How does Ohlson's information dynamics match up with observed stock prices?

Ohlson[1] shows that with clean surplus accounting,

$$P_t \quad = \quad b_t + R^{-1}.x^a_{t+1} + R^{-2}.x^a_{t+2} + R^{-3}.x^a_{t+3} \;\; R^{-4}.x^a_{t+4} \; ..... \qquad (1)$$

where

P_t = the value of the company at time t, and
b_t = the book value of assets at t
x^a_t = residual income
= $x_t - (R_f \,.\, b_{t-1})$
x_t = earnings at t
R = $1 + R_f$
R_f = the return on the riskless (or zero beta) asset

Ohlson's contribution is made up of two parts: first, to show that the above equation can be derived from the dividend valuation model; and secondly, to specify how the residual income component of companies might behave (called the "information dynamics").

An important issue is therefore whether the Ohlson information dynamics represents some approximation as to how companies are actually valued on the stock market. This is investigated in the following paper, and is the subject of these notes.

Dechow, Hutton and Sloan (1999), "An empirical assessment of the residual income valuation model", Journal of Accounting & Economics, 26/1-3 January,1-34.

Essentially, what the DHS paper does is to suggest some values for the coefficients of the Ohlson information dynamics and to see how closely the predictions correspond to share prices.

1. Definitions

The information dynamics are

$$x^a_{t+1} \quad = \quad \omega\, x^a_t \; + \; v_t \; + \; e_{1,t+1} \qquad (2)$$

$$v_{t+1} \quad = \quad \gamma\, v_t \; + \; e_{2,t+1} \qquad (2a)$$

where

ω and γ fixed parameters, which are non negative and less than unity.

v_t = the information about future abnormal earnings which is not contained in current abnormal earnings, called "other information" for short.

[1]Ohlson, "A synthesis of security valuation theory and the role of dividends, cash flows and earnings", *Contemporary Accounting Research*, 1990, 648-676

$e_{1,t+1}$ = a zero mean disturbance

$e_{2,t+1}$ = a zero mean disturbance

When this model of information dynamics is combined with equation 1, the price of the share is given by:

$$P_t = b_t + \alpha_1 x^a_t + \alpha_2 v_t \quad (3)$$

where

$$\alpha_1 = \omega / (1 + R_f - \omega) \quad (4)$$

$$\alpha_2 = (1 + R_f) / [\, (1 + R_f - \omega)(1 + R_f - \gamma) \,] \quad (5)$$

In this model, there are three components of valuation: book value; residual income and other information.

Taking expectations of equation 2

$$E_t [x^a_{t+1}] = \omega x^a_t + v_t$$

Therefore, other information can be defined as

$$v_t = E_t [x^a_{t+1}] - \omega x^a_t \quad (7)$$

and $E_t [x^a_{t+1}]$ can be estimated from analysts forecasts, since

$$E_t [x^a_{t+1}] = E_t [x_{t+1}] - (R_f \,.\, b_t)$$

2. The different specifications of the information dynamics

DHS make a number of different assumptions about ω and γ to see how they predict share prices. ω is the persistence parameter on residual income and γ is the persistence parameter on "other information". We insert these assumptions in to equations 3, 4 & 5 to obtain each valuation model. A few of the models they test are illustrated below.

I - Specifying values a priori

Some of the a priori models which DHS suggest are:

Assume that ω = 0 and ignore other information

This is a highly simplified version of the model and leads to $P_t = b_t$

Assume that ω = 1 and ignore other information

This leads to $P_t = b_{t\,-}\, b_{t-1} + (x_t / r)$ and is similar to the perpetuity model of Miller Modigliani, but with the prior change in book value as the estimate of the present value of future investment opportunities.

Assume that $\omega = 0$ and $\gamma = 0$

Inserting these values in equations 3,4,5 and 7, this leads to $P_t = b_t + v_t / (1+R_f) = b_t + E_t [x^a_{t+1}] / (1+R_f)$.

We can see why the model is like this from equations 2 and 2a. Recall that we are at date t, and are trying to forecast residual income for t+1, t+2, t+3 etc. From equation 2a we can see that if $\gamma = 0$, then this means that other information v_t is random with zero mean.

From equation 2 we can see that if $\omega = 0$, then v_t will be the only determinant of residual income at t+1, x^a_{t+1}. Therefore there is only one value of v_t which needs to be discounted.

Assume that $\omega = 1$ and $\gamma = 0$

This leads to $P_t = b_t + E_t [x^a_{t+1}] / R_f = b_t + E_t [x_{t+1}] / R_f - [R_f. b_t / R_f] = E_t [x_{t+1}] / R_f$

This is in fact *identical* to the first part of MM's model. The term X_0 in MM and the term x_{t+1} is next year's earnings. Of course MM also have another term, which is the value from the excess profits from future investments.

Assume that $\omega = 0$ and $\gamma = 1$

This leads to the same result as $\omega = 1$, $\gamma = 0$ above.

II - EMPIRICAL ESTIMATES OF THE PARAMETERS

Another approach to estimating the coefficients is to look at their historical values up to the date of the valuation. This is done in a number of ways.

ω^u is the term used when ω is the estimated first order autoregression coefficient as in the equation $x^a_{t+1} = \mu + \omega x^a_t + e_{1,t+1}$. For all companies over the whole sample period , the value of ω^u is 0.62.

ω^c is the term used when ω is estimated by the use of other explanatory variables (such as dividend yield and the size of accruals) as well as x^a_t

γ^ω is the first order autoregression coefficient for the variable v_t, when v_t is estimated from analysts forecasts as in equation 7 above [2]. For all companies over the whole sample period the value of γ^ω is 0.32 (using the value of ω^u); that is other information mean reverts at about twice the speed of abnormal earnings.

[2] Note that v_t also requires a value of ω, which is why γ is superscripted with ω

3. The results

The main results are given in DHS Table 5, which show the properties of the forecast error, defined as the observed stock price minus the predicted price, scaled by stock price at the end of the year.

A key result is that the mean forecast error in all of the models is positive. This indicates that all the models seriously underestimate the price. The range is from 22.7% to 37.8% of share price. A possible reason is that the discount rate of 12% is too high. However, another reason is suggested by another key result, discussed next.

The model with the smallest forecast error is when $\omega = 1$ and $\gamma = 0$. As explained above, this is a special case of the MM model in which the values from future investments are assumed to be zero; no wonder that the model underestimates the price. It also suggests that the full MM model would not underestimate price so badly!

Table 5
Relative forecasting ability of alternative modles for explaining contemporaneous stock prices

Panel A: Price estimates for models ignoring 'other information', computed as

$$P_t = b_t + \frac{\omega}{1 + r - \omega} x_t^a$$

	Mean forecast error	Mean absolute forecast error	Mean square forecast error
$\omega = 0$	0.291	0.461	0.284
$\omega = 1$	0.378	0.519	0.363
$\omega = \omega^u$	0.320	0.461	0.284
$\omega = \omega^c$	0.326	0.465	0.291

Panel B: Price estimates for models incorporating 'other information', computed as

$$P_t = b_t + \frac{\omega}{1 + r - \omega} x_t^a + \frac{1 + r}{(1 + r - \omega)(1 + r - \gamma)} v_t$$

	Mean forecast error	Mean absolute forecast error	Mean square forecast error
$(\omega = 0, \gamma = 0)$	0.285	0.445	0.266
$(\omega = 1, \gamma = 0)$ and $(\omega = 0, \gamma = 1)$	0.227	0.402	0.232
$(\omega = \omega^u, \gamma = 0)$ and $(\omega = 0, \gamma = \gamma^{\omega})$	0.278	0.427	0.248
$(\omega = \omega^u, \gamma = \gamma^{\omega})$	0.259	0.419	0.241

Notes: Sample consists of 50,133 observations from 1976 to 1995. Forecast errors are scaled by stock price at the end of year t

The forecast error for year t is computed by subtracting the forecast stock price for year t from the observed market stock price at the end of the month following the announcement of earnings for year t.

Abnormal earnings for year t is defined as

$$x_t^a = x_t - r.b_t$$

where x_t denotes earnings before extraordinary items and discontinued operations for year t, r denotes the discount rate (assumed to be 12%), and b_t denotes book value of equity at the end of year t;

ω^u is the first order autoregression coefficient for abnormal earnings and is estimated using all historically available data from 1950 through the forecast year in a pooled time-series cross-sectional regression;

ω^c is the predicted value of ω from the regression model specified in Table 2 and estimated using all historically available data from 1950 through the forecast year;

γ^{ω} is the first order autoregression coefficient for the other information variable, v_t, and is estimated using all historically available data from 1950 through the forecast year in a pooled time-series cross-sectional regression.

v_t is defined as

$$v_t = f_t^a - \omega^u x_t^a$$

where the period t consensus analyst forecast of abnormal earnings for the next period is defined as

$$f_t^a = f_t - r.b_t$$

f_t denotes the I/B/E/S consensus forecast of earnings for year $t + 1$ measured in the first month following the announcement of earnings for year t.