than *arr*. Nevertheless, estimates of *cirr* are based on assumed values for *b*, the cash flow parameter. Using a particular value of *b* or shape of the cash flow profile for all firms in a sample may introduce sufficient measurement error to yield the results reported in the current study. If firm-specific estimates of *b* and the cash flow profile could be obtained, the random error present in estimates of *cirr* may be reduced (Griner and Stark, 1991;

Table 5
Results of Tests of H_o2: $\sigma^2_{u**} = \sigma^2_{v**}$

Variable Compared With *arr*	Variable With Larger *MSE*	*F*-Statistic	*P*-Value
Panel A: 7-Year Sample Period, 138 Firms			
$cirr_1$	$cirr_1$	1.282	.0782
$cirr_2$	*arr*	8.538	.0000
$cirr_3$	*arr*	5.451	.0000
$cirr_4$	*arr*	7.464	.0000
$cirr_5$	*arr*	6.374	.0000
$cirr_6$	*arr*	5.954	.0000
Panel B: 8-Year Sample Period, 122 Firms			
$cirr_1$	$cirr_1$	1.075	.3494
$cirr_2$	*arr*	1.153	.2232
$cirr_3$	*arr*	1.366	.0479
$cirr_4$	*arr*	1.191	.1750
$cirr_5$	*arr*	1.263	.1061
$cirr_6$	*arr*	1.294	.0843
Panel C: 10-Year Sample Period, 91 Firms			
$cirr_1$	$cirr_1$	1.372	.0747
$cirr_2$	*arr*	1.383	.0697
$cirr_3$	*arr*	1.011	.4801
$cirr_4$	$cirr_4$	1.393	.0654
$cirr_5$	$cirr_5$	1.321	.1021
$cirr_6$	$cirr_6$	1.267	.1401

Notes: The test statistics produced by the *F*-test for the 7-, 8-, and 10-year samples follow *F* distributions with numerator and denominator degrees of freedom and 131, 115, and 84, respectively.

Stark, Thomas, and Watson, 1992). This issue requires further investigation.

Conclusion

A fundamental problem in evaluating a firm's performance is that its *IRR* is unobservable. The most widely used surrogate, *ARR,* has well-known deficiencies. *CIRR* is a recently developed surrogate; consequently, its strengths and limitations are not well established. The objective of this study was to compare the error with which *ARR* and *CIRR* measure *IRR* to determine which is the better surrogate for *IRR* within the context of the traditional econometric trade-off between bias and efficiency.

Two types of measurement error were examined in this study: systematic error introduced by growth and accounting method choices, and random error. With respect to systematic error, the results of this study do not support the findings of previous theoretical and empirical work as those findings relate to the influence of accounting method choices on *ARR*. Accounting method choices generally did not contribute significantly to explaining the variation in *ARR*. However, growth consistently contributed significantly toward explaining variation in *ARR*. *ARR* provides biased estimates of *IRR* regardless of the sample period involved. The current study found inconsistent results regarding the importance of growth and accounting method choices in explaining the variation in *CIRR*. The importance of these variables differed across sample periods and assumed cash flow profile. Nevertheless, it appears that *CIRR* also is a biased estimator of *IRR*. Alternatively, the interpretation of accounting policy variables offered in previous research may not have adequately captured the strategic considerations or cash flow (tax) impact of accounting method choices. Future research into the usefulness of accounting-based profitability measures should consider these alternative explanations.

The results also provide mixed evidence about which accounting-based profitability measure estimates *IRR* with greater efficiency (i.e., less random error). In the shortest (7-year) sample period, *ARR* generally estimated *IRR* with less efficiency than did *CIRR*. As the sample period lengthened, this relationship appeared to reverse. Thus the accounting-based profitability measure that is the most efficient estimator of *IRR* may be conditioned on the length of time under consideration.

The results of this study should interest those parties responsible for establishing antitrust, accounting, and other related public policies. The establishment of antitrust policies requires information about the economic profits earned by firms. Since for shorter periods of time *CIRR* and, to a lesser extent, *ARR* both appear to be related to *IRR*, these surrogates can provide a basis for antitrust regulation if appropriate adjustments are made for the biases introduced by differences in growth rates and accounting policy choices. Some of the contradictory results previously reported in the economics literature investigating the relationship between observed (accounting) profit rates market structure may be attributable to the diversity of growth rates experienced and accounting policies used by firms in the samples. Contradictory results also could reflect the use of different sample periods. The results of this study suggest that researchers should examine their samples for similarity of growth rates and accounting policies across firms and consider the length of time over which they intend to estimate accounting-based profitability measures. As the similarity of growth rates and accounting policies within the sample decreases, researchers should explicitly incorporate these factors in their experimental designs. Regardless of growth rates experienced or accounting policy choices used by sample firms, *CIRR* appears to provide more efficient estimates of *IRR* for shorter intervals of time than does *ARR* and should be selected as an *IRR* surrogate. This area of research may benefit from improved model specification and variable definitions.

The Financial Accounting Standards Board stated that published financial statements should provide information about "the amounts, timing, and uncertainty of prospective net cash inflows to the related enterprise" (Financial Accounting Standards Board, 1978, 1987). Since the firm's *IRR* is the rate of return which equates and the present values of future cash flows from a firm's projects with the costs of those projects (Copeland and Weston, 1983), the information described by the Financial Accounting Standards Board seems to be closely related to the concept of *IRR*. Therefore, evidence that accounting-based profitability measures are related to *IRR* may be of interest to the Financial Accounting Standards Board as it formulates current and prospective financial accounting standards. Additionally, the results of this study support the continuing requirement under generally accepted accounting principles of disclosing significant accounting policies so that financial statement users and financial researchers can assess the potential impact of accounting policy choices (Accounting Principles Board, 1972).

Suggestions For Future Research

The results of this study suggest two directions for future research. First, researchers interested in the effects of industrial concentration and market structure on profitability may wish to reexamine these relationships while controlling for accounting policy choices. This study examined the influence of depreciation methods and inventory cost flow assumptions on observed profitability measures. Other accounting policy choices (for example, consolidation accounting methods) also may need to be considered in designing future investigations in this area.

Second, while this study used the relationship between *IRR* and risk to provide indirect evidence about the relative merits of two accounting-based profitability measures, it also may be possible to collect direct evidence. Computer simulation is a methodology with the potential to facilitate a more direct examination of the relationships between *IRR* and accounting-based profitability measures. 🕮

This research was financially supported, in part, by Deloitte and Touche, the School of Management at Syracuse University, and a Culverhouse School of Accountancy Summer Research Grant. We are grateful for the helpful comments of Emmitt Griner, Rob Ingram, Al Leitch, John Rasp, Gerry Salamon, Paul Thistle, and participants in the Accounting Research Workshop at Syracuse University. 🕮

❄❄❄ Footnotes ❄❄❄

1. Jensen (1986) and Luckett (1984) provide comprehensive reviews of the literature addressing the ability of ARR to estimate IRR.
2. See Brealey and Myers (1984, ch. 9) and Salamon (1988, p. 269, fn. 4) for further discussions of this issue.
3. Callahan and Mohr (1989) provide a review and synthesis of this continuing line or research.
4. *DOL* is defined as the percentage deviation of earnings before interest and taxes from its expected value resulting from a percentage deviation in real output from its expected value. *DFL* is defined as the

percentage deviation of net income from its expected value resulting from a percentage deviation in earnings before interest and taxes from its expected value. Mandelker and Rhee (1984) defined β^o as the covariability of the product of the firm's net profit margin and equity turnover with the return on the market. The formula used to calculate β^o is presented in the next section.

5. The influence of accounting policy choices on *cirr* is uncertain, although Salamon (1985) presented indirect evidence of *cirr*'s insensitivity to a firm's accounting policies. For the purposes of the current study, the effect of inventory cost flow assumptions and depreciation methods on *cirr* is treated as an empirical question and tested accordingly.
6. Representing these accounting policy choices with dummy or indicator variables ignores the fact that inventory and plant assets constitute different proportions of total assets for different firms. The approach used in the current study accommodates the development of models in which *INV* and *DEP* interact with other right-hand-side variables. To be included in the samples for the current study, firms had to use the same inventory cost flow assumption and depreciation method throughout the sample period.
7. The form of (11) and (12) would have been much different if *INV* and *DEP* were assumed to affect the error terms rather than the slopes in (7) and (8). The resulting equations would have had no interaction terms and would have emphasized the separate effects of accounting policy choices. However, using this formulation would have required the assumption that accounting policy choices and *irr* had independent effects on accounting profitability measures, an assumption we considered but later rejected as unjustifiable on *a priori* grounds. The model specification tests referenced in footnote 20 supported our decision to adopt an interactive model.
8. Other less obvious accounting policy choices also may impact observed profitability measures, such as the decision to disclose certain events as extraordinary items (Salamon and Smith, 1979). Omitting relevant accounting policy variable bases the tests described below in favor of the null hypothesis.
9. For example, when a firm uses LIFO rather than FIFO, arr may be biased downward becasue the difference in inventory value has a greater impact on income than on total assets. On the other hand, when a firm uses an accelerated depreciation method rather than straight-line, *arr* may be biased upward because depreciation expense is a smaller part of income determination than plant assets are in the determination of total assets.
10. Again, to be included in the sample, firms must have used the same inventory cost flow assumption and depreciation method throughout the sample period.
11. Defining the sample in terms of accounting policies used and the availability of specific data results from the research hypotheses developed above. Never-the-less, the results of this study may be biased if the firms for which data were available differed from those for which data were not available in ways that are systematically related to the variables included in the study.
12. Salamon (1985) also derived the relationship between a firm's cash recovery rate and the conditional estimate of its nominal internal rate of return.
13. Although Salamon (1989) acknowledged the appropriateness of the procedures developed by Buijink and Jegers (1989), and revised his earlier analyses accordingly, the results of his analyses remained unchanged.
14. If b<1, the project's cash flows decline at a constant rate; if b>1, the projects's cash flows increase at a constant rate; and if b=1, the project's cash flows remain level.
15. This formula for *ARR* reflects the notion that the firm's investing decisions are separate from its financing decisions. The formula also removes some of the effects of changing tax laws for corporations over the time period included in the study.
16. Although this approach avoids many of the complexities involved when calculating, for example, constant dollar accounting values, it should be considered a primitive substitute for profitability measures that could be derived from inflation-adjusted accounting information.
17. The numerator of equation (18) could be rewritten as follows:

$$COV\left[\frac{E_{it-1}(1+g)}{VE_{it-1}}, R_{mt}\right] \tag{18A}$$

if sales grow at rate g. Thus, the numerator might be interpreted as the covariance between a ratio correlated with arr and the market rate of return. To determine whether this expression biased our hypothesis tests in favor of *arr*, CFO_{it-1} was substituted for E_{it-1} in equation (18), and the analyses were repeated. The results of the hypothesis tests were not affected by this change.

18. A test developed by White (1980) detected no significant first- or second-order model misspecification in any of the models.
19. Neither Salamon (1982) nor Gordon and Hamer (1988) calculated *cirr* using a value of 1.2 for the cash flow parameter (b).

❄❄❄ References ❄❄❄

1. Accounting Principles Board, *Accounting Principles Board Opinion No. 19: Reporting Changes in Financial Position*. AICPA, New York, New York, 1971.
2. ________, *Accounting Principles Board Opinion No. 22: Disclosure of Accounting Policies*. AICPA, New York, New York, 1972.
3. Beaver, William H., "Accounting for Inflation in an Efficient Market," In *The Impact of Inflation on Accounting: A Global View*, ed., K. V. Zimmerman, The Board of Trustees of the University of Illinois, Urbana, Illinois, pp. 21-42, 1979.
4. Brealey, Richard and Stewart Myers, *Principles of Corporate Finance*, Second Edition. McGraw-Hill, New York, New York, 1984.
5. Brief, Richard P., "Limitations of Using the Cash Recovery Rate to Estimate the IRR: A Note," *Journal of Business Finance & Accounting*, Vol. 12, No. 3, pp. 473-475, 1985.
6. Buijink, Willem and Marc Jegers, "Accounting Rates of Return: Comment," *American Economic Review*, Vol. 79, No. 1, pp. 287-289, 1989.
7. Callahan, Carolyn, M. and Roxanne Mohr, "The Determinants of Systematic Risk: A Synthesis," *Financial Review*, Vol. 24, No. 2, pp. 157-181, 1989.
8. Chow, G. C., "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," *Econometrica*, Vol. 28, No. 3, pp. 591-605, 1960.
9. Copeland, Thomas E., and J. Fred Weston, *Financial Theory and Corporate Policy*, Second Edition. Addison-Wesley, Reading, Massachusetts, 1983.
10. Financial Accounting Standards Board, *Statement of Financial Accounting Concepts No. 1: Objectives of Financial Reporting by Business Enterprises*, Financial Accounting Standards Board, Stamford, Connecticutt, 1978.
11. ________, *Statement of Financial Accounting Concepts No. 1: Statement of Financial Accounting Standards No. 95: Statement of Cash Flows*, Financial Accounting Standards Board, Stamford, Connecticut, 1987.
12. Fisher, Franklin M., and John J. McGowan, "On the Misuse of Accounting Rates of Return to Infer Monopoly Profits," *American Economic Review*, Vol. 73, No. 1, pp. 82-97, 1983.
13. Fisher, Irving, *The Theory of Interest*, New York: Macmillan, New York, New York, 1930.
14. Gahlon, James M., and James A. Gentry, "On the Relationship Between Systematic Risk and the Degree of Operating and Financial Leverage," *Financial Management*, Vol. 11, No. 2, pp. 15-23, 1982.
15. Gordon, Lawrence A., and Michelle M. Hamer, "Rates of Return and Cash Flow Profiles: An Extension," *Accounting Review*, Vol. 63, No. 3, pp. 514-521, 1988.
16. Greene, William H., *Econometric Analysis*, Macmillan, New York, New York, 1990.
17. Griner, Emmitt H., and Andrew W. Stark, "Cash Recovery Rates, Accounting Rates of Return and the Estimation of Economic Performance," *Journal of Acounting and Public Policy*, Vol. 7, No. 4, pp. 293-311, 1988.
18. ________, "On the Properties of Measurement Error in Cash Recovery Rate Based Estimates of Economic Performance," *Journal of Accounting and Public Policy*, Vol. 10, No. 3, pp. 207-223,
19. Hamada, Robert S., "Portfolio Analysis, Market Equilibrium and Corporation Finance," *Journal of Finance*, Vol. 24, No. 1, pp. 13-31, 1969.
20. Harcourt, G. C., "The Accountant in a Golden Age," *Oxford Economic Papers*, Vol. 17, No. 1, pp. 66-80, 1965.
21. Hubbard, Carl M., and Robert E. Jensen, "Lack of Robustness and Systematic Bias in Cash Recovery Rate Methods of Deriving Internal (Economic) Rates of Return for Business Firms," *Journal of Accounting and Public Policy*, Vol. 10, No. 3, pp. 225-242, 1991.
22. Ijiri, Yuji, "Cash Flow Accounting and Its Structure," *Journal of Accounting, Auditing, and Finance*, Vol. 1, No. 4, pp. 341-348, 1978.
23. ________, "Convergence of Cash Recovery Rate," In *Quantitative Planning and Control*, eds., Yuji Ijiri and Andrew B. Whinston, Academic Press, New York, New York, pp. 259-267, 1979.
24. ________, "Recovery Rate and Cash Flow Accounting," *Financial Executive*, vol. 48, No. 3, pp. 54-60, 1980.
25. Ismail, Badr E., "Some Time Series Properties of Corporate Cash Recovery Rates," *Contemporary Accounting Research*, Vol. 4, No. 1, pp. 76-88, 1987.
26. Jensen, Robert E., "The Befuddled Merchant of Venice: More on the 'Misuse' of Accounting Rates of Return vis-à-vis Economic Rates of Return," In *Advances in Public Interest Accounting*, Vol. 1, eds., Marilyn Neimark, Barbara Merino, and Tony Tinker, JAI Press, New York, New York, pp. 113-166, 1986.
27. Kay, J. A., "The Accountant, Too, Could Be Happy in a Golden Age: The Accountant's Rate of Profit and the Internal Rate of Return," *Oxford Economic Papers*, Vol. 28, No. 3, pp. 447-460, 1976.
28. ________, and C. P. Mayer, "On the Application of Accounting Rates of Return," *Economic Journal*, Vol. 96, No. 381, pp. 199-207, 1986.

29. Lee, Thomas A., and Andrew W. Stark, "Ijiri's Cash Flow Accounting and Capital Budgeting," *Accounting and Business Research*, Vol. 17, No. 66, pp. 125-132, 1987.
30. Lintner, John, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Review of Economics and Statistics*, Vol. 47, No. 1, pp. 13-37, 1965.
31. Livingstone, John L., and Gerald L. Salamon, "Relationship Between the Accounting and the Internal Rate of Return Measures: A Synthesis," *Journal of Accounting Research*, Vol. 8, No. 2, pp. 199-216, 1970.
32. Luckett, Peter F., "ARR vs. IRR: A Review and Analysis," *Journal of Business Finance & Accounting*, Vol. 11, No. 2, pp. 213-231, 1984.
33. Mandelker, Gershon N., and S. Ghon Rhee, "The Impact of the Degrees of Operating and Financial Leverage on Systematic Risk of Common Stock," *Journal of Financial and Quantitative Analysis*, Vol. 19, No. 1, pp. 45-57, 1984.
34. Meeks, G., *Disappointing Marriage: A Study of the Gains from Merger*, Cambridge University Press, Oxford, England, 1977.
35. Mossin, Jan, "Equilibrium in Capital Asset Markets," *Econometrica*, Vol. 34, No. 4, pp. 768-783, 1966.
36. Mueller, Dennis C., *Profits in the Long Run*, Cambridge University Press, Cambridge, England, 1986.
37. Rubenstein, Mark E., "A Mean-Variance Synthesis of Corporate Financial Theory," *Journal of Finance*, Vol. 28, No. 1, pp. 167-182, 1973.
38. Salamon, Gerald L., "Cash Recovery Rates and Measures of Firm Profitability," *Accounting Review*, Vol. 57, No. 2, pp. 292-302, 1982.
39. ________, "Accounting Rates of Return," *American Economic Review*, Vol. 75, No. 3, pp. 495-504, 1985.
40 ________, "On the Validity of Accounting Rates of Return in Cross-Sectional Analysis: Theory, Evidence, and Implications," *Journal of Accounting and Public Policy*, Vol. 7, No. 1, pp. 267-292, 1988.
41. ________, "Accounting Rates of Return: Reply," *American Economic Review*, Vol. 79, No. 1, pp. 290-293, 1989.
42. ________, and E. D. Smith, "Corporate Control and Managerial Misrepresentation of Firm Performance," *Bell Journal of Economics*, Vol. 10, No. 1, pp. 319-328, 1989.
43. Scherer, Frederick M., *Industrial Market Structure and Economic Performance*, Rand McNally, Chicago, Illinois, 1980.
44. Schwert, G. William, "Using Financial Data to Measure Effects of Regulation," *Journal of Law and Economics*, Vol. 24, No. 1, pp. 121-158, 1981.
45. Sharpe, William F., "A Simplified Model for Portfolio Analysis," *Management Science*, Vol. 9, No. 1, pp. 277-293, 1963.
46. ________, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," *Journal of Finance*, Vol. 19, No. 4, pp. 425-442, 1964.
47. Solomon, Ezra, "Return on Investment: The Relation of Book-Yield to True Yield," In *Research in Accounting Measurement*, eds., Robert K. Jaedicke, Yuji Ijiri, and O. Nielsen, American Accounting Association, Madison, Wisconsin, pp. 232-244, 1966.
48. Stark, Andrew W., "On Testing the Assumptions of the Cash Recovery Rate Approach to the Estimation Economic Performance," *Accounting and Business Research*, Vol. 19, No. 75, pp. 277-285, 1989.
49. ________, Hardy M. Thomas, and Iain D. Watson, "On the Practical Importance of Systematic Error in Conditional IRRs," *Journal of Business Finance and Accounting*, Vol. 19, No. 3, pp. 407-424, 1992.
50. Stauffer, Thomas R., " The Measurement of Corporate Rates of Return: A Generalized Formulation," *Bell Journal of Economics and Management Science*, Vol. 2, No. 2, pp. 434-469, 1971.
51. van Breda, Michael F., "Accounting Rates of Return Under Inflation," *Sloan Management Review*, Vol. 22, No. 4, pp. 15-28, 1981.
52. Watts, Ross L., and Jerold L. Zimmerman, *Positive Accounting Theory*, Prentice-Hall, Englewood cliffs, New Jersey, 1986.
53. Weiss, Leonard W., "The Concentration-Profits Relationship and Antitrust," In *Industrial Concentration: The New Learning*, eds., Harvey J. Goldschmid, H. Michael Mann, and J. Fred Weston, Little, Brown and Co., Boston, Massachusetts, pp. 184-233, 1974.
54. White, Halbert, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica*, Vol. 48, No. 4, pp. 817-838, 1980.
55. Whittington, Geoffrey, "On the Use of the Accounting Rate of Return in Empirical Research," *Accounting and Business Research*, Vol. 9, No. 35, pp. 201-208, 1979.

Appendix
Data Items Used To Construct Variables and Their Sources

Variable	Component	Source	Item(s)
arr	*EBIT*	INDA	(18) Income Before Extraordinary Items + (16) Income Taxes--Total + (15) Interest Expense
	TA	INDA	(6) Assets--Total
	I	CITI	Implicit Price Deflator: Gross Domestic Product
cirr	*CFO*	INDA	(110) Funds from Operations--Total + (15) Interest Expense + (109) Sale of Investments + (107) Sale of Property, Plant, and Equipment + Δ(70) Accounts Payable + Δ(71) Income Taxes Payable + Δ(72) Current Liabilities--Other - Δ(2) Receivables--Total - Δ(3) Inventories--Total - Δ(68) Current Assets--Other
	GA	INDA	(6) Assets--Total - (4) Current Assets--Total + (7) Property, Plant, and Equipment--Total (Gross) - (8) Property, Plant, and Equipment--Total (Net)
	g	INDA	[log[1 + change in GA across sample period] / years in sample period
	n	INDA	average of annual values for [(7) Property, Plant, and Equipment--Total (Gross) / (103) Depreciation Expense]
β^o	*E*	INDA	(18) Income Before Extraordinary Items
	S	INDA	(12) Sales (Net)
	VE	INDA	(25) Common Shares Outstanding x (24) Price--Close
	R_m	PDE	S&P 500 Index %Δ in Price + [Annualized Dividend Rate / Previous Period Close for S&P 500 Index
INV		INDA	(59) Inventory Valuation Method
DEP		INDA	Footnote 15

Notes: The abbreviations for data sources refer to the following: INDA--Compustat Annual Industrial File (Limited Subscription); PDE--Compustat Price, Dividends, and Earnings File (Limited Subscription); and CITI--Citibase Econometric Database. The numbers in parentheses under "Item(s)" refer to the Compustat Annual Industrial File data item number.