A Lintnerian Linear Accounting Valuation Model

JEFFREY L. CALLEN*
MINDY MOREL**

This paper develops and tests a linear valuation accounting model based on Lintner's (1956) dividend model. Two test methodologies are employed on a firm-level time-series basis. First, abstracting from the nonlinear relationships among the parameters, the information dynamic and valuation equation are estimated by linear OLS and linear SUR. The estimated equations are evaluated by reference to the sign and value predictions of the model. Second, recognizing the underlying nonlinear relationships among the parameters, the Lintnerian system of equations is estimated by nonlinear OLS and nonlinear SUR. All parameters are estimated endogenously at the firm level, including each firm's cost of capital. The resulting parameter estimates are evaluated for statistical and, in the case of costs of capital, for economic significance.

Results of the first (linear) methodology by and large confirm the validity of the Lintner model. The signs and values of the estimated coefficients are consistent with the predictions of the Lintner model except that the (mean) estimated book value coefficient in the price equation exceeds its theoretical upper bound. The results of the second (nonlinear) methodology are somewhat more problematic. Although the Lintner model yields statistically significant firm-level costs of capital, these estimates are not economically significant for the sample period.

1. Introduction

This paper develops and tests a linear accounting valuation model in the spirit of Lintner (1956). Unlike the Ohlson (1995) linear valuation model wherein dividends are a residual, dividends in the Lintner model are a decision variable. Specifically, Lintner recognizes that managers are unlikely to increase dividends, unless the earnings increases that generate the dividend increases are deemed to be permanent in nature. This stickiness aspect of dividends is well recognized in the

*Stern School of Business, New York University
**Jerusalem School of Business Administration, The Hebrew University
We wish to thank the participants at the 1999 KPMG-JAAF conference, and especially Tom Stober, our discussant, for helpful comments.

empirical finance literature, most recently by Benzartzi, Michaely, and Thaler (1997). Whether the stickiness of the dividend process has valuation consequences is one of the central issues of this study.

Despite the preeminance of the Ohlson (1995) model in financial accounting research, the model seems to have little empirical content. Myers (1999) and Dechow, Hutton, and Sloan (1999) find that price predictions of the Ohlson model are no better than book values alone. This negative result obtains even when the abnormal earnings dynamic of the Ohlson model is extended to an AR(2) process (Callen and Morel [2000]). Morel (1999a) finds that the firm-level risk premia predicted by the Ohlson model are not significantly different from zero.

What we propose is to maintain ex cathedra that price can be represented by the present value of expected dividends (conditional on current information) discounted at the firm's cost of capital. Furthermore, in contradistinction to Ohlson, dividends are assumed to evolve according to a Lintnerian dividend dynamic. The resulting model, as we shall see, still satisfies the nice linearity properties of the Ohlson model. However, it differs from Ohlson in two major respects. First, price is a function of contemporaneous earnings and book value rather than contemporaneous abnormal earnings and book value. Second, the Modigliani-Miller (Miller and Modigliani [1961]) dividend irrelevance proposition no longer holds. Whereas in the Ohlson model firms can access the debt markets costlessly at the risk-free rate in order to pay dividends, so that a dollar of dividends this period reduces next period's earnings by the risk-free rate, the Lintner model implicitly assumes that a dollar of dividends this period reduces next period's earnings by the return on investment. In short, distributing dividends is not a zero net present value activity. This is not unreasonable if only because externally generated funds are more costly than internally generated funds.

We follow Morel (1998, 1999a) by estimating all model parameters endogenously, including firm-level costs of capital. Also, the model parameters are estimated nonlinearly (as well as linearly) since the parameters enter these models in a nonlinear fashion. Although a number of studies have estimated the Ohlson (1995) and Ohlson-like models using firm-level time-series data,[1] with the exception of Morel (1998, 1999a), these studies either assume cross-sectionally constant costs of capital or estimate firm-level costs of capital exogenously using alternative models such as the three-factor Fama-French (1997) variant of the CAPM. In addition, with the exception of Ramakrishnan and Thomas (1992) and Morel (1998, 1999a), model parameters are estimated by ordinary least squares, effectively disregarding nonlinearity issues.

It is extremely important when estimating the Lintner (or the Ohlson) model to estimate all parameters endogenously at the firm level, especially costs of capital. This is problematic in cross-sectional studies since endogenously estimated parameters are necessarily constant across all firms. The assumption that all firms have

1. Ahmed, Morton, and Schaefer (2000); Bar-Yosef, Callen, and Livnat (1996); Morel (1998, 1999a, 1999b); Myers (1999); Qi, Wu, and Xiang (2000); and Ramakrishnan and Thomas (1992).

the same cost of capital and the same earnings persistence parameter are rejected by the finance literature and the time series literature on (annual) accounting earnings. Some cross-sectional studies try to avoid this criticism for the cost of capital—although the persistence parameter is typically assumed to be cross-sectionally constant[2]—by employing alternative models such as the CAPM or the Fama-French (1997) three-factor model to estimate firm-level costs of capital and then "plug" these estimates into the Ohlson valuation equation. Virtually all time-series studies are guilty of this as well. There are at least three (interrelated) reasons why this "mixing and matching" of models and the exogenous estimation of the cost of capital is problematic. First, a firm's value and its cost of capital are determined simultaneously so that it is conceptually problematic to use two disparate models, one to estimate the firm's value and the other to estimate its cost of capital. Second, since each model has its own unique assumptions and since neither model is a derivative of the other, the parameters estimated from one model need not be consistent with those estimated from the other. Third, besides being conceptually unsound, the exogenous estimation of a parameter from another model such as the CAPM, when that parameter is endogenous to the model being tested *and* can in fact be estimated endogenously, suggests that the model being estimated (Ohlson or Lintner) is incorrectly specified ab initio.[3]

This paper is organized as follows. Section 2 briefly develops the Lintner model. Section 3 describes two empirical methodologies for testing the Lintner model using firm-level time-series data. Section 4 describes the sample. Section 5 gives the empirical results for the two test methodologies. Section 6 concludes the paper.

2. The Lintner Model

The Ohlson (1995) model and its variants assume that the clean surplus relationship holds but otherwise dividends are unconstrained. In contrast, the Lintner dividend model, although consistent with clean surplus, assumes a specific dividend policy for the firm. More specifically, in order to account for the well-documented reluctance of managers to increase dividends unless earnings increase permanently, Lintner (1956) assumes that firms have a constant long-run target payout ratio in mind when setting dividends:

$$d_t^* = k^* x_t, \; 0 \leq k^* \leq 1, \tag{1}$$

2. Dechow, Hutton, and Sloan (1999) try to finesse this by estimating an earnings dynamic inclusive of firm-level characteristics interacted with lagged earnings. But, as Myers (1999) correctly points out, this approach is not consistent with the Ohlson valuation equation.

3. Ohlson (1995, p. 680) seems to condone the use of the CAPM to estimate the cost of capital. Ohlson states that one can gross up the risk-free rate by a risk premium estimated, for example, from the CAPM. (He calls this the replacement procedure.) However, as Ohlson recognizes and emphasizes on the same page, two paragraphs later: "Although this approach is simple and perhaps useful for many practical purposes, it lacks theoretical appeal. . . . In sum, the 'replacement procedure' is *ad hoc* and exogenous to the extreme."

where k^* is the target payout ratio, d_t^* denotes target dividends, and x_t denotes earnings. Actual dividends are further assumed to adjust slowly to the target. In particular, Lintner assumes that the change in actual dividends (d_t) is proportional to the extent to which target dividends deviate from last period's actual dividends:

$$d_t - d_{t-1} = c(d_t^* - d_{t-1}), \tag{2}$$

where c is the "speed of adjustment" factor. In the spirit of the Ohlson framework—in which firm value is a function of accounting numbers rather than dividends—instead of eq. (2), we assume that firms set actual dividends by comparing target dividends with the return on last year's book value of equity.[4] The return on last year's book value is a simple measure of long-run earnings in the absence of growth. Mathematically,

$$d_t - (R - 1)y_{t-1} = c\,[d_t^* - (R - 1)\,y_{t-1}], \tag{3}$$

where R denotes one plus the firm's cost of capital and y_{t-1} is last period's book value of equity. Equation (3) says in words that firms adjust actual dividends above (below) long-run earnings in proportion to the extent to which target dividends exceed (are below) long-run earnings. Substituting eq. (1) into eq. (3) yields the Lintnerian dividend dynamic:

$$d_t = ck^*x_t + (1 - c)(R - 1)\,y_{t-1} \quad 0 \leq c,\, k^* \leq 1. \tag{4}$$

The assumptions of the Lintner model can be described in a manner similar to that of the Ohlson model.[5] Price is the present value of expected future dividends conditional on current information. The clean surplus relation holds. Earnings and the "other information" variable follow first order autoregressive processes.[6] Dividends follow a Lintnerian dividend dynamic. Formally,

$$P_t = \sum R^{-\tau}E_t(d_{t+\tau}) \qquad \text{(PVED)}, \tag{5}$$

$$x_{t+1} = \omega\, x_t + v_t + \varepsilon_{1t+1} \tag{6a}$$

$$v_{t+1} = \gamma v_t + \varepsilon_{2t+1}, \qquad \text{(linear dynamic)}, \tag{6b}$$

$$d_t = ck^*x_t + (1 - c)(R - 1)\,y_{t-1} \quad 0 \leq c,\, k^* \leq 1, \tag{6c}$$

where

4. Using Lintner's original formulation, namely, eqs. (1) and (2), it can be shown that the resulting valuation equation is a linear function of contemporaneous earnings and dividends.

5. For simplicity of expression, we henceforth refer to this model as the Lintner model rather than the Lintnerian accounting valuation model. However, the true Lintner model is based on eq. (2), not eq. (4).

6. In the Ohlson model, abnormal earnings rather than earnings are assumed to be AR(1). This difference is hardly innocuous. It is directly related to MM dividend irrelevance.

P_t = firm value at the beginning of period t,
d_t = dividends during period t,
x_t = earnings during period t,
y_t = book value of common equity at the end of period t,
v_t = "other information" during period t,
ω, γ, c, k^* = parameters of the processes,
ε_{it+1} = white noise error terms,
E_t = expectations operator at time t.

Since v_t is conceptually problematic and difficult to specify empirically for a large sample of firms, we assume that it enters the empirical estimation process as an intercept term.

It is shown in the appendix that the Lintner model assumptions yield the valuation equation:

$$P_t = \kappa_t + \frac{\omega(1 - c + k^*c)}{(R - \omega)(2 - c)} x_t + \frac{1 - c}{2 - c} y_t, \tag{7}$$

where κ_t is an intercept term.

It is worth noting that when $c = 1$, the Lintner model becomes the Gordon (1962) constant dividend growth model where k^* is interpreted as the constant dividend payout ratio. In fact, the Gordon constant dividend growth model is a special case of the Lintner model.

In summary, the Lintner model can be described as follows:

Earnings dynamic: $x_t = v_t + \omega x_{t-1} + \varepsilon_t$, (8a)

Dividend dynamic: $d_t = ck^*x_t + (1 - c)(R - 1)y_{t-1}$, (8b)

Valuation equation: $P_t = \kappa_t + \dfrac{\omega(1 - c + k^*c)}{(R - \omega)(2 - c)} x_t + \dfrac{1 - c}{2 - c} y_t$. (8c)

It is worth noting that those papers that regress price on earnings and book value—such as Burgstahler and Dichev (1997) or Collins, Maydew, and Weiss (1997), for example—are actually consistent with the Lintner model but are not consistent with the Ohlson model. To be consistent with Ohlson, price has to be regressed either on abnormal earnings and book value or, equivalently, earnings, book value, and book value lagged.

3. Test Methodologies

This paper uses two different methodologies to test the empirical content of the Lintner model. In the first methodology, the information dynamic and the valuation equation are estimated by linear ordinary least squares (OLS) and linear seemingly unrelated regressions (SUR) for each firm separately, implicitly abstract-

ing from the nonlinear relationship among the various parameters.[7] More specifically, the linear system of equations:

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \varepsilon_{1t}, \tag{9a}$$

$$d_t = \beta_1 x_t + \beta_2 y_{t-1} + \varepsilon_{2t}, \tag{9b}$$

$$P_t = \gamma_0 + \gamma_1 x_t + \gamma_2 y_t + \varepsilon_{3t}, \tag{9c}$$

is estimated for each firm in the sample. As predicted by eqs. (8a) to (8c), the Lintner model has empirical content provided we find that $1 > \alpha_1 > 0$, $1 > \beta_1 > 0$, $1 > \beta_2 > 0$, $\gamma_1 > 0$, $\frac{1}{2} > \gamma_2 > 0$.

For the second test methodology, the Lintner model is estimated as a system of nonlinear (in the parameters) equations where the parameters k^*, c, ω, and R are restricted to be identical across the three eqs. (8a) through (8c). The parameters are estimated both by nonlinear OLS and nonlinear SUR. Here the focus is on parameter values obtained for the long-run payout ratio k^*, the speed of adjustment parameter c, the earnings persistence parameter ω, and the firm's cost of capital $R - 1$. Does the Lintner model yield statistically significant values for these parameters? Furthermore, are the estimated values of the firm's cost of capital economically significant?[8]

4. Sample Selection

The sample is selected from the period 1962 to 1996, a maximum of 34 years of annual data. The sample selection criteria are as follows:

1. Data must be available for each firm on at least 25 years of Compustat Primary, Secondary, and Tertiary, Full Coverage, and Research Annual Industrial Files.[9] The data include annual earnings, book values of equity, total liabilities, common equity shares outstanding, the adjustment factor for stock splits and dividends, and the closing price at the end of the third month after the firm's fiscal year-end.[10]

7. Since the system of eqs. (8a) to (8c) (or equivalently eqs. [9a] to [9c]) is triangular, simultaneous equations bias is not an issue.

8. Since medium and long-term U.S. government bonds were yielding a minimum of four percent for the sample period under consideration, building in a risk premium, we would expect a minimal economically significant cost of capital of no less than 9 percent. See Ibbotson Associates (1996).

9. The 25 year requirement limits the generality of this paper because of potential survivorship bias. It is necessitated by the firm-level analysis.

10. Annual earnings are defined as earnings per share before extraordinary items and discontinued operations (annual Compustat item 58), book value is defined as common equity (annual Compustat item 60), price is defined as the closing price at the end of the third month of the first quarter after the firm's fiscal year-end (quarterly Compustat item 14), all items which are listed in per share form are scaled by the adjustment factor (annual Compustat item 27), Total assets are defined as book value of equity (60) plus total liabilities (181). The latter definition was necessary because Compustat contained many missing values for total assets, especially in the early sample years. Since this study investigates whether annual earnings and book values are reflected in stock price valuation and since annual earnings

TABLE 1

Distribution of Sample by Industry

SIC Codes	Industry	Number of Firms with obs ≥ 25
1000–1999	Mining/construction	30
2000–3999	Manufacturing	442
4000–4999	Regulated	157
5000–5999	Wholesale/retail	76
7000–9999	Services	30
1000–9999	Total	735

2. Book values of equity must be greater than zero.
3. Firms in the financial sector are excluded.

The selection process yielded 735 firms with 25 years or more of data per firm, a total of 22,175 firm-years. The distribution of sample firm SIC codes is shown in Table 1.

In the regressions that follow, all variables are scaled by beginning of the year total assets. Unlike cross-sectional regressions, where scaling is done to minimize heteroscedasticity problems and to enhance cross-sectional comparability, scaling is performed in time series analysis in order to help induce stationarity for each firm's time series. A recent study by Qi, Wu, and Xiang (2000) finds in fact that nonstationarity is mitigated in the Ohlson model if the data are normalized.[11]

Table 2 presents Spearman and Pearson mean correlations—correlations are computed separately for each firm and the mean taken over all firms in the sample—among the independent variables that are used in the regression analysis. All correlations are significant at $p = .0001$ based on a cross-sectional t test. Not surprisingly, earnings and end-of-year book values are highly correlated as are earnings and earnings lagged and book values and book values lagged.

5. Empirical Results

5.1 Linear OLS and SUR Regressions

The information dynamic and the valuation equation were estimated by linear OLS and linear SUR for each firm separately. The coefficients were not restricted in any fashion. Tables 3 and 4 list the mean (across all firms) coefficient estimates for the system of eqs. (9a) to (9c) using OLS and SUR, respectively. The numbers

are generally released toward the end of the first quarter, stock prices at the end of the first quarter are used in the analysis.

11. Stationarity is also discussed further below.

TABLE 2

Pearson/Spearman Correlations

	x_t	x_{t-1}	y_t	y_{t-1}
x_t	—	.478	.602	.218
x_{t-1}	.562	—	.380	.246
y_t	.593	.415	—	.400
y_{t-1}	.340	.497	.637	—

x_t = Annual earnings year t (normalized by beginning of the year total assets).

y_t = Book value end of year t (normalized by beginning of the year total assets).

Spearman (Pearson) correlations are below (above) the diagonal. These correlations represent average correlations across all 735 firms in the sample. All correlations are significant at p = .0001 based on a cross-sectional t test computed as the mean coefficient divided by the standard error over all firms.

in parentheses are the associated cross-sectional t statistics computed as the mean coefficient over all firms in the sample divided by the standard error of the coefficient. Both the OLS and SUR regressions yielded qualitatively similar results. All regression coefficients are significant at the 1% level. Except for the book value coefficient in the price equation, all other parameter estimates have the correct signs and satisfy the bounds predicted by the Lintner model. The book value parameter estimate in the price equation has the correct sign but is significantly greater than 0.5, the upper bound value predicted by the Lintner model.[12]

5.2 Nonlinear OLS and SUR Regressions

Unlike the linear methodology, the second test methodology recognizes that the parameters in the dividend and price equations are nonlinearly related. The second test involves estimating the system of eqs. (8a) to (8c) of the Lintner model on a firm-level time-series basis using nonlinear OLS and nonlinear SUR.[13] The parameters are assumed to be identical across the information dynamic and valuation equation. Table 5 gives the mean parameter estimates for both nonlinear OLS and nonlinear SUR. The upper figure in parentheses is the median Wald statistic for the parameter estimate. The Wald statistic in nonlinear regression takes the place of the t test in linear regression and tests the hypothesis that the parameter estimate is statistically insignificant. The lower figure in parentheses gives the proportion of firms in the sample for which the null hypothesis of a zero coefficient

12. Although the book value coefficient appears to be close to 1, this does not confirm Ohlson. In the Ohlson model, price is regressed on abnormal earnings, not earnings.

13. The nonlinear regressions were performed using the SAS model procedure. Various initial estimates were tried for each regression (for each firm) based on a grid for c, k^*, ω, and R. In particular, the initial values of c, k^*, and ω were bounded by 0.1 and 1.0 with increments of 0.1 whereas the initial values of R were bounded by 1.0 and 1.25 with increments of 0.025. Globally, c, k^*, and ω were bounded by 0 below and 1 above, whereas R was bounded by 1 below and 1.25 above.

TABLE 3

Linear OLS Time Series Regression Summary

Dependent Variable	$1/TA_{t-1}$	x_{t-1}	x_t	y_t	y_{t-1}
x_t	0.366	0.555	—	—	—
	(23.8)*	(64.7)*			
d_t	—	—	0.094	—	0.037
			(16.9)*		(33.5)*
P_t	3.009	—	3.958	1.067	—
	(7.1)*		(11.0)*	(14.4)*	

Linear system:
$$x_t = \alpha_0 (1/TA_{t-1}) + \alpha_1 x_{t-1} + \varepsilon_{1t}$$
$$d_t = \beta_1 x_t + \beta_2 y_{t-1} + \varepsilon_{2t}$$
$$P_t = \gamma_0 (1/TA_{t-1}) + \gamma_1 x_t + \gamma_2 y_t + \varepsilon_{3t}$$

x_t = Annual earnings year t (normalized by beginning of the year total assets).
d_t = Dividends year t (normalized by beginning of year t total assets).
P_t = Firm value three months after year-end t (normalized by beginning of year t total assets).
y_t = Book value of equity end of year t (normalized by beginning of the year total assets).
TA_{t-1} = Total assets beginning of year t.
Table entries are mean coefficients over all sample firms. The figures in parentheses are t statistics computed as the mean coefficient divided by the standard error over all firms.
*Significant at the 1% level.

is rejected by the Wald test at the 5 percent significance level. The nonlinear OLS and SUR regressions yield qualitatively similar results with approximate mean parameter estimates of $k^* = .66$, $c = .30$, $\omega = .81$, and $R - 1 = .0425$. Of these parameters, ω and $R - 1$ are statistically significant at the 1% level, c is not statistically significant, and k^* is statistically significant in one regression but not the other. However, although $R - 1$ is statistically significant, it is clearly not economically significant (on average) for the sample period.

5.3 Summary

Overall, the empirical results tend to confirm some aspects of the Lintner valuation model but not others. The linear regressions (OLS and SUR) yield mean parameter coefficients that are statistically significant as predicted, of the correct sign, and with one exception, consistent with the underlying bounds on these parameters as predicted by the model. The mean book value coefficient estimate in the price equation while positive and significant, as predicted by the model, exceeds the theoretical upper bound of 0.5. Although the nonlinear regressions (OLS and SUR) yield significant mean coefficients for most of the parameters, the mean dividend equation parameter c was not statistically significant. Interestingly, this is precisely the coefficient that determines the upper bound for the book value co-

TABLE 4

Linear SUR Time Series Regression Summary

Dependent Variable	$1/TA_{t-1}$	x_{t-1}	x_t	y_t	y_{t-1}
x_t	0.374	0.556	—	—	—
	(23.9)*	(63.9)*			
d_t	—	—	0.103	—	0.036
			(178.0)*		(32.7)*
P_t	2.970	—	5.659	0.877	—
	(7.0)*		(14.6)*	(12.7)*	

Linear system:
$$x_t = \alpha_0 (1/TA_{t-1}) + \alpha_1 x_{t-1} + \varepsilon_{1t}$$
$$d_t = \beta_1 x_t + \beta_2 y_{t-1} + \varepsilon_{2t}$$
$$P_t = \gamma_0 (1/TA_{t-1}) + \gamma_1 x_t + \gamma_2 y_t + \varepsilon_{3t}$$

x_t = Annual earnings year t (normalized by beginning of the year total assets).
d_t = Dividends year t (normalized by beginning of year t total assets).
P_t = Firm value three months after year-end t (normalized by beginning of year t total assets).
y_t = Book value of equity end of year t (normalized by beginning of the year total assets).
TA_{t-1} = Total assets beginning of year t.
Table entries are mean coefficients over all sample firms. The figures in parentheses are t statistics computed as the mean coefficient divided by the standard error over all firms.
*Significant at the 1% level.

efficient in the price equation. Equally problematic, although the endogenously determined cost of capital estimates are statistically significant on average, they are not economically significant.[14]

5.4 Stationarity

The time series regressions models in this paper rely implicitly on stationarity for their validity. If the process generating any one of the variables is nonstationary, then the nonlinear regression model results may be spurious.[15] Since economic and accounting data generally tend to exhibit nonstationary behavior, such as upward trending over time, nonstationarity can be a serious problem.[16] Therefore, each of the 735 firms in the sample was tested for stationarity using the Phillips-Perron (1988) unit root tests.[17]

14. This is somewhat of an improvement on the Ohlson model where the cost of capital estimates were found to be both statistically and economically insignificant on average (See Morel [1998]).

15. In particular, the variance-covariance matrix (divided by the sample size) does not tend to a positive definite matrix as the sample size increases.

16. Normalizing of the data by total assets is an attempt to mitigate this potential problem. Differencing the data, although preferable from a statistical point of view, is inconsistent with the levels spirit of the Ohlson model.

17. The Phillips-Perron test makes fairly mild assumptions about the error structure. Unlike the

TABLE 5

Parameter Values from the Restricted Nonlinear Regressions Lintner Model

Estimation Method	N	V_t	η_t	κ^*	c	ω	R − 1
Nonlinear OLS	722	0.188	4.906	0.616	0.315	0.829	0.040
		(0.5)	(10.7)*	(46.8)*	(2.9)	(780.0)*	(127.0)*
		(.13)	(.66)	(.70)	(.40)	(.94)	(.88)
Nonlinear SUR	619	0.222	5.115	0.701	0.280	0.788	0.045
		(0.8)	(14.4)*	(1.6)	(4.9)	(394.0)*	(29.6)*
		(.20)	(.70)	(.39)	(.49)	(.90)	(.73)

Nonlinear system:

$$x_t = v_t(1/\mathrm{TA}_{t-1}) + \omega x_{t-1} + \varepsilon_{t1}$$

$$d_t = c\,k^*\,x_t + (1 - c)\,(R - 1)\,y_{t-1} + \varepsilon_{t2} \quad 0 \le c,\ k^* \le 1$$

$$P_t = \eta_t\,(1/\mathrm{TA}_{t-1}) + \frac{\omega(1 - c + k^*c)}{(R - \omega)\,(2 - c)}\,x_t + \frac{1 - c}{2 - c}\,y_t + \varepsilon_{t3}$$

x_t = Annual earnings year t (normalized by beginning of year t total assets).
y_t = Book value end of year t (normalized by beginning of the year total assets).
d_t = Annual dividends year t (normalized by beginning of year t total assets).
TA_{t-1} = Total assets beginning of year t.
v_t, η_t = Intercept terms.
ω = Earnings growth (persistence) rate.
R = One plus the firm's cost of capital.
P_t = Firm value three months after year-end t (normalized by beginning of year t total assets).
c = dividend speed of adjustment.
N = number of observations.
k^* = target dividend payout ratio.

Table entries are mean coefficients over all sample firms. The top bracketed number is the median of the Wald statistic (the square of the pseudo t statistic) over all sample firms. The Wald statistic in these tables tests if the parameter is statistically different from zero (or 1 for R). It is distributed asymptotically chi-square with one degree of freedom. The bottom bracketed figure is the proportion of firms for which the null hypothesis could be rejected at the 5% significance level based on a Wald test.

*Significant at the 1% level.

A firm was deemed to be stationary if nonstationarity could be rejected for *each one* of its time series (normalized price, earnings and book values) at the 10 percent significance level.[18] This requirement yielded a subsample of 129 firms. All regressions and sample statistics were rerun for this smaller subsample of stationary firms.[19] The results are qualitatively similar to those of the larger sample suggesting that nonstationarity is not driving the results.

Dickey-Fuller (1979, 1981) tests, the Phillips-Perron does not assume that the errors are statistically independent and of constant variance.

18. We also tried the 5 percent significance level. Nonstationarity was rejected for 66 firms. The regression results for this subsample also yielded comparable results.

19. The results are available from the author.

6. Summary

This paper develops a Lintnerian linear accounting valuation model. The empirical content of the model is tested in two ways. First, estimating the information dynamic and the valuation equation by linear OLS and SUR—thus abstracting from the nonlinear relationships among the parameters—the model is evaluated by reference to the parameter signs and values. Second, the model is estimated as a system of restricted nonlinear equations where it is assumed that the parameters are equal across equations. The resulting estimates of each firm's parameters are evaluated for statistical significance, as well as economic significance in the case of the cost of capital.

Results of the first test are consistent with the Lintner model with the one exception of the book value coefficient. The results of the second test are more problematic. Most bothersome is the finding that cost of capital estimates are not economically significant for the time period under consideration, although they are statistically significant.

Overall, these results suggest that the Lintnerian linear accounting valuation model, like the Ohlson (1995) model and its variants, need to be improved on if they are to have strong empirical content. The call for further research is evident.

Appendix

Valuation in a Lintner Model of Dividends

As pointed out in the text, the assumptions of the Lintner model can be described in a manner similar to that of the Ohlson model. Formally,

$$P_t = \sum R^{-\tau} E_t(d_{t+\tau}) \quad \text{(PVED)}, \tag{A.1}$$

$$x_{t+1} = \omega x_t + v_t + \varepsilon_{t+1} \quad \text{(Linear dynamic)}, \tag{A.2}$$

$$v_{t+1} = \gamma v_t + \varepsilon_{2t+1} \tag{A.3}$$

$$d_t = ck^* x_t + (1 - c)(R - 1)y_{t-1} \quad 0 \leq c, k^* \leq 1 \quad \text{(Payout policy)}. \tag{A.4}$$

To solve for P_t, we first simplify the structure of the linear dynamic by assuming that $v_t = v$, a constant (intercept), thereby eliminating eq. (A.3).[20] Define $a = ck^*$ and $b = (1 - c)(R - 1)$. Substituting eq. (A4) into the clean surplus relation gives

$$\begin{aligned} y_t &= y_{t-1} + x_t - d_t \\ &= y_{t-1} + x_t - (ax_t + by_{t-1}) \\ &= (1 - a)x_t + (1 - b)y_{t-1}. \end{aligned} \tag{A.5}$$

Substituting eqs. (A.2) and (A.5) into eq. (A.4) recursively yields

20. To simplify the appendix, we assume $v_t = 0$. However, we include a constant term in the valuation equation, both in the text and in the empirical work. This constant is a consequence of assuming that v_t is not zero.

$$
\begin{aligned}
E_t(d_{t+1}) &= ax_{t+1} + by_t \\
&= a\omega x_t + by_t, \\
E_t(d_{t+2}) &= ax_{t+2} + by_{t+1} \\
&= a\omega^2 x_t + b(1-a)\omega x_t + b(1-b)y_t, \\
E_t(d_{t+3}) &= ax_{t+3} + by_{t+2} \\
&= a\omega^3 x_t + b(1-a)\omega^2 x_t + b(1-a)(1-b)\omega x_t + b(1-b)^2 y_t, \\
E_t(d_{t+4}) &= ax_{t+4} + by_{t+3} \\
&= a\omega^4 x_t + b(1-a)\omega^3 x_t + b(1-a)(1-b)\omega^2 x_t + b(1-a)(1-b)^2\omega x_t + \\
&\quad b(1-b)^3 y_t.
\end{aligned}
$$

In general,

$$
\begin{aligned}
E_t(d_{t+k}) &= a\omega^k x_t + b(1-a)x_t \sum_{m=0}^{k-2} (1-b)^m \omega^{k-m-1} + b(1-b)^{k-1} y_t \\
&= a\omega^k x_t + [b(1-a)/\omega]x_t \sum_{m=0}^{k} (1-b)^m \omega^{k-m} - b(1-a) \\
&\quad [(1-b)^{k-1} + (1-b)^k/\omega)]x_t + b(1-b)^{k-1} y_t.
\end{aligned} \tag{A.6}
$$

Therefore,

$$
\begin{aligned}
R^{-k} E_t(d_{t+k}) &= a(\omega/R)^k x_t + [b(1-a)/\omega]x_t \sum_{m=0}^{k} \{(1-b)/R\}^m (\omega/R)^{k-m} \\
&\quad -b(1-a)[1/(1-b)+1/\omega]\,[(1-b)/R]^k x_t + [b/(1-b)] \\
&\quad [(1-b)/R]^k y_t.
\end{aligned} \tag{A.7}
$$

Thus,

$$
\begin{aligned}
P_t &= \sum_{k=1}^{\infty} R^{-k} E_t(d_{t+k}) \\
&= [a\omega/(R-\omega)]x_t + [b(1-a)/\omega]\, x_t \sum_{k=1}^{\infty} \sum_{m=0}^{k} [(1-b)/R]^m (\omega/R)^{k-m} \\
&\quad -b(1-a)[1/(1-b)+1/\omega]\,[(1-b)/(R-1+b)]\, x_t + [b/(R-1+b)]y_t \\
&= [a\omega/(R-\omega)]\, x_t + [b(1-a)/\omega]x_t \sum_{k=1}^{\infty} (\omega/R)^k \sum_{m=0}^{k} [(1-b)/\omega]^m \\
&\quad -b(1-a)[1/(1-b)+1/\omega]\,[(1-b)/(R-1+b)]x_t + [b/(R-1+b)]y_t \\
&= [a\omega/(R-\omega)]x_t + [b(1-a)/\omega]x_t\,\{[\omega^2/(\omega-1+b)(R-\omega)] - \\
&\quad [(1-b)^2/(\omega-1+b)(R-1+b)]\} \\
&\quad -b(1-a)[1/(1-b)+1/\omega]\,[(1-b)/(R-1+b)]x_t + [b/(R-1+b)]y_t \\
&= \{[a(R-1)+b]/[(R-\omega)(R-1+b)]\}\omega x_t + [b/(R-1+b)]y_t.
\end{aligned} \tag{A.8}
$$

Substituting back for a and b (and adding an intercept term) yields

$$
P_t = \kappa_t + \frac{\omega(1-c+k^*c)}{(R-\omega)(2-c)}\, x_t + \frac{1-c}{2-c}\, y_t, \tag{A.9}
$$

provided $\omega < R$.

Using the clean surplus relationship, it can be shown in a straightforward fashion that

the Lintner valuation model satisfies the transversality condition: $\lim_{k \to \infty} R^{-k} y_{t+k} = 0$, provided $\omega < R$.

REFERENCES

Ahmed, A. S., R. M. Morton, and T. F. Schaefer. 2000. "Accounting Conservatism and the Valuation of Accounting Numbers: Evidence on the Feltham-Ohlson (1996) Model." *Journal of Accounting, Auditing & Finance*, this issue.

Bar-Yosef, S., J. L. Callen, and J. Livnat. 1996. "Modeling Dividends, Earnings and Book Value of Equity: An Empirical Investigation of the Ohlson Valuation Dynamics." *Review of Accounting Studies* 1:207–224.

Benzartzi, S., R. Michaely, and R. Thaler. 1997. "Do Changes in Dividends Signal the Future or the Past." *Journal of Finance* 52 (July): 1007–1034.

Burgstahler, D. C., and I. D. Dichev. 1997. "Earnings, Adaptations and Equity Value."*Accounting Review* 72 (April): 187–215.

Callen, J. L., and M. Morel. 2000. "Linear Valuation When Abnormal Earnings Are AR(2)." The Hebrew University, mimeo.

Collins, D., W. E. Maydew, and I. Weiss. 1997. "Changes in the Value-Relevance of Earnings and Book Values Over the Past Forty Years." *Journal of Accounting and Economics* 24 (December): 39–67.

Dechow, P. M., A. P. Hutton, and R. G. Sloan. 1999. "An Empirical Assessment of the Residual Income Valuation Model." *Journal of Accounting and Economics* 26 (January): 1–34.

Dickey, D. A., and W. A. Fuller. 1979. "Distribution of the Estimators for Autoregressive Time Series with a Unit Root." *Journal of the American Statistical Association* 74 (June): 427–431.

Dickey, D. A., and W. A. Fuller. 1981. "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root." *Econometrica* 49 (July): 1057–1072.

Fama, E. F., and K. R. French. 1997. "Industry Costs of Equity." *Journal of Financial Economics* 43 (February): 153–193.

Feltham, G. A., and J. M. Ohlson. 1995. "Valuation and Clean Surplus Accounting for Operating and Financial Activities." *Contemporary Accounting Research* 11 (Spring): 689–732.

Feltham, G. A., and J. M. Ohlson. 1996. "Uncertainty Resolution and the Theory of Depreciation Measurement." *Journal of Accounting Research* 34 (Autumn): 209–234.

Gordon, M. J. 1962. *The Investment, Financing and Valuation of the Corporation*. Homewood, Ill.: Richard D. Irwin.

Ibbotson Associates. 1996. *Stocks Bonds Bills and Inflation 1996 Yearbook*. Chicago, Author.

Lintner, J. 1956. "Distribution of Incomes of Corporations among Dividends, Retained Earnings, and Taxes." *American Economic Review* 46 (May): 97–113.

Miller, M. H., and F. Modigliani. 1961. "Dividend Policy, Growth, and the Valuation of Shares." *Journal of Business* 34 (October): 411–433.

Morel, M. 1998. "Endogenous Parameter Estimation: Ohlson Versus Nested Cash Flow Models." Rutgers University, mimeo.

Morel, M. 1999a. "Endogenous Parameter Time Series Estimation of the Ohlson Model: Linear and Nonlinear Analyses." The Hebrew University, mimeo.

Morel, M. 1999b. "Multi-lagged Specification of the Ohlson Model." *Journal of Accounting, Auditing & Finance* 14 (Spring): 147–162.

Myers, J. N. 1999. Implementing Residual Income Valuation with Linear Information Dynamics." *Accounting Review* 74 (January): 1–28.

Ohlson, J. A. 1995. "Earnings, Book Values, and Dividends in Security Valuation." *Contemporary Accounting Research* 11 (Spring): 661–687.

Phillips, P., and P. Perron. 1988. "Testing for a Unit Root in Time Series Regression." *Biometrica* 75: 335–346.

Qi, D. D., W. Wu, and B. Xiang. 2000. "Stationarity and Cointegration Tests of the Ohlson Model." *Journal of Accounting, Auditing & Finance* 15 (Spring): 141–160.

Ramakrishnan, R. T. S., and J. K. Thomas. 1992. "What Matters from the Past: Market Value, Book Value, or Earnings? Earnings Valuation and Sufficient Statistics for Prior Information." *Journal of Accounting, Auditing & Finance* 7 (Fall): 423–464.