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ABSTRACT In this paper, I explore a modified Ohlson (1995) model, which incorporates future positive net present value (NPV) investments. I first utilize an approach to simultaneously estimate the parameters in the linear information dynamic alongside the cost of equity capital, then evaluate the model's performance in equity valuation and return prediction. Contrary to the systematic undervaluation of the Ohlson (1995) model reported in prior literature, I find that there is no systematic undervaluation of stock prices by using the modified Ohlson (1995) model. The out-of-sample median valuation bias estimated with this new approach is only 3.3% compared with 34.8% achieved when carrying out the estimation using existing methods. I also find that using a time-varying cost of equity capital reduces valuation bias and improves valuation accuracy. Furthermore, the expected return estimates developed from the model generate a monotonic decile ranking of future realized stock returns.

Keywords: The Residual Income Valuation; Linear Information Dynamic; Valuation Accuracy; Return Prediction

1. Introduction

The residual income valuation (RIV) model is one of the major earnings-based equity valuation models. To implement the model, in the seminal paper 'Earnings, Book Values, and Dividends in Security Valuation,' Ohlson (1995) proposes a parsimonious linear information dynamic (LID) and establishes a link between stock values and accounting fundamentals. The LID model with its neat closed-form solution has made a significant impact on both theoretical and empirical work in equity valuation. However, the LID model is developed in an unbiased accounting framework and it is argued to be inconsistent with firms having nonzero net present value (NPV) investment projects. Existing empirical evidence seems to lend only limited support for the model. It leads to an obvious question: how can the deficiency of the model be overcome, and in particular, how can the LID model be extended and implemented in equity valuation?

In this paper, I explore a modified Ohlson (1995) LID model, which can in theory incorporate conservative accounting and future nonzero NPV investments. I propose a new approach to estimate simultaneously the modified LID parameters alongside the cost of equity capital. I find that the out-of-sample median valuation bias is substantially reduced compared with those in the

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existing literature applying the Ohlson (1995) model. The valuation inaccuracy can be improved when a time-varying cost of equity capital is utilized. I also find that the expected return estimates based on the model generate a monotonic decile ranking of future realized stock returns.

The modified LID as proposed in Ohlson (2003) involves the same two variables as in Ohlson (1995): residual income (or abnormal earnings) and 'other information' (henceforth OI) that can be useful to forecast future residual incomes. However, it permits firms' economic profits to persist in the long run with positive NPV investments by allowing the persistence of OI to be greater than or equal to one. In contrast to prior literature that applies a sequential procedure to estimating the two persistence parameters in the LID, I simultaneously estimate the LID parameters. These estimates are internally consistent as they are grounded in a no-arbitrage condition.[1] Estimating on both a year-by-year basis and an industry-year basis, I find that on average the persistence of OI is indeed between one and one plus the cost of equity capital, while the persistence of residual income remains between zero and one. This suggests that the parameter restrictions in the modified LID are justified and competition may not necessarily drive out firms' economic profits even in the long run. 'Asset light' companies in this digital era might be such an example. Firms with strong brands and other human capital may generate economic profits for a prolonged period. After estimating the industry LID parameters including the cost of capital and growth rate, I then evaluate the modified model's out-of-sample performance in equity valuation. In contrast to the systematic undervaluation of the Ohlson (1995) model reported in prior literature, I find that the systematic undervaluation using the modified model disappears. Defining valuation bias as the mean difference between the observed stock price and model predicted value scaled by price, the median bias estimated with this new approach is only 3.3% compared with 34.8% achieved when carrying out the estimation using existing methods. Contrary to Dechow et al. (1999), my results suggest that stock prices are not systematically overstated relative to their intrinsic values, and investors do not place too high a weight on the one-year ahead forecasts of earnings relative to the theoretical coefficients attached to forward earnings.

The new approach allows the implied discount rate to change over time and to be industry-specific. The results show that using the implied time-varying industry-specific cost of equity capital further improves valuation accuracy. This is in contrast to Beaver (1999, p. 37) who suggests that '(it) is remarkable that the assumption of constant discount rates across firms and time is the best we can do.' I also apply the model to estimate a proxy of firm-specific expected returns. When regressing realized returns on the proxy of the expected returns, I find that the coefficient of the proxy is positive and statistically different from zero. In addition, not only are realized stock returns sensitive to both cash flow news and discount rate news with the predicted signs, but the coefficients are also closer to their theoretical values than those reported in prior studies. Furthermore, the expected return estimates generate a monotonic decile ranking of future realized stock returns.

This paper makes three main contributions. Firstly, it extends the Ohlson (1995) model to a parsimonious model that incorporates positive NPV investments and is supported by empirical evidence in equity valuation. Secondly, it offers a new approach to estimate simultaneously the parameters in the linear information dynamic, in sharp contrast to the sequential procedure applied in the existing literature. Thirdly, it provides an addition to the set of tools for estimation of the implied cost of equity capital (ICC). The new approach starts from a linear information dynamic and the mapping between accounting information dynamic and stock prices. To my knowledge, it is the first paper to adopt this approach to estimate the implied cost of equity capital. I extend it to develop a proxy for the firm-specific expected returns.

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[1]This is in contrast with many valuation studies, which assume a short-term growth, long-term growth and discount rate (Frankel & Lee, 1998; Dechow et al., 1999). Myers (1999, p. 6) argues that they fail to preserve internal consistency.

The rest of the paper is organized as follows. Section 2 presents the motivation and relation to prior literature. Section 3 introduces the modified Ohlson (1995) model and the estimation procedure of the modified LID parameters. Section 4 describes the data. Section 5 estimates the LID parameters and evaluates the out-of-sample valuation bias and valuation inaccuracy. It also assesses the validity of the proxy for the expected stock returns. Section 6 presents and discusses the robustness tests for potential sample selection bias, different industry classification and survivorship bias. Finally, section 7 concludes.

2. Motivation and Relation to Prior Literature

The Ohlson (1995) LID is parsimonious in that it does not require any other accounting information beyond current residual income to forecast future residual incomes in implementing the RIV model.[2] The resulting closed-form valuation is consistent with the Miller and Modigliani (MM, 1961) dividend policy irrelevancy, a practical and intuitive property.[3] The LID, however, is developed in an unbiased accounting framework. Holthausen and Watts (2001) argue that the Ohlson (1995) model is of limited usefulness because it is inconsistent with firms having positive NPV projects.

Feltham and Ohlson (FO, 1995, 1996) subsequently extend the Ohlson (1995) model by incorporating conservative accounting and future nonzero NPV investments. Unlike the Ohlson (1995) model, FO (1995, 1996) make additional assumptions on the dynamics of the book value of assets in the development of valuation models. Specifically, the FO models assume that expectations about future residual incomes can be written in terms of current residual incomes and book value of assets with a positive coefficient attached to the latter. Callen and Segal (2005) argue that the vital variable in the FO (1995) model is the expected growth rate in the book value of assets. This expected growth rate essentially distinguishes the FO (1995) model from the Ohlson (1995) model because it establishes a relationship between conservative accounting and equity values. However, empirical investigations of the information dynamics in FO (1995, 1996) provide contradictory evidence. Almost all empirical studies find a negative coefficient attached to book values in their formulation of the linear information dynamics (Ahmed et al., 2000; Choi et al., 2006; Dechow et al., 1999; Myers, 1999). In addition, these studies show that the FO (1995, 1996) models still undervalue equity shares even after including a book value term to adjust for accounting conservatism in a restructuring of the Ohlson (1995) LID. While confirming the importance of incorporating conservatism into valuation, Myers (1999) and Callen and Segal (2005) point out that equity price predictions of the FO (1995, 1996) models are no more accurate than those of the Ohlson (1995) model.

Nevertheless, both conservative accounting and nonzero NPV projects can be accommodated by amending the Ohlson (1995) LID parameter constraints. Specifically, the LID can be modified to allow for the persistence of OI to be between zero and one plus the cost of equity capital thus capturing a company's future growth.[4] Indeed, both Ohlson (2003) and Pope and Wang (2003)

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[2] Another popular approach in implementing the RIV model is to assume that the firm's return on equity (ROE) tends to its industry median or assuming an arbitrary terminal growth rate in an arbitrary forecast horizon, say 5-year or 12-year. It also needs to specify a dividend payout policy to estimate future book values of equity in recursion. In addition, this literature almost always assumes an exogenous constant discount rate. See for example Frankel and Lee (1998), Lee et al. (1999), Francis et al. (2000).

[3] Ohlson and Gao (2006) argue that without dividend policy irrelevancy the value function becomes very complicated because the policy parameters would have a direct influence on any formula that determines value. It would exclude any practical or intuitive results.

[4] The modified parsimonious LID model contrasts with Zhang (2000) who builds a nonlinear relation between equity value and accounting numbers in a real-option-based framework.

argue that if we assume the persistence of OI is greater than or equal to one, then the Ohlson (1995) model allows for positive NPV projects, even when the persistence of residual income is between zero and one. It permits that firms' economic profits persist in the long run with NPV > 0 investments arising from either competitive advantages or accounting conservatism while the persistence of abnormal earnings disappears over time due to market competition. In contrast to FO (1995, 1996), the modified Ohlson (1995) model does not require any additional assumption on the book value dynamic in developing a closed-form valuation, hence it improves the practicability of implementation of the model. Under the assumptions of this modified model, we can establish a one-to-one mapping between the one-year ahead forecasts of earnings and current stock value. This mapping is important because it links a firm's performance in its product market to the capital market and may avoid potential violation of no-arbitrage condition. Myers (1999, p. 6) argues 'adopting information dynamics that seem reasonable in isolation can generate rather subtle inconsistencies when evaluated within the totality of the model linking information to firm value.' Like the original Ohlson (1995) model, the modified model requires the input of less information than most other existing equity valuation models in its implementation.[5]

Although the Ohlson (1995) model has the virtue of parsimony in its description of the LID, implementing the LID model has proved to be challenging because OI is unidentified. The existing empirical studies are subject to the criticism that they fail to adequately model for the OI variable in either the Ohlson (1995) or the FO (1995, 1996) framework. Dechow et al. (1999) were among the first to provide a comprehensive empirical assessment of the model. They use a sequential procedure to estimate two parameters in the Ohlson (1995) LIDs. First, they estimate the persistence of abnormal earnings on a year-by-year basis as if abnormal earnings follow an autoregressive process, AR(1). Second, they estimate the persistence of OI by using the one-year ahead analysts' forecasts of earnings and the unconditional persistence of abnormal earnings estimated from the first stage. This effectively assumes that the role of OI in valuation is subordinate to that of abnormal earnings. They report that the Ohlson model underestimates equity value on average by more than 25%. Lo and Lys (2000) argue that this sequential procedure is problematic because the correlation between abnormal earnings and OI is important from an empirical standpoint. OI constitutes a correlated omitted variable when we simply omit OI in estimating the persistence of abnormal earnings in the model. Attempts to use some accounting variables as a proxy for OI may be helpful in forecasting future abnormal earnings, but this could still potentially be misleading by omitting important value relevant information. For example, Myers (1999) considers a firm's capital expenditure and order backlog as a proxy for OI. This results in a substantial undervaluation bias with a median of 35.6%. In addition to a possible misidentification of OI, there are other reasons in the existing literature that may lead to systematic underestimates of stock values using the Ohlson (1995) model. For instance, empirical studies on panel data often assume that all sample firms have the same constant cost of capital when implementing the model. The existing literature often assumes a constant cost of capital of 12% as in Dechow et al. (1999). However, if 12% as a discount rate is too high for some firms, then future economic profits for those firms will be too low or even negative for given values of earnings and assets. A high cost of capital not only influences the calculation of the present value of residual incomes, but also on the numerator itself in residual income valuation. The present value of expected future economic profits will be too low if the assumed cost of capital is higher than the true cost of capital. Furthermore, Dechow et al. (1999) also suggest that there is a possibility that stock prices may not reflect rational expectations and are overstated relative to the intrinsic

[5] Both Ohlson and Juettner-Nauroth (2005) and Ohlson and Johannesson (2016) models rely on multi-period forecasts of earnings and assume a dividend policy, and a perpetual growth rate and/or a short-term growth rate in application (Gode & Mohanram, 2003; Gao et al., 2019).

values generated from the Ohlson (1995) model because investors place 'too low a weight on book value and too high a weight on the analysts' forecast of next year's earnings.' Overall, the existing empirical evidence lends little support to the use of the Ohlson (1995) model as a valuation model and empirical evidence suggests that it leads to a systematic undervaluation of equity shares.

In the spirit of Easton et al. (2002) and Ashton and Wang (2013), I utilize a regression approach to simultaneously estimate the LID parameters alongside the cost of equity capital on an industry-year basis in the modified Ohlson (1995) model, rather than to estimate the LID parameters in a sequential procedure and assume a constant cost of capital.[6] It relies on one-year ahead forecasts of earnings, which are expected to be more accurate than the multi-period ahead forecasts. Dividend payout policy is redundant when estimating the implied cost of capital. This is in contrast to existing ICC literature that often requires multiperiod forecasts of earnings or price targets and assumes a dividend payout policy over a finite forecast horizon in addition to assume a long-term growth of variables of interest.[7] In addition to assessing the valuation bias and valuation inaccuracy, I also develop a proxy for the expected stock returns and investigate the validity of the proxy. It establishes how accounting fundamentals governed by conservative principles effectively convey the risk of future expected growth (Penman & Yehuda, 2019; Penman & Zhang, 2020). Prior literature that assesses the validity of firm-specific estimates of expected returns has been motivated on the predictability of future realized returns. Given that there is often an insignificant or negative relation between the proxy and future realized stock returns after controlling for cash flow news and discount rate news, I evaluate the expected return proxy on the predictability of future realized returns in the Easton and Monahan (2005) framework.

3. The Modified Ohlson (1995) Model and Its Estimation Procedure

In this section, I outline the modified Ohlson LID model and its estimation procedure. I first follow Ohlson (1995) in making two standard initial assumptions. (1) Assume that the equity is valued in an arbitrage-free market with $RP_t = E_t[P_{t+1} + d_{t+1}]$, where P_t is the ex-dividend equity value at time *t*, R equals one plus the cost of equity capital, and $E_t[.]$ is the expectations operator based on information available at time *t*. This assumption leads to the well-known dividend discount valuation model. (2) Assume that the clean surplus accounting relation (CSR) holds: $b_t = b_{t-1} + x_t - d_t$, where x_t is earnings and b_t is the book value of equity at time *t*. That is, changes in the book value of equity must go through earnings. I also assume the following restrictions originating in the accounting for owners' equity: $\partial x_t/\partial d_t = 0$ and $\partial b_t/\partial d_t = -1$ indicating dividends do not affect contemporaneous earnings but reduce the book value of equity dollar-for-dollar. The well-known residual income valuation model (RIV) then directly follows from the above two assumptions (Edwards & Bell, 1961; Peasnell, 1982). RIV shows that market value of equity equals to the sum of book value and the present value of all expected future abnormal earnings.

[6]O'Hanlon and Steele (2000) were among the first to use a regression approach to estimate simultaneously the cost of equity capital and the growth rate of abnormal earnings. Wang (2018) also applies a similar approach to directly estimate valuation parameters.

[7]Claus and Thomas (2001) assume that firms retain 50% of earnings each period. Gebhardt et al. (2001) use up to three years of forecasts of earnings and assume that firms have a 100% dividend payout ratio beyond the forecast horizon. Easton et al. (2002) are based on up to four years of earnings forecasts and assume that the expected dividends in the forecast period are equal to current dividends. A more recent comprehensive review of the research using the implied cost of capital (ICC) methodology can be found in Echterling et al. (2015).

Following Ohlson (1995, 2003), I assume the following linear information dynamics (LID):

$$x^a_{t+1} = \omega x^a_t + OI_t + \varepsilon_{x,t+1} \quad (1)$$

$$OI_{t+1} = \gamma OI_t + \varepsilon_{OI,t+1} \quad (2)$$

where $x^a_t = x_t - (R-1)b_{t-1}$ is residual income or abnormal earnings, OI_t is 'other information' that has not yet been captured by current abnormal earnings but is useful in predicting future abnormal earnings. $\varepsilon_{x,t+1}$ and $\varepsilon_{OI,t+1}$ are mean zero random error terms, and $\partial OI_t/\partial d_t = 0$. To explicitly incorporate the firm's future growth opportunities and accounting conservatism, I allow for $0 \leq \omega < 1$ and $0 \leq \gamma < R$. The last inequality ensures convergence of the model. I call the system defined by equations (1) and (2) the modified Ohlson (1995) LID.[8] Note that abnormal earnings do not asymptotically approach to zero if the firm has NPV > 0 investments with $\gamma > 1$, even if $\omega < 1$ or the persistence of abnormal earnings disappears over time.[9] Therefore, accounting is conservative with respect to book value and the value relevance of current abnormal earnings is negligible in the long run. The following propositions follow:

Proposition 1 *Given the residual income valuation model (RIV) and information dynamic* (2), *abnormal earnings dynamic* (1) *holds if, and only if the following valuation equation holds:*

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

where $\alpha_1 = \frac{\omega}{R-\omega}$ *and* $\alpha_2 = \frac{R}{(R-\omega)(R-\gamma)}$.

Ohlson (1995) actually shows the 'only if' part of the proposition regardless of the LID parameter restrictions. Equation (3) intuitively demonstrates that the coefficient of residual income is the declining-perpetuity term $\omega/(R-\omega)$. The coefficient of OI reflects a discounted compounding effect, and can be written as $(1+\omega/(R-\omega))(1+\gamma/(R-\gamma))/R = R/((R-\omega)(R-\gamma))$. Proposition 1 further shows that the reverse is also true. All proofs can be found in the Appendix. Under the assumptions, abnormal earnings dynamic (1) is a necessary condition for valuation model (3). In other words, there is a one-to-one mapping between the one-year ahead forecasts of abnormal earnings and current stock value. This is consistent with Ohlson (1999) and Pope and Wang (2005), who demonstrate that valuation of equity and forecasting of future earnings are interlinked. The model maintains the MM dividend policy irrelevancy, $\partial P_t/\partial d_t = -1$.[10] The OI term represents the value of growth opportunities captured by current stock value. Accordingly, $(\gamma - 1)$ can be interpreted as the growth rate based on current available information.

Proposition 2 *Given the residual income valuation model (RIV), any two of the following three statements imply the third: (i) abnormal earnings dynamic* (1) *holds; (ii) equity value is given by*

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[8]The extension of γ from original (0, 1) to (0, R) allows abnormal earnings and OI to be nonstationary, like the dividend growth assumption in the Gordon growth model. As Lo and Lys (2000) point out, 'it is well known that managers hold dividends stable and tend to increase them over time, and even casual observation suggests that book value and earnings are not stationary for most companies (and tend to drift upwards).'

[9]Abnormal earnings dynamics (1) and (2) imply $E_t[x^a_{t+n}] = \omega^n x^a_t + ((\gamma^n - \omega^n)/(\gamma - \omega))OI_t$. If $0 < \omega < 1$, then $\omega^n \to 0$ $(n \to \infty)$. Abnormal earnings eventually capture value relevant information included in OI > 0 that reflects a firm's new investment opportunities and future prospects. Ohlson (2003) shows that the LID model allows for positive NPV projects when $0 < \omega < 1$ and $\gamma = 1$.

[10]This is in contrast with FO (1995, 1996), who separate operating activities from financial activities and assume that paying dividends is a financial activity, whereas financing activities are zero NPV investments. However, distinguishing between operating and financial assets can be arbitrary and all assets may be operating assets (Callen & Segal, 2005).

equation (3)*; (iii) abnormal earnings satisfy:*

$$E_t[x^a_{t+1}] = \delta_1 x^a_t + \delta_2(P_t - b_t) \tag{4}$$

where $\delta_1 = \frac{\omega\gamma}{R}$ *and* $\delta_2 = \frac{(R-\omega)(R-\gamma)}{R}$.

Note first that statements (i) and (ii) are independent without information dynamic (2). While Proposition 1 builds a mapping between forecasting of future earnings and stock value, Equation (4) establishes explicitly a link between stock value and the one-period ahead forecasts of earnings. Combining (4) with either (1) or (3) implies the other. It shows that the expected one-year ahead abnormal earnings can be written in terms of current abnormal earnings, book equity and stock value. Comparing information dynamic (4) with (1), it is clear that 'other information' OI can be inferred from accounting goodwill (the difference between market value and book value of equity) and current abnormal earnings. In other words, unlike abnormal earnings dynamic (1) and valuation equation (3), information dynamic (4) expresses future (abnormal) earnings in terms of observables if stock price is a good proxy for its intrinsic value. It builds a foundation for the following empirical examination. The intrinsic relations in Propositions 1 and 2 link a firm's financial performance in its product market to the capital market. It is intuitive to assume $\omega < 1$ in (1) in a competitive economic market, though the two persistence parameters in (4), ω and γ, have symmetric roles.

Since $E_t[x^a_{t+1}] = E_t[x_{t+1}] - (R-1)b_t$ and $x^a_t = x_t - (R-1)b_{t-1}$, (4) can be written in terms of earnings as

$$E_t[x_{t+1}] = \frac{(R-\omega)(R-\gamma)}{R}P_t + \frac{\omega\gamma}{R}x_t + (R-1-\frac{(R-\omega)(R-\gamma)}{R})b_t - (R-1)\frac{\omega\gamma}{R}b_{t-1}. \tag{5}$$

It suggests that stock prices can be a leading indicator of future earnings (Beaver et al., 1980, 1987, 1997). If we know market expectation of the firm's one-period ahead earnings ($E_t[x_{t+1}]$) and stock prices, Equation (5) can be used to estimate the LID parameters and the cost of equity capital. Following Ashton and Wang (2013), to reduce nonstationarity and minimize the effects of endogeneity, I divide both sides of information dynamic (5) by price and transform the information dynamic of future earnings into a dynamic of the forward earnings-to-price ratio as below:

$$\begin{aligned}\frac{x_{t+1}}{P_t} &= \frac{(R-\gamma)(R-\omega)}{R} + \frac{\omega\gamma}{R}\frac{x_t}{P_t} + \left[R-1-\frac{(R-\gamma)(R-\omega)}{R}\right]\frac{b_t}{P_t} \\ &\quad - \frac{(R-1)\omega\gamma}{R}\frac{b_{t-1}}{P_t} + \varepsilon_{x,t+1}\end{aligned} \tag{6}$$

It establishes a nonlinear relationship between the forward earnings-to-price and the LID parameters. The importance of this observation is that we can estimate simultaneously the LID parameters, ω, γ and the cost of equity capital *(R-1)* by running a nonlinear regression. This approach contrasts sharply with existing studies that estimate the Ohlson style LID parameters in a sequential procedure, whereby estimates are first made of ω and these are used to estimate γ.

Equation (5), in turn, implies that stock value can be written in terms of earnings, book value, dividends and the expected one-period ahead earnings as below, noting $b_{t-1} = b_t - (x_t - d_t)$,

$$P_t = \frac{-R\omega\gamma}{(R-\omega)(R-\gamma)}x_t + \frac{R(1-\omega)(1-\gamma)}{(R-\omega)(R-\gamma)}b_t + \frac{(R-1)\omega\gamma}{(R-\omega)(R-\gamma)}d_t + \frac{R}{(R-\omega)(R-\gamma)}E_t[x_{t+1}] \tag{7}$$

Therefore, value is a nonlinear function of (ω, γ, R), whose values must be estimated. Since both ω and $\gamma < R$, the coefficient of future earnings is expected to be positive and larger than the other coefficients in (7) reflecting the paramount importance of future earnings in valuation.

Consistent with long-standing financial analysts' practice, I use industry-year value drivers and value multiples as proxies for those of individual firms in the industry. By running a nonlinear regression based on (6), I can estimate simultaneously the LID parameters, the persistence of abnormal earnings (ω), and value drivers: growth rate $(\gamma - 1)$ and the cost of equity capital *(R-1)* for each industry-year portfolio given market expectation of firms' one-year ahead earnings.

It then follows from (7) that equity value can be estimated as

$$P_t = \Psi_{it} \times x_t + \mathrm{B}_{it} \times b_t + \Delta_{it} \times d_t + \Phi_{it} \times E_t[x_{t+1}] \tag{8}$$

where

$$\Psi_{it} = \frac{-R_{it}\omega_{it}\gamma_{it}}{(R_{it} - \omega_{it})(R_{it} - \gamma_{it})}, \; \mathrm{B}_{it} = \frac{R_{it}(1 - \omega_{it})(1 - \gamma_{it})}{(R_{it} - \omega_{it})(R_{it} - \gamma_{it})},$$
$$\Delta_{it} = \frac{(R_{it} - 1)\omega_{it}\gamma_{it}}{(R_{it} - \omega_{it})(R_{it} - \gamma_{it})}, \text{ and } \Phi_{it} = \frac{R_{it}}{(R_{it} - \omega_{it})(R_{it} - \gamma_{it})}, \tag{9}$$

are the theoretical coefficients of earnings, book value, dividends and one-period ahead forecasts of earnings for individual firms in industry i in year t respectively.

It is worth emphasizing that the above simultaneous procedure uses fundamental accounting information as well as stock prices in estimating the cross-sectional LID parameters. The resulting estimates of the theoretical values of the coefficients of book value, earnings, dividends and the one-year ahead forecasts of earnings in (9) contain information included in stock price at time t. Therefore, I compare valuation biases 'out-of-sample' from different estimation procedures. Specifically, to eliminate the effect of time t stock price information in estimating the LID parameters, I use the lagged one-year industry average theoretical values of the coefficients of book value, earnings, dividends and the one-year ahead forecasts of earnings to calculate intrinsic value at time t.[11] These estimates determine valuation multiples $(\Psi, \mathrm{B}, \Delta, \Phi)$ in (9) and the intrinsic value given by (8).

Applying valuation model (8), we can compare the valuation bias and valuation inaccuracy in different approaches to estimating the LID parameters, (ω, γ, R). Following prior studies, valuation bias is defined as the mean difference between the observed stock price and model predicted value, scaled by price. Valuation inaccuracy is defined as the mean absolute value of the difference between the observed stock price and model predicted value, scaled by price.

Furthermore, we can use industry-year specific parameters to represent firm-year specific parameters to develop a proxy for the firm-specific expected stock returns.[12] Specifically,

$$E_t\left[\frac{P_{t+1} + d_{t+1}}{P_t}\right] = \gamma_{it} + \frac{R_{it}}{R_{it} - \omega_{it}}\frac{E_t[x_{t+1}]}{P_t} - (\gamma_{it} - 1)\frac{b_t}{P_t} - \frac{\omega_{it}\gamma_{it}}{R_{it} - \omega_{it}}\frac{x_t}{P_t}$$
$$- \frac{(R_{it} - 1)\omega_{it}}{R_{it} - \omega_{it}}\frac{b_t - \gamma_{it}b_{t-1}}{P_t} \tag{10}$$

[11] This is similar to test almost all asset pricing models. One typically assumes that the factor risk premia and firm risk exposure (the 'betas') estimated from past information carry forward to the future. I also use a jack-knifing procedure to estimate firm-industry-year specific parameters. The valuation bias and inaccuracy at time t are similar to the results reported in the paper.

[12] There is no need to identify risk factors, nor estimate risk premium and risk loadings as applying factor models in estimating the expected return. It is also in contrast with studies in implementing characteristic models, which often uses noisy historical stock returns to estimate the coefficients attached to the fundamental accounting ratios (for example, Lyle et al., 2013; Penman & Zhu, 2014).

It shows that the coefficients of current earnings and forward earnings in return expression (10) are negative and positive respectively under the model assumptions. If $\gamma_{it} \geq 1$, then the coefficient of current book value is also negative. It suggests that the recognition of current earnings implies lower risk, and similarly booked assets have lower risk (Penman, 2016; Penman & Yehuda, 2019). A lower (higher) earnings realization implies higher (lower) expected returns. It is also consistent with Penman and Zhang (2020) who show that, in conservative accounting, the higher expected future earnings are at risk, hence are associated with higher expected returns. Firms expense investment when outcomes are uncertain reducing current earnings and pushing earnings to the future. Accounting fundamentals governed by conservative principles effectively convey the risk of future expected growth. Return expression (10) provides a theoretical representation of these insights. It incorporates risk aversion and conservative accounting, and demonstrates the time-varying property of stock returns reflecting the arrival of new information.

4. Data Description

The sample includes all listed securities in NYSE, Amex and Nasdaq. Data is extracted from the CRSP monthly returns file, the Compustat industrial annual file and forecasts of earnings from the Institutional Brokers Estimate System (I/B/E/S) from 1979 to 2015. The adjusted number of shares outstanding and adjusted price at the end of the fiscal year, and adjusted price of equity three months after the fiscal year-end are collected from CRSP. The cumulated adjustment factors for number of shares and stock prices are collected from CRSP to calculate the adjusted number of shares outstanding and the adjusted prices. Stock prices three months after the fiscal year-end are used to ensure that information about the prior year financials have been incorporated in the analysts' forecasts of earnings. Relevant accounting data are collected from Compustat. Firms with negative book values (CEQ) are deleted. Earnings are measured as net income before extraordinary items (IB). For the purpose of comparison, I use the one-year ahead analysts' forecasts of earnings ($feps_{t+1}$) as a proxy of the market's expectation of the firm's future earnings. The median consensus forecasts of earnings per share at the first month after the corresponding I/B/E/S-reported prior-year earnings announcements are used. All total variables used in the estimation are divided by the adjusted number of shares outstanding to reduce heteroskedasticity and increase comparability across time. In constructing the data set, 1% at the top and bottom stock prices, (price deflated) book value, (price deflated) earnings and dividends and (price deflated) analysts' consensus forecasts of earnings are deleted to avoid the influence of extreme observations.

Panel A of Table 1 presents the descriptive statistics of the sample firms. These are largely consistent with those reported in previous studies. Panel B of Table 1 shows the annual cross-sectional correlations for 98,955 observations over the 35-year period from 1980 to 2014. The upper (lower) right triangle of the matrix presents Spearman (Pearson) correlations. These correlations show that current prices and earnings are the variables with the largest correlation coefficients with forecasts of earnings.

5. Evaluating the Performance of the Modified Ohlson (1995) Model

In this section, I investigate the valuation implications by using the simultaneous approach to estimate the LID parameters in the modified Ohlson (1995) model. I evaluate the out-of-sample valuation bias and valuation inaccuracy as well as the valuation effects by using a time-varying cost of equity capital. I also assess the validity of the proxy for the expected stock returns.

Table 1. Descriptive statistics of sample firms and correlations between variables

Panel A: Sample descriptive statistics

	p	*x*	*b*	*d*	*feps*	*feps/p*	*x/p*	*b/p*	*lb/p*
N	98955	98955	98955	98955	98955	98955	98955	98955	98955
Mean	18.700	0.954	11.590	0.419	1.199	0.067	0.035	0.719	0.701
St.Dev	18.740	2.653	18.570	1.084	1.530	0.069	0.142	0.659	0.707
p1	1.156	− 5.190	0.465	0.000	− 1.630	− 0.192	− 0.556	0.089	0.065
p25	6.988	0.139	3.710	0.000	0.380	0.043	0.018	0.348	0.306
p50	13.500	0.671	7.423	0.054	0.900	0.068	0.053	0.568	0.529
p75	23.880	1.484	13.700	0.465	1.660	0.096	0.084	0.871	0.848
p99	95.050	9.324	74.320	3.996	7.000	0.255	0.365	3.409	3.566

Panel B: Correlations

	p	*x*	*b*	*d*	*feps*	*feps/p*	*x/p*	*b/p*	*lb/p*
p	1	0.610	0.705	0.390	0.734	− 0.100	0.092	− 0.258	− 0.271
x	0.418	1	0.596	0.490	0.810	0.399	0.752	0.046	− 0.049
b	0.516	0.608	1	0.491	0.687	0.179	0.287	0.444	0.394
d	0.337	0.516	0.526	1	0.498	0.252	0.355	0.177	0.188
feps	0.666	0.596	0.469	0.361	1	0.507	0.481	0.023	− 0.031
feps/p	− 0.041	0.257	0.075	0.092	0.450	1	0.664	0.388	0.311
x/p	0.111	0.607	0.227	0.235	0.315	0.485	1	0.291	0.166
b/p	− 0.149	0.183	0.475	0.226	0.009	0.191	0.138	1	0.937
lb/p	− 0.161	0.079	0.404	0.217	− 0.035	0.113	− 0.043	0.916	1

Notes: Panel A shows descriptive statistics for 98955 firm-year observations (N) between 1980 and 2014. Observations outside the 1st and 99th percentiles for price, book value, earnings, dividends and the one-year ahead forecasts of earnings are deleted. The mean, standard deviation (St.Dev), Q1, median, Q3, and 1% and 99% are reported. $feps_t$ is the median consensus one-year ahead forecasts of earnings at the first month after the corresponding I/B/E/S-reported prior-year earnings announcements. Price (p) is stock price 3-months after the fiscal year-end. b, lb, x and d are book value per share, lagged book value per share, earnings per share and dividend per share respectively. Earnings are net income per share before extraordinary items.
Panel B shows the annual cross-sectional correlations for 98955 firm-year observations. The upper (lower) right triangle of the matrix shows Spearman (Pearson) correlations.

5.1. Estimation of the LID Parameters

I use analysts' consensus earnings forecasts as a proxy for the market's expectation of future earnings, and stock prices as a proxy for the intrinsic value to estimate the modified LID parameters. I run the following cross-sectional nonlinear regressions based on (6):

$$\frac{feps_{t+1}}{P_t} = \frac{(R-\gamma)(R-\omega)}{R} + \frac{\omega\gamma}{R}\frac{x_t}{P_t} + \left[R - 1 - \frac{(R-\gamma)(R-\omega)}{R}\right]\frac{b_t}{P_t} - \frac{(R-1)\omega\gamma}{R}\frac{b_{t-1}}{P_t} + \varepsilon_{x,t+1} \quad (11)$$

where $feps_{t+1}$ is the one-year ahead analysts' forecasts of earnings for each year k = 1981, … ,2014.[13] Table 2 reports the average estimated LID parameters $(\omega, \gamma - 1)$ and the implied cost of capital *R-1* (≡ *ICC*) as well as their t-statistics on a year-by-year basis.[14]

[13]For a nonlinear regression, I use $(\omega, \gamma, R-1) = (0.2, 1.0, 0.09)$ as a starting point. These are parameter values similar to those used or reported in prior literature.
[14]Dechow et al. (1999) estimate the LID parameters on a yearly basis, not on an industry-year basis. Note that the sequential approach is unable to estimate parameters in the first year, 1980 in my sample. For the purpose of comparison, I report the results from 1981.

Table 2. Simultaneous estimation of the LID parameters and cost of capital (ICC)

Year	ω	t-stat	$\gamma - 1$	t-stat	ICC	t-stat	N
1981	0.275	27.92	0.041	16.70	0.149	89.49	2174
1982	0.291	44.63	0.048	26.17	0.133	113.70	4346
1983	0.267	51.58	0.048	33.55	0.131	147.60	6606
1984	0.241	54.67	0.046	37.53	0.127	170.70	8718
1985	0.203	49.51	0.038	32.19	0.113	162.60	9164
1986	0.178	44.78	0.032	28.19	0.107	157.00	9410
1987	0.160	40.77	0.027	24.36	0.102	149.90	9600
1988	0.168	42.47	0.024	21.67	0.100	144.50	9730
1989	0.161	40.74	0.027	24.50	0.103	149.00	9867
1990	0.156	39.57	0.027	25.79	0.105	151.00	9923
1991	0.165	43.54	0.026	24.81	0.100	145.90	10,019
1992	0.157	42.12	0.024	24.00	0.093	136.40	10,324
1993	0.168	45.02	0.022	22.08	0.087	125.50	10,923
1994	0.192	51.05	0.018	17.89	0.085	124.10	12,060
1995	0.190	50.48	0.017	17.27	0.083	124.90	13,335
1996	0.181	50.53	0.017	17.76	0.082	128.90	14,532
1997	0.182	52.22	0.015	16.50	0.077	125.80	15,497
1998	0.171	50.95	0.013	15.43	0.074	123.20	15,692
1999	0.187	52.61	0.016	18.27	0.076	119.90	15,258
2000	0.203	54.34	0.016	18.12	0.076	110.40	14,402
2001	0.212	59.35	0.015	16.13	0.074	99.89	13,548
2002	0.220	63.10	0.017	17.39	0.073	93.32	12,836
2003	0.219	64.96	0.014	13.82	0.064	84.21	12,748
2004	0.230	69.56	0.009	8.88	0.057	78.40	12,899
2005	0.247	69.15	0.006	5.95	0.056	77.88	12,989
2006	0.293	74.74	−0.008	−7.18	0.048	63.02	13,135
2007	0.280	71.02	−0.006	−5.70	0.048	64.40	12,903
2008	0.205	58.45	0.005	4.85	0.056	74.56	12,599
2009	0.198	58.13	0.004	4.59	0.057	74.39	12,463
2010	0.198	57.11	0.004	4.30	0.059	75.71	12,280
2011	0.201	57.61	0.006	5.93	0.060	76.00	12,273
2012	0.236	64.68	0.003	2.77	0.057	77.77	12,291
2013	0.256	65.66	0.002	1.61	0.055	75.44	12,154
2014	0.252	57.40	0.003	2.80	0.056	65.80	9273
Mean	0.210		0.018		0.083		
Median	0.202		0.017		0.077		

Notes: Table 2 reports the modified Ohlson (1995) LID parameters (ω, γ), the cost of equity capital $(R\text{–}1 = ICC)$, and their t-statistics on a yearly basis between 1981 and 2014. The LIDs are:

$$x^a_{t+1} = \omega x^a_t + OI_t + \varepsilon_{x,t+1},\ 0 \le \omega < 1,$$

$$OI_{t+1} = \gamma OI_t + \varepsilon_{OI,t+1},\ 0 \le \gamma < R,$$

where $x^a_t = x_t - (R-1)b_{t-1}$ is abnormal earnings and OI is 'other information.' x_t, and b_t are earnings and book value at time t respectively. A nonlinear least squares procedure is used to estimate simultaneously three parameters (ω, γ, R) from the following cross-sectional nonlinear regressions:

$$\frac{feps_{t+1}}{P_t} = \frac{(R-\gamma)(R-\omega)}{R} + \frac{\omega\gamma}{R}\frac{x_t}{P_t} + \left[R - 1 - \frac{(R-\gamma)(R-\omega)}{R}\right]\frac{b_t}{P_t} - \frac{(R-1)\omega\gamma}{R}\frac{b_{t-1}}{P_t} + \varepsilon_{x,t+1}$$

where $feps_{t+1}$ is the one-year ahead analysts' forecasts of earnings, and P_t is stock price at time t.

The most noteworthy feature of the results in Table 2 is that on average, $1 < \gamma < R$, with the mean (median) of $\gamma = 1.018$ (1.017). 32 out of the 34 observed values of γ are significantly greater than 1. Only in 2006–2007, are the values of γ significantly less than 1. It suggests

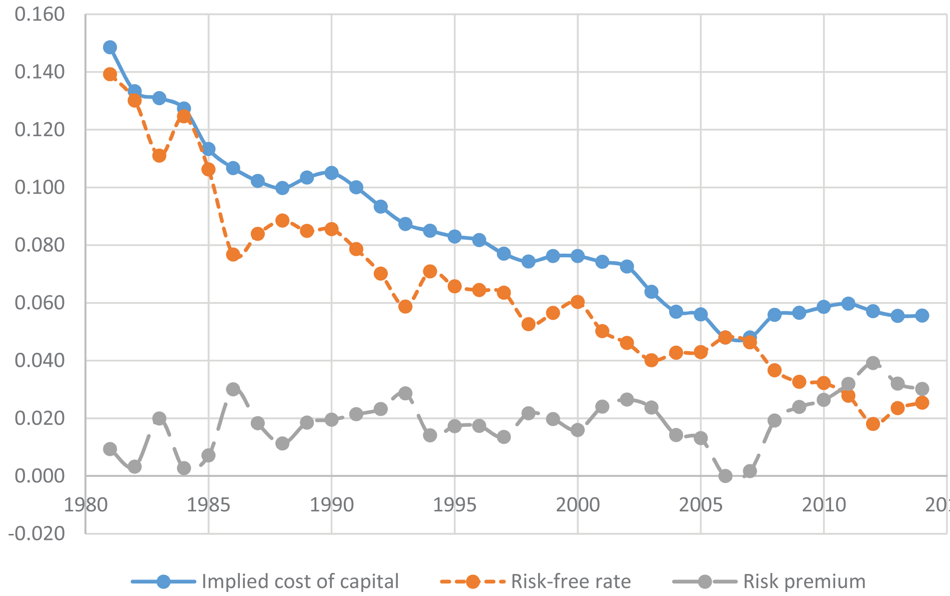

Figure 1. The relation between estimates of the cost of capital and risk premium.
Notes: Figure 1 shows the trends of the implied annual average cost of equity capital and risk premium over 1981–2014. Risk premium equals the difference between the implied cost of equity capital and 10-year US government bond yields.

lack of significant growth opportunities in the few years before the 2008 global financial crisis. The mean (median) of the persistence of abnormal earnings, ω, is 0.21 (0.20). These values are similar to those reported in Myers (1999). Consistent with Ashton and Wang (2013), the cost of equity capital falls almost monotonically from a high of 14.9% in 1981 to 4.8% in 2006–2007. It is more than 10% in 1980s and is between 4.8% and 6% after 2004. All are lower than 9% after 1992. The mean and the median values are 8.3% and 7.7% respectively. Comparing the trend of the implied cost of capital with ten-year U.S. government bond yields, we see that the cost of capital generally declines with the risk-free rate. However, Figure 1 shows that the risk premium increases from 2006 to 2012.

The summary statistics of the estimated parameters, the persistence of abnormal earnings and the growth rate, $(\omega, \gamma - 1)$, are presented in Panel A of Table 3.

Prior literature assumes empirically a temporally and cross-sectional constant discount rate in the model application. To see the impact of a fixed cost of equity capital for each firm-year on the LID parameters estimation and valuation, I follow prior literature and assume a constant discount rate in the model implementation. Specifically, I run cross-sectional nonlinear regressions with a constant *R-1* $=$ 9% based on Equation (11).[15] I simultaneously estimate (ω, γ) each year and refer to two LID parameters (ω, γ) as (ω', γ'), where the dashes denote estimates using a constant cost of capital. Panel B of Table 3 reports these summary statistics of the implied persistence of abnormal earnings (ω') and growth rate $(\gamma' - 1)$ as well as their t-statistics. Note that the persistence of OI satisfy: $1 < \gamma' < R$ for all sample years. Both the mean and the median of persistence of abnormal earnings (ω') are close to 0.23. In general, the magnitudes of $\omega'(\gamma')$ in Panel B and $\omega(\gamma)$ in Panel A are similar.

For the purpose of comparison, I also estimate the LID parameters in a sequential procedure as is normally adopted in the existing literature. The procedure effectively sets $OI_t = 0$ in estimating

[15] I choose R-1 $=$ 9% because the mean and the median of implied cost of equity capital are close to 9%, which is also a discount rate used in the robustness test in Dechow et al. (1999).

Table 3. Summary statistics of LID parameters estimated from different estimation procedures and alternative discount rates

	Mean	St.Dev	Min	Q1	Median	Q3	Max	FM-t
Panel A: Simultaneous approach, R-1 = ICC								
ω	0.210	0.040	0.156	0.179	0.202	0.240	0.293	30.39
t-stat	53.54	10.41	27.92	44.84	52.42	59.13	74.74	
$\gamma - 1$	0.018	0.014	− 0.008	0.006	0.017	0.026	0.048	7.30
t-stat	15.85	10.80	− 7.18	5.94	17.33	24.27	37.53	
Panel B: Simultaneous approach, R–1 = 9%								
ω'	0.228	0.057	0.142	0.189	0.233	0.274	0.357	23.25
t-stat	57.14	15.06	30.39	42.36	56.99	69.92	82.63	
$\gamma' - 1$	0.024	0.009	0.013	0.020	0.022	0.025	0.057	16.14
t-stat	22.04	4.94	12.32	18.36	22.65	25.82	31.40	
Panel C: Sequential approach, R–1 = 9%								
ω''	0.473	0.052	0.377	0.435	0.463	0.509	0.568	53.08
t-stat	24.42	5.10	8.76	21.08	25.22	27.23	33.48	
γ''	0.603	0.069	0.460	0.553	0.598	0.665	0.731	51.21
t-stat	20.79	8.02	6.66	16.32	18.86	27.33	35.70	
Panel D: Compare the LID parameters								
$\omega' - \omega$	0.018	0.022	− 0.014	0.003	0.016	0.038	0.082	4.64
$\omega'' - \omega$	0.263	0.041	0.179	0.237	0.266	0.293	0.344	37.16
$\gamma' - \gamma$	0.006	0.012	− 0.015	− 0.004	0.006	0.013	0.034	2.88
$\gamma'' - \gamma$	− 0.415	0.078	− 0.588	− 0.458	− 0.427	− 0.348	− 0.262	− 31.03

Notes: Table 3 reports the summary statistics of the modified Ohlson LID parameters estimated from different estimation procedures and alternative discount rates between 1981 and 2014 on a yearly basis. The summary statistics include mean, standard deviation, minimum, the 1st quartile, median, the 3rd quartile, maximum and the Fama-MacBeth t-statistic.
Panel A presents the summary statistics of LID parameters, $(\omega, \gamma - 1)$, reported in Table 2.
In Panel B, the same nonlinear least squares procedure as in Panel A is used to simultaneously estimate two parameters, $(\omega, \gamma - 1)$, but a constant R–1 = 9% is assumed for every firm each year.
Panel C reports the summary statistics of the LID parameters, (ω, γ), estimated from the sequential estimation procedure assuming R–1 = 9% for every firm each year. ω is the regression coefficient from the following cross-sectional regressions: $x^a_{t+1}/P_t = \omega_0 + \omega x^a_t/P_t + \varepsilon_{x,t+1}$, where $x^a_{t+1} = x_{t+1} - (R-1)b_t$ is calculated by using realized earnings. ω_0 is the intercept term. γ is estimated from the following cross-sectional regressions: $OI_{t+1}/P_t = \gamma_0 + \gamma OI_t/P_t + \varepsilon_{OI,t+1}$, where 'other information': $OI_t = feps_{t+1} - (R-1)b_t - \omega x^a_t$, and $feps_{t+1}$ is the one-year ahead analysts' forecasts of earnings. γ_0 is the intercept term.
Panel D shows the summary statistics of the difference of the LID parameters, when using different estimating procedures (the simultaneous estimation vs. sequential estimation) and different discount rates (R-1 = ICC vs. 9%).

the LID parameter ω, ignoring the possibility that OI_t constitutes a correlated omitted variable in the LID. Again, I assume R-1 = 9% in information dynamics (1) and (2), and run cross-sectional regressions. Specifically, I first estimate an unconditional value of ω from an abnormal earnings autoregression on a year-by-year basis (ignoring OI_t). I then use the unconditional ω estimated to calculate OI as: $OI_t = feps_{t+1} - (R-1)b_t - \omega x^a_t = feps_{t+1} - (R-1)b_t - \omega(x_t - (R-1)b_{t-1})$, and finally estimate γ from regressions based on information dynamic (2). I report the summary statistics of the estimates (ω, γ) in Panel C of Table 3. For the purpose of my presentation, I refer to (ω, γ) as (ω'', γ''), where the double dashes denote their values based on the sequential estimates of the parameters. It shows that values of ω'' and γ'' are very similar to those reported in Choi et al. (2006).[16] The mean value estimates for the persistence of abnormal earnings and OI are 0.473 and 0.603 respectively. ω'' is in a range of 0.377–0.568, while γ'' is between 0.46 and 0.731. While the sequential estimation procedure produces values of the persistence (γ'') of OI that are significantly less than 1, in striking contrast, γ' estimated from the simultaneous

[16]Following Dechow et al. (1999), Choi et al. (2006) too estimate the LID parameters in a sequential procedure.

estimation procedure is significantly greater than 1 in each of the sample years as reported in Panel B.

Finally, a formal comparison of parameter estimates is presented in Panel D of Table 3, which reports the summary statistics in differences between LID parameters estimated by using different discount rates and different estimation procedures. It shows that both persistence of abnormal earnings and OI from the simultaneous estimation procedure when assuming a constant discount rate are statistically significantly larger than those when using the time-varying discount rate, the mean of $(\omega' - \omega)$ is 0.018 and mean of $(\gamma' - \gamma)$ is 0.006. It suggests that on average LID parameter estimates (ω', γ') may be upwardly biased when using a constant discount rate of 9% relative to using the time-varying implied cost of capital as a discount rate. I will show that this result has implication in estimating the intrinsic value of equity. Panel D also shows that the persistence of abnormal earnings is larger and the persistence of OI is much smaller when using the sequential estimation procedure than those when using the simultaneous estimation procedure. The mean of $(\omega'' - \omega)$ is 0.263 and mean of $(\gamma'' - \gamma)$ is -0.415. The impact of these differences on valuation is shown in the analysis next.

5.2. Valuation Bias and Inaccuracy by Using Different Estimation Procedures and Alternative Estimates of Discount Rates to Determine the LID Parameters

Because the cost of capital varies by industry and competition is mainly between firms in the same industry, I estimate the modified Ohlson LID parameters and the time-varying industry-specific cost of equity capital by running industry-year regressions when examining the valuation biases in this section. This allows the LID parameters to reflect variation in economic and accounting environment across industries and over years (Barth et al., 2005; Fama & French, 1997). Since some industries only have a limited number of observations in some sample years, firms are grouped into five industries based on the industry classification from Ken French's website and pooled cross-sectional nonlinear regressions are run in a four-year rolling window.[17] For each year $k = 1981, \ldots, 2014$, the model is estimated using only data that are available in years between k-3 and k. The estimated parameters from the regressions are then used as year k parameters in the following analysis. Since the proposed approach utilizes time t information contained in stock prices, I make an out-of-sample comparison of valuation biases and valuation inaccuracies with those generated from existing approaches.

Three parameters $(\omega_{it}, \gamma_{it}, R_{it} - 1)$ for industry i in year t are estimated either by a simultaneous estimation procedure or a sequential procedure. When applying a sequential procedure, I assume $R_{it} - 1 = 9\%$ for each firm-year. The persistence of abnormal earnings (ω_{it}) is the regression coefficient from pooled cross-sectional four-year rolling window regressions on an industry-year basis: $x^a_{t+1}/P_t = \omega_0 + \omega x^a_t/P_t + \varepsilon_{x,t+1}$, where $x^a_{t+1} = x_{t+1} - (R-1)b_t$ is calculated by using realized earnings. ω_0 is the intercept term. The persistence of OI (γ_{it}) is also estimated from four-year rolling window regressions on an industry-year basis: $OI_{t+1}/P_t = \gamma_0 + \gamma OI_t/P_t + \varepsilon_{OI,t+1}$, where 'other information': $OI_t = feps_{t+1} - (R-1)b_t - \omega x^a_t$, and $feps_{t+1}$ is the one-year ahead analysts' forecasts of earnings. γ_0 is the intercept term. When applying a simultaneous procedure, I use information up to time *(t-1)* and estimate $(\omega_{it}, \gamma_{it}, R_{it} - 1)$ for industry i in year t based on (11).[18] I also estimate $(\omega_{it}, \gamma_{it})$ for industry i in year t by assuming $R_{it} - 1 = 9\%$ from regressions on (11).

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[17]http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. Industry 'Healthcare, Medical Equipment, and Drugs' has a small number of observations in the earlier sample period. I use 4-year rolling window to increase the industry-year sample observations. The results are similar if I run regressions in a three- or five-year rolling window.

[18]Strictly speaking, Dechow et al. (1999) have also implicitly used time t price information when they use price as a deflator in estimation.

With different sets of LID parameters estimated using different estimation procedures and different discount rates, Equation (8) gives different sets of intrinsic values of equity shares. Following prior literature, the extreme 1% of the model predicted values are deleted and negative predicted equity values are set to zero (Barth et al., 2005). Moreover, the extreme 1% of biases and inaccuracies are winsorized. Table 4 reports the valuation bias and valuation inaccuracy from the LID model with the theoretical coefficient of each variable in (9) estimated at time t information from the sequential approach, and with the theoretical coefficients of relevant variables estimated at time *t-1* information from the simultaneous approach. Panel A of Table 4 shows that the intrinsic value estimated from the sequential procedure understates stock prices on average by 25.7%, which is similar to those reported in the existing literature. On the other hand, the intrinsic value estimated from the simultaneous procedure overstates stock prices on average by 9.9% to 10.5% depending on whether the discount rate is time-varying or assumed constant. The median bias from the sequential procedure is 34.8%. In sharp contrast, it is between 3.3% and 6.4% from the simultaneous procedure. When using the simultaneous procedure and a constant discount rate of 9%, equity value is overstated more than that when using the time-varying implied cost of capital as a discount rate. This is consistent with Panel D of Table 3 since LID parameter estimates (ω', γ') are upwardly biased relative to (ω, γ). The smallest median bias is based on the LID with the time-varying industry-specific discount rate. There is no evidence of systematic undervaluation or overvaluation of stock prices from the LID model based on the simultaneous estimation procedure. This leads to higher standard deviations of valuation biases relative to that from the sequential procedure. Panel A of Table 4 also reports the pairwise t-tests for the valuation biases across different estimation procedures and different discount rates. While the means of valuation inaccuracies are comparable from different estimation approaches, Panel B of Table 4 shows that the first quartile, the median and the third quartile valuation inaccuracy using the simultaneous estimation procedure are all lower than those from the sequential estimation procedure. In particular, the LID model estimated from the time-varying discount rate generates the most accurate valuation. The median valuation inaccuracy is 29.5%, which is significantly smaller than 40.4% when the sequential estimation procedure is used. Panel B of Table 4 also reports the pairwise t-tests for the valuation inaccuracies across different estimation procedures and different discount rates. The pairwise t-tests show that these differences in valuation biases and valuation inaccuracies are statistically significant. These results suggest that we should estimate simultaneously both LID parameters (ω, γ) and the time-varying cost of equity capital in implementing the RIV valuation model. It suggests that OI is not subordinate to the abnormal earnings in valuation.

5.3. Theoretical Weights and Those Investors Place on Short-Term Earnings Forecasts

The intrinsic values estimated by the Ohlson (1995) model based on the sequential estimation procedure substantially understate stock prices. The magnitude of underestimation reported in Table 4 is similar to that documented by Dechow et al. (1999), who argue that investors may overreact to the short-term forecasts of earnings since too high (low) a weight is placed on one-period ahead earnings (book value) relative to the theoretically predicted value. In a rational capital market, stock value is determined by the present value of expected future earnings (cash flows). We should expect the theoretical coefficient of future earnings (Φ) in (8) to be positive and larger than the coefficients of current earnings, dividends and book value.

As in the last subsection, I apply the simultaneous procedure to estimate $(\omega_{it}, \gamma_{it}, R_{it} - 1)$ for industry i in year t from pooled cross-sectional nonlinear regressions based on equation (11) on an industry-year basis. I calculate the implied values of the theoretical coefficients attached to book value, earnings, dividends and the one-year ahead forecasts of earnings for each industry-year as

Table 4. Valuation bias and valuation inaccuracy

Panel A: Valuation bias

	N	Mean	St.Dev	Q1	Median	Q3
R-1 = 9%, Sequential estimation	76,653	0.257	0.426	0.090	0.348	0.545
R-1 = 9%, Simultaneous estimation	76,653	– 0.105	0.662	– 0.340	0.064	0.323
R-1 = ICC, Simultaneous estimation	76,653	– 0.099	0.593	– 0.316	0.033	0.283

H_0: mean of valuation bias from SIM (9%) = mean of bias from SEQ (9%), *t*-statistic = – 180
H_0: mean of valuation bias from SIM (ICC) = mean of bias from SEQ (9%), *t*-statistic = – 190
H_0: mean of valuation bias from SIM (ICC) = mean of bias from SIM (9%), *t*-statistic = 4.06

Panel B: Valuation inaccuracy

	N	Mean	St.Dev	Q1	Median	Q3
R-1 = 9%, Sequential estimation	76,653	0.418	0.269	0.221	0.404	0.582
R-1 = 9%, Simultaneous estimation	76,653	0.462	0.486	0.160	0.329	0.572
R-1 = ICC, Simultaneous estimation	76,653	0.413	0.438	0.140	0.295	0.518

H_0: mean of inaccuracy from SIM (9%) = mean of inaccuracy SEQ (9%), *t*-statistic = 23.01
H_0: mean of inaccuracy from SIM (ICC) = mean of inaccuracy SEQ (9%), *t*-statistic = – 3.06
H_0: mean of inaccuracy from SIM (ICC) = mean of inaccuracy SIM (9%), *t*-statistic = – 35.81

Notes: Table 4 shows the valuation bias and valuation inaccuracy using different estimating procedures: sequential estimation (SEQ) or simultaneous (SIM) estimation, to estimate the modified Ohlson LID parameters and alternative discount rates, 9% or the implied cost of equity capital (ICC). The number of observations, mean, standard deviation, the first quartile (Q1), median and the third quartile (Q3) are reported. Panel A reports the valuation bias and Panel B reports the valuation inaccuracy. The results on pairwise *t*-tests for the valuation bias and inaccuracy across different estimation procedures and discount rates are also reported.
The value of equity is given by:

$$P_t = \Psi_{it} \times x_t + \mathrm{B}_{it} \times b_t + \Delta_{it} \times d_t + \Phi_{it} \times feps_{t+1}$$

where

$$\Psi_{it} = \frac{-R_{it}\omega_{it}\gamma_{it}}{(R_{it}-\omega_{it})(R_{it}-\gamma_{it})},\ \mathrm{B}_{it} = \frac{R_{it}(1-\omega_{it})(1-\gamma_{it})}{(R_{it}-\omega_{it})(R_{it}-\gamma_{it})},$$
$$\Delta_{it} = \frac{(R_{it}-1)\omega_{it}\gamma_{it}}{(R_{it}-\omega_{it})(R_{it}-\gamma_{it})},\ \text{and}\ \Phi_{it} = \frac{R_{it}}{(R_{it}-\omega_{it})(R_{it}-\gamma_{it})},$$

are the theoretical coefficients of earnings (x_t), book value (b_t), dividends (d_t) and one-period ahead forecasts of earnings ($feps_{t+1}$) for individual firms in industry *i* in year *t* respectively. Three parameters ($\omega_{it}, \gamma_{it}, R_{it}-1$) are estimated either from a simultaneous estimation procedure or a sequential procedure.
When applying a sequential procedure, I assume $R_{it}-1 = 9\%$ for each firm and each year. The persistence of abnormal earnings (ω_{it}) for industry i in year *t* is the regression coefficient from 4-year rolling window regressions: $x^a_{t+1}/P_t = \omega_0 + \omega x^a_t/P_t + \varepsilon_{x,t+1}$, where $x^a_{t+1} = x_{t+1} - (R-1)b_t$ is calculated by using realized earnings. ω_0 is the intercept term. The persistence of OI (γ_{it}) for industry i in year *t* is estimated from 4-year rolling window regressions: $OI_{t+1}/P_t = \gamma_0 + \gamma OI_t/P_t + \varepsilon_{OI,t+1}$, where 'other information': $OI_t = feps_{t+1} - (R-1)b_t - \omega x^a_t$, and $feps_{t+1}$ is the one-year ahead analysts' forecasts of earnings. γ_0 is the intercept term.
When applying a simultaneous procedure, I use information up to time (*t–1*) and estimate ($\omega_{it}, \gamma_{it}, R_{it}-1$) for industry *i* in year *t* from the following pooled cross-sectional nonlinear 4-year rolling window regression on an industry-year basis:

$$\frac{feps_{t+1}}{P_t} = \frac{(R-\gamma)(R-\omega)}{R} + \frac{\omega\gamma}{R}\frac{x_t}{P_t} + \left[R - 1 - \frac{(R-\gamma)(R-\omega)}{R}\right]\frac{b_t}{P_t} - \frac{(R-1)\omega\gamma}{R}\frac{b_{t-1}}{P_t} + \varepsilon_{x,t+1}$$

The table reports results on valuation bias and valuation inaccuracy with a constant cost of capital ($R_{it}-1 = 9\%$) as well as time-varying industry-specific cost of capital (ICC) as a discount rate in parameter estimation. 1% of extreme values and negative values are dropped. Following prior literature, the extreme 1% of the model predicted values are deleted and negative predicted equity values are set to zero. Valuation bias is the mean difference between observable stock prices and model predicted values, scaled by price and valuation inaccuracy is the mean of absolute value of the bias.

expressed in equation (9). Table 5 columns 2–5 report the means of these theoretical values each year across 5-industry between 1981 and 2014. It shows that the means (the Fama-MacBeth *t*-statistic) of the theoretical values of the coefficients of book value, earnings, dividends and forecasts of earnings over 34 years are: −0.216 (−5.95), −4.122 (−19.97), 0.284 (19.13) and 19.193 (31.52) respectively.

To investigate what weight investors place on each of book value, earnings, dividends and the one-year ahead analysts' forecasts of earnings, I next regress stock prices on these variables on an industry-year basis:

$$P_t = \beta_0 + \beta_1 b_t + \beta_2 x_t + \beta_3 d_t + \beta_4 feps_{t+1} + \varepsilon_t$$

Table 5 columns 6–9 report regression coefficients of price on book value, earnings, dividends and the one-year ahead analysts' forecasts of earnings over the same sample period across 5-industry. The average regression coefficients (the Fama-MacBeth *t*-statistic) of book value, earnings, dividends and forecasts of earnings are: 0.323 (14.0), −0.871 (−6.86), 0.517 (1.89) and 6.845 (20.56) respectively. The last four columns of Table 5 report the difference between the corresponding theoretical coefficients and regression coefficients over the sample period. Contrary to Dechow et al. (1999), the difference between the theoretical coefficients and regression coefficients of future earnings (book value) is positive (negative) in each sample year. These differences are statistically significant. It suggests that investors neither place a too high weight on the one-year ahead forecasts of earnings, nor place a too low weight on book value. While the one-period ahead forecasted earnings are short term and may not be realized, investors effectively put a conservative weight on it and anchor the stock price to book value. The theoretical coefficients of earnings are less than the regression coefficients in each sample year. On the other hand, the theoretical valuation coefficients put almost all (positive) weights on the forecasts of future earnings reflecting that assets are valued based on the expected future earnings (cash flows). In other words, future earnings subsume value relevant information in book value and current earnings. Note also that the difference between the theoretical coefficients and regression coefficients of dividends is not statistically different from zero supporting dividend irrelevancy.

5.4. Prediction of Stock Returns

If we use the one-year ahead analysts' forecasts of earnings as a proxy for the market expectation of firms' one-period ahead earnings, Equation (10) can be used to estimate the expected stock returns. That is, a proxy for the expected stock return for firm *j* in industry *i* at time *t* is

$$E_t\left[\frac{P_{t+1}+d_{t+1}}{P_t}\right] = \gamma_{it} + \frac{R_{it}}{R_{it}-\omega_{it}}\frac{feps_{t+1}}{P_t} - (\gamma_{it}-1)\frac{b_t}{P_t} - \frac{\omega_{it}\gamma_{it}}{R_{it}-\omega_{it}}\frac{x_t}{P_t} - \frac{(R_{it}-1)\omega_{it}}{R_{it}-\omega_{it}}\frac{b_t-\gamma_{it}b_{t-1}}{P_t}, \tag{12}$$

where the industry-year LID parameters (ω_{it}, γ_{it}) and discount rate ($R_{it} - 1$) are estimated simultaneously as described in section 5.2. To evaluate the usefulness of the proxy, I follow prior literature and test whether it can predict realized future stock returns. Based on two tautologies, the log-transformed realized $t+1$ period returns are usually decomposed into three components: 'true' expected return, cash flow news (CFN) and discount rate news (DRN) at $t+1$. Denote $R_t = \ln(1+RET_t)$ the log of the realized one-period ahead stock returns ($\mathrm{RET_t}$), and $ER_t = \ln(1+MPR_t)$ the log of model (12) predicted returns, where $MPR_t = E_t[P_{t+1}+d_{t+1}]/P_t - 1$. When future realized cash flows or earnings are greater (less) than the expected cash flows or earnings, time $t+1$ realized return will be greater (less) than the expected return, all else being

Table 5. Compare the theoretical coefficients in valuation model with regression coefficients

	B	Ψ	Δ	Φ	β_1	β_2	β_3	β_4	B-β_1	Ψ-β_2	Δ-β_3	Φ-β_4
1981	– 0.416	– 3.478	0.462	12.310	0.500	1.241	– 3.134	2.047	– 0.916	– 4.719	3.597	10.263
1982	– 0.573	– 4.818	0.593	15.550	0.692	– 0.708	– 5.111	4.704	– 1.265	– 4.110	5.704	10.846
1983	– 0.566	– 4.408	0.521	15.810	0.487	– 1.117	– 0.749	5.163	– 1.053	– 3.291	1.270	10.647
1984	– 0.554	– 3.762	0.435	15.260	0.525	– 0.108	– 1.477	4.570	– 1.079	– 3.654	1.913	10.690
1985	– 0.507	– 3.262	0.334	16.210	0.396	– 0.732	– 0.830	7.267	– 0.903	– 2.530	1.164	8.943
1986	– 0.565	– 2.967	0.290	17.140	0.397	– 1.079	– 0.365	7.599	– 0.962	– 1.888	0.654	9.541
1987	– 0.496	– 2.720	0.255	16.890	0.326	0.126	– 0.049	5.580	– 0.822	– 2.846	0.304	11.310
1988	– 0.457	– 2.982	0.274	17.040	0.345	0.760	0.349	4.184	– 0.802	– 3.742	– 0.075	12.856
1989	– 0.434	– 2.818	0.264	16.340	0.230	0.014	1.394	4.878	– 0.665	– 2.832	– 1.130	11.462
1990	– 0.346	– 2.684	0.251	15.310	0.137	0.096	2.099	6.253	– 0.484	– 2.780	– 1.848	9.057
1991	– 0.303	– 2.932	0.259	15.790	0.064	– 0.641	1.273	6.878	– 0.368	– 2.291	– 1.014	8.912
1992	– 0.293	– 3.074	0.246	16.990	0.310	– 1.203	1.732	7.048	– 0.602	– 1.871	– 1.486	9.942
1993	– 0.229	– 3.336	0.243	17.410	0.304	– 0.749	1.188	5.739	– 0.532	– 2.587	– 0.945	11.671
1994	– 0.165	– 3.160	0.240	16.530	0.364	– 1.385	1.086	5.962	– 0.529	– 1.775	– 0.846	10.568
1995	– 0.157	– 3.100	0.227	16.840	0.347	– 1.386	0.183	6.981	– 0.504	– 1.714	0.043	9.859
1996	– 0.170	– 3.271	0.229	17.570	0.323	– 1.191	– 0.607	8.093	– 0.493	– 2.080	0.836	9.477
1997	– 0.176	– 3.529	0.238	18.650	0.350	– 1.165	– 0.001	8.241	– 0.526	– 2.364	0.239	10.409
1998	– 0.210	– 3.662	0.227	20.440	0.272	– 0.660	0.690	7.056	– 0.481	– 3.002	– 0.463	13.384
1999	– 0.269	– 4.147	0.267	21.340	0.338	– 1.137	0.056	4.249	– 0.607	– 3.010	0.211	17.091
2000	– 0.210	– 3.737	0.255	19.370	0.404	– 1.397	0.698	5.665	– 0.614	– 2.340	– 0.443	13.705
2001	– 0.175	– 4.388	0.268	20.980	0.379	– 1.036	– 0.035	6.263	– 0.554	– 3.352	0.303	14.717
2002	– 0.149	– 4.457	0.265	20.570	0.349	– 0.891	1.264	6.663	– 0.498	– 3.566	– 0.999	13.907
2003	– 0.099	– 4.670	0.244	22.050	0.354	– 1.971	0.582	7.192	– 0.453	– 2.699	– 0.338	14.858
2004	– 0.045	– 4.590	0.244	21.510	0.318	– 2.376	2.590	8.419	– 0.363	– 2.214	– 2.347	13.091
2005	– 0.025	– 4.605	0.243	21.230	0.335	– 1.205	1.145	7.226	– 0.359	– 3.400	– 0.902	14.004
2006	0.113	– 4.873	0.251	20.510	0.198	– 1.586	2.963	8.833	– 0.086	– 3.287	– 2.712	11.677
2007	0.085	– 4.641	0.243	20.360	0.257	– 1.192	0.979	7.714	– 0.172	– 3.449	– 0.736	12.646
2008	0.012	– 4.333	0.210	21.570	0.227	– 0.295	0.739	5.248	– 0.215	– 4.038	– 0.529	16.322
2009	0.008	– 4.683	0.221	22.190	0.214	– 1.120	0.882	7.420	– 0.206	– 3.563	– 0.662	14.770
2010	0.012	– 4.909	0.230	21.950	0.213	– 1.398	1.517	8.664	– 0.202	– 3.511	– 1.286	13.286

(*Continued*)

Table 5. Continued.

	B	Ψ	Δ	Φ	β_1	β_2	β_3	β_4	B-β_1	Ψ-β_2	Δ-β_3	Φ-β_4
2011	– 0.168	– 8.696	0.333	31.880	0.080	– 0.203	0.764	8.552	– 0.248	– 8.493	– 0.432	23.328
2012	0.039	– 5.923	0.256	23.530	0.124	– 0.806	1.512	9.855	– 0.085	– 5.117	– 1.256	13.675
2013	0.056	– 5.479	0.262	22.130	0.218	– 1.057	0.439	11.061	– 0.162	– 4.422	– 0.177	11.069
2014	0.102	– 6.062	0.269	23.320	0.602	– 2.056	3.814	11.475	– 0.500	– 4.006	– 3.546	11.845
Mean	– 0.216	– 4.122	0.284	19.193	0.323	– 0.871	0.517	6.845	– 0.539	– 3.251	– 0.233	12.348
StDev	0.211	1.204	0.086	3.551	0.134	0.740	1.594	1.942	0.294	1.241	1.660	2.841
t-stat	– 5.95	– 19.97	19.13	31.52	14.00	– 6.86	1.89	20.56	– 10.70	– 15.27	– 0.82	25.34

Notes: Table 5 columns 2–5 report the mean theoretical coefficients attached to book value (b), earnings (x), dividends (d) and one-period ahead analysts' forecasts of earnings (feps) across 5-industry over 34-year between 1981 and 2014 in the following model:

$$P_t = \mathrm{B} \times b_t + \Psi \times x_t + \Delta \times d_t + \Phi \times feps_{t+1}$$

where $\mathrm{B} = \frac{R(1-\omega)(1-\gamma)}{(R-\omega)(R-\gamma)}$, $\Psi = \frac{-R\omega\gamma}{(R-\omega)(R-\gamma)}$, $\Delta = \frac{(R-1)\omega\gamma}{(R-\omega)(R-\gamma)}$ and $\Phi = \frac{R}{(R-\omega)(R-\gamma)}$.
Three parameters $(\omega, \gamma, R-1)$ are estimated simultaneously on an industry-year basis from the following regression:

$$\frac{feps_{t+1}}{P_t} = \frac{(R-\gamma)(R-\omega)}{R} + \frac{\omega\gamma}{R}\frac{x_t}{P_t} + \left[R - 1 - \frac{(R-\gamma)(R-\omega)}{R}\right]\frac{b_t}{P_t} - \frac{(R-1)\omega\gamma}{R}\frac{b_{t-1}}{P_t} + \varepsilon_{x,t+1}$$

Columns 6–9 report regression coefficients of price on book value, earnings, dividends and the one-year ahead analysts' forecasts of earnings over the same period: $P_t = \beta_0 + \beta_1 b_t + \beta_2 x_t + \beta_3 d_t + \beta_4 feps_{t+1} + \varepsilon_t$. The last four columns report the difference between the corresponding theoretical coefficients and regression coefficients. The average value, standard deviation and the Fama-MacBeth *t*-statistic are also reported.

equal. When future discount rates are upwardly (downwardly) revised, time $t+1$ realized return will be lower (higher) than the expected return, all else being equal. By definition, the two news components are unpredictable *ex ante*. Vuolteenaho (2002) suggests that the proxy for discount rate news should be a function of the time $t+1$ change in the implied expected returns and firm-specific. Hence, consistent with Easton and Monahan (2005, 2016), time $t+1$ discount rate news is proxied by $DRN_{t+1} = resER_{t+1}/(1-0.98\kappa)$, where $resER_{t+1}$ is the residual from the following firm level model predicted return regression: $ER_{t+1} = \text{constant} + \kappa ER_t + resER_{t+1}$ and κ is the slope.[19] It captures firm-specific discount rate shocks. Cash flow news is defined as actual earnings per share for year $t+1$ less analysts' forecasts of one-year ahead earnings per share or 'earnings surprise,' scaled by stock price at time t. It intends to capture firm-specific cash flow shocks. Therefore, I examine the relationship between the realized one-period ahead stock returns and model (12) predicted returns after controlling for CFN and DRN. In the following regression:

$$XRET_{t+1} = \delta_0 + \delta_1 XER_t + \delta_2 CFN_{t+1} + \delta_3 DRN_{t+1} + \varepsilon_{t+1}$$

where $XRET_{t+1} = R_{t+1} - \ln(1+r_f)$ and $XER_{t+1} = ER_{t+1} - \ln(1+r_f)$ are the one-year ahead excess realized stock returns and the excess model predicted returns respectively, and r_f is the 10-year US government bond yield, δ_1 and δ_2 are expected to be close to one and δ_3 is expected to be close to minus one if the model predicted returns (MPR) are a good proxy for the expected returns. Since the proxy of expected return is measured with error, the coefficients of XER, CFN and DRN are expected to differ from their theoretical values.

Table 6 Panel A reports the summary statistics of the one-year ahead excess realized stock returns (XRET), the model predicted excess returns (XER), cash flow news (CFN) and discount rate news (DRN). It shows that XRET is much more volatile than XER. The mean of XRET is much smaller than its median, while the mean and the median of XER are similar.

Panel B presents regression coefficients (t-values) of the one-year ahead excess realized stock returns (XRET) on the model predicted excess returns (XER). Two-way cluster-robust standard errors are used to correct for both cross-sectional and time series dependence. The coefficient of XER in the univariate regression is 1.41, which is significantly different from zero (t-statistic 29.06).[20] In the multivariate regression, the coefficient of XER is 2.31 with t-statistic of 49.3. It suggests that ER is a downward biased measure of the expected return as documented in the ICC literature. The results in Table 6 are, however, in contrast with findings in Easton and Monahan (2005) who find that many popular ICC measures are negatively associated with realized returns after controlling for CFN and DRN. The coefficients on proxies for CFN and DRN are positive (1.246) and negative (-0.992) respectively with theoretically predicted signs. In particular, the coefficient of DRN is statistically indifferent from minus one. Panel C reports the cross-sectional regression results based on Fama and MacBeth (FM 1973) method. I report the average estimates in the sample period. While the coefficient of XER is less (greater) than one in the univariate (multivariate) regression, both CFN and DRN have correct signs. They are closer to their theoretical values than those reported in prior studies.[21]

[19] In order to estimate the firm level discount rate news, I delete all firms with less than 6 observations in the firm level regressions. As a result, sample firms reduce from 10759 to 4696.

[20] Guay et al. (2011) report that the coefficients of most ICC measures are between –0.33 and 0.43 in univariate cross-sectional regressions and they are not statistically distinguishable from zero at conventional levels.

[21] Studies show that realized stock returns are often insensitive to discount rate news when regressing realized returns on a proxy of the expected return, CFN and DRN (Easton & Monahan, 2005; Nekrasov & Ogneva, 2011; Gode & Mohanram, 2013).

Table 6. Relation between excess realized returns and excess model predicted returns

Panel A: Descriptive statistics

	N	Mean	StDev	P5	P25	Median	P75	P95
XRET	61265	0.009	0.420	– 0.712	– 0.186	0.042	0.243	0.610
XER	61265	0.026	0.035	– 0.020	0.003	0.021	0.041	0.090
CFN	61265	– 0.024	0.093	– 0.164	– 0.031	– 0.004	0.007	0.052
DRN	56569	0.000	0.077	– 0.061	– 0.020	– 0.003	0.016	0.075

Panel B: Fixed effect regression

	Univariate regression			Multivariate regression				
	Const.	XER	R^2	Const.	XER	CFN	DRN	R^2
XRET	– 0.027	1.410	1.4%	– 0.002	2.310	1.246	– 0.992	10.2%
t-value	– 12.85	29.06		– 0.93	49.3	58.35	– 49.05	

Panel C: The Fama-MacBeth regression

	Univariate regression			Multivariate regression				
	Const.	XER	R^2	Const.	XER	CFN	DRN	R^2
XRET	– 0.007	0.758		1.7%	1.736	1.418	– 1.104	15.7%
t-value	– 0.26	3.73	0.0166	0.66	11.53	11.84	– 7.82	

Notes: Panel A of Table 6 reports descriptive statistics of the one-year ahead excess log realized return (XRET), the excess log model predicted return (XER), cash flow news proxy (CFN) and discount rate news proxy (DRN) over 1981–2014. Annual realized returns are calculated by compounding 12-monthly returns after the financial year-end. The risk-free rate is proxied by the 10-year US government bond yield. CFN equals actual earnings per share for year $t + 1$ less analysts' forecasts of one-year-ahead earnings per share, scaled by stock price at time t. DRN is proxied by $resER_{t+1}/(1 - 0.98\kappa)$, where $resER_{t+1}$ is the residual from the following firm level model predicted return regression: $ER_{t+1} = \text{constant} + \kappa ER_t + resER_{t+1}$ and κ is the slope. Panel B presents regression coefficients (t-values) of XRET on XER, CFN and DRN. Two-way cluster-robust standard errors are used to correct for both cross-sectional and time-series dependence. Panel C presents the Fama-MacBeth regression coefficients (t-values) of XRET on XER, CFN and DRN. Average of R-squared is also reported.

I also document the model predicted returns' out-of-sample predictive ability with respect to future realized stock returns by sorting firms into deciles of the model predicted return distribution at the end of each financial year in Table 7.

For each portfolio, the mean buy-and-hold returns for the next 12-, 24- and 36-months are calculated. It exhibits a strictly monotonic relationship with future realized returns for all three horizons. The hedge returns, the differences in realized returns over 12-, 24- and 36-month between the top and bottom deciles of the predicted expected stock returns are equal to 13%, 23.8% and 35.3% respectively. In addition, Table 7 appears to suggest that the monotonic relation with future realized returns is associated with the book-to-market ratio and firms' market capitalization (Fama & French, 1992, 1993). It is also almost monotonically positively associated with the Sharpe ratio, though it cannot be explained by the CAPM beta.[22]

6. Robustness Tests

In the above analysis, I use the one-year ahead analysts' forecasts of earnings from the I/B/E/S as a proxy for the market expectation of firms' one-period ahead earnings in estimating the modified

[22] It is well documented that Beta is notorious for its poor association with stock returns despite its deep theoretical appeal (e.g., Frazzini & Pedersen, 2014).

Table 7. 12-, 24- and 36-month ahead realized returns from the model predicted return decile sorted portfolios

	1	2	3	4	5	6	7	8	9	10
Return	0.040	0.056	0.066	0.074	0.081	0.088	0.096	0.106	0.123	0.174
bhr1	0.099	0.112	0.129	0.132	0.145	0.151	0.159	0.177	0.181	0.228
Beta	1.245	1.172	1.074	1.021	0.978	0.947	0.956	0.994	1.033	1.093
B/M	0.510	0.518	0.535	0.560	0.584	0.627	0.664	0.719	0.810	0.993
Mktcap	6.161	6.226	6.265	6.277	6.272	6.231	6.039	5.909	5.677	5.351
Sharpe ratio	0.087	0.133	0.181	0.185	0.246	0.287	0.304	0.319	0.305	0.350
bhr2	0.179	0.207	0.234	0.265	0.271	0.280	0.308	0.313	0.341	0.416
bhr3	0.268	0.335	0.372	0.405	0.436	0.437	0.463	0.505	0.540	0.621

Notes: Table 7 reports the mean of 12-, 24- and 36-month ahead realized returns from models' predicted return decile sorted portfolios based on 61265 firm-year observations between 1981 and 2014. B/M is the book-to-market ratio and Mktcap is the log of price per share multiplied by the number of share outstanding. Beta is the CAPM beta estimated via the market model using the value weighted NYSE/Amex market index return applying at least 18 and up to 60 months of lagged monthly returns. The Sharpe ratio is the difference between bhr1 and 10-year US treasury bond yield divided by the standard deviation of annual stock returns. bhr1-, bhr2- and bhr3 are 12-, 24- and 36-month buy-and-hold returns for each firm after the financial year end respectively. The model predicted return is given by:

$$E_t\left[\frac{P_{t+1}+d_{t+1}}{P_t}\right]-1=\gamma_{it}+\left[R_{it}\frac{1-\omega_{it}}{R_{it}-\omega_{it}}-\gamma_{it}\right]\frac{b_t}{P_t}+\frac{R_{it}}{R_{it}-\omega_{it}}\frac{feps_{t+1}}{P_t}-\frac{\omega_{it}\gamma_{it}}{R_{it}-\omega_{it}}\frac{x_t}{P_t}+\frac{(R_{it}-1)\omega_{it}\gamma_{it}}{R_{it}-\omega_{it}}\frac{b_{t-1}}{P_t}-1.$$

Parameters with subscript *it* stand for the average for industry *i* at year *t*. $feps_{t+1}$ is the one-year ahead analysts' forecasts of earnings. x_t, b_t and P_t are earnings, book value and price at time *t* respectively. The parameters (ω, γ, *R-1*) are estimated simultaneously from the following regression on an industry-year basis:

$$\frac{feps_{t+1}}{P_t}=\frac{(R-\gamma)(R-\omega)}{R}+\frac{\omega\gamma}{R}\frac{x_t}{P_t}+\left[R-1-\frac{(R-\gamma)(R-\omega)}{R}\right]\frac{b_t}{P_t}-\frac{(R-1)\omega\gamma}{R}\frac{b_{t-1}}{P_t}+\varepsilon_{x,t+1}$$

Ohlson LID parameters in stock valuation. However, it is well documented that the I/B/E/S analysts' forecasts are upwardly biased and only available for large and financially healthy firms, especially in the earlier sample years. To examine whether the underrepresented small firms and financially distressed firms affect the results in valuation bias and valuation inaccuracy, I use the Heckman two-stage correction to account for the endogeneity in this selection bias. I estimate the probability of being included in the I/B/E/S consensus forecast as a function of the control variables presented in (6) and firm size in the first stage. While size is assumed to affect the probability of analysts' following, it is not supposed to influence earnings per share.

Table 8 reports the descriptive statistics of the estimated modified Ohlson LID parameters ($\omega_{it}, \gamma_{it}, R_{it}-1$) for industry *i* in year *t* alongside the inverse Mills ratio (λ) between 1981 and 2014. They are estimated from the pooled cross-sectional nonlinear regressions on an industry-year basis by applying the simultaneous procedure on (11). It shows that these LID parameters are compatible with those reported in Table 2. The mean and the median of λ are significantly positive. However, this is mainly because all λ are significantly positive from 1981 to 2003. In fact, all λ are not significantly different from zero after 2008. It suggests that unobserved factors that make the I/B/E/S forecasts are more likely to be associated with upwardly biased forecasts in the earlier sample years. Table 8 also reports the descriptive statistics of the valuation bias and valuation inaccuracy based on the Heckman two-stage correction model. It shows that the magnitudes are similar to those reported in Table 4.

The above analyses are based on the 5-industry classification to grouping firms. The 5-industry classification can provide sufficient numbers of observations within each cross-section to ease the concern that finite-sample estimates from the generalized method of moments (GMM) may fall

Table 8. Valuation bias and valuation inaccuracy with the Heckman two-stage correction

	ω	t-value	$\gamma-1$	t-value	ICC	t-value	IMR	t-value	bias	Inaccuracy
N	130,191	130,191	130,191	130,191	130,191	130,191	130,191	130,171	71,079	71,079
Mean	0.185	23.74	0.015	6.44	0.082	55.33	0.019	2.61	− 0.146	0.438
Stdev	0.075	5.70	0.017	4.95	0.025	23.89	0.045	4.95	0.661	0.516
Q1	0.146	19.83	0.005	2.90	0.066	41.68	− 0.004	− 0.47	− 0.359	0.142
Median	0.161	23.41	0.012	7.17	0.081	59.72	0.023	3.10	0.008	0.297
Q3	0.192	27.44	0.020	9.85	0.097	74.37	0.050	6.40	0.261	0.527

Notes: Table 8 reports the descriptive statistics of the modified Ohlson (1995) LID parameters (ω, γ), the cost of equity capital (R-$1 = ICC$), their t-statistics alongside the inverse Mills ratio (IMR). The LIDs are: $x^a_{t+1} = \omega x^a_t + OI_t + \varepsilon_{x,t+1}$, $0 \leq \omega < 1$, and $OI_{t+1} = \gamma OI_t + \varepsilon_{OI,t+1}$, $0 \leq \gamma < R$, where $x^a_t = x_t - (R-1)b_{t-1}$ is abnormal earnings and OI is 'other information.' x_t, and b_t are earnings and book value at time t respectively. A nonlinear least squares procedure is used to estimate simultaneously three parameters (ω, γ, R) from the following pooled cross-sectional nonlinear regression on an industry-year basis in a four-year rolling window:

$$\frac{feps_{t+1}}{P_t} = \frac{(R-\gamma)(R-\omega)}{R} + \frac{\omega\gamma}{R}\frac{x_t}{P_t} + \left[R - 1 - \frac{(R-\gamma)(R-\omega)}{R}\right]\frac{b_t}{P_t} - \frac{(R-1)\omega\gamma}{R}\frac{b_{t-1}}{P_t} + \varepsilon_{x,t+1}$$

where $feps_{t+1}$ is the one-year ahead analysts' forecasts of earnings, and P_t is stock price at time t. 5-industry is based on the classification from Ken French's website. Firm size is included in the first-stage regression.

far from their asymptotic values, but it may not achieve sufficient homogeneity. To mitigate this concern, I replicate the above results based on the Fama-French 12-industry classification. The results not tabulated are generally consistent with those based on the 5-industry classification. However, the valuation inaccuracies appear to be slightly improved, which may reflect a more homogeneous grouping in parameter estimations.

In principle, the simultaneous estimation procedure on (11) can be applied at the individual firm level if the firm has sufficient time series data. When I delete all firms with less than 10 observations in the firm level regressions to estimate valuation parameters for each firm, I find that the mean and the median of all three parameters are slightly greater than those presented in Table 2. The valuation biases are comparable with those shown in Table 4 in the industry-year analysis. The valuation accuracy is slightly improved. It may reflect a survivorship bias since sample firms only include those having a long history in the market place.[23]

7. Conclusion

In implementing the residual income valuation model, Ohlson (1995) proposes a parsimonious information dynamic LID. However, it is argued that the LID does not consider conservative accounting and fails to capture a firm's nonzero NPV investment projects. Existing empirical studies document that the model systematically undervalues equity shares. In this paper, I study a modified LID model in which the information dynamics incorporate firms' accounting conservatism and allow for possible future growth. The modified model does not assume any additional assumption on the book value dynamic and the modification remains consistent with MM dividend irrelevancy. It offers benefits in terms of practicability of implementation relative to the Feltham and Ohlson (1995, 1996) models. I provide an approach to estimate simultaneously the LID parameters alongside the cost of equity capital from a one-to-one mapping between the one-year ahead forecasts of earnings and current stock prices. The one-to-one mapping is important

[23]The detailed results are available on request.

because it links a firm's performance in the capital market to its product market. The approach provides a new tool for the estimation of the implied cost of equity capital.

The empirical results show that on average the persistence of 'other information' is greater than one suggesting that the modified LID parameters indeed reflect companies' future growth and investment opportunities. The out-of-sample median valuation bias and valuation inaccuracy are substantially reduced compared with results in the existing literature. There is no systematic undervaluation of stock prices using the modified LID model. The empirical results are further strengthened if a time-varying industry-specific cost of capital is used. Relative to its theoretical value, I find that investors do not place too much a weight on the short-term future earnings. I also find that the model predicted return as a proxy for the expected return measure exhibits a monotonic relation with future realized stock returns.

Intuitively, it is important to estimate parameters in information dynamics using homogeneous firms in a simultaneous estimation procedure. The main results in this paper are based on industry portfolios because industry classification is convenient to group firms sharing similar economic and accounting characteristics, and ensures a relative stability of parameter estimates. However, analysis based on an industry classification has its drawbacks. For example, industries can be very widely based, and a company may operate in two or more different industries. Future research may form homogeneous portfolio from other grouping such as from text analysis of firm 10 K product descriptions to improve valuation bias and valuation inaccuracy.

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References

Ahmed, A. S., Morton, R. M., & Schaefer, T. F. (2000). Accounting conservatism and the valuation of accounting numbers: Evidence of the Feltham-Ohlson (1996) model. *Journal of Accounting, Auditing and Finance*, *15*(3), 271–292. https://doi.org/10.1177/0148558X0001500305

Ashton, D., & Wang, P. (2013). Terminal valuations, growth rates and the implied cost of capital. *Review of Accounting Studies*, *18*(1), 261–290. https://doi.org/10.1007/s11142-012-9208-5

Barth, M. E., Beaver, W. H., Hand, J. M., & Landsman, W. R. (2005). Accruals, accounting-based valuation models, and the prediction of equity values. *Journal of Accounting, Auditing & Finance*, *20*(4), 311–345. https://doi.org/10.1177/0148558X0502000401

Beaver, W. H. (1999). Comments on an empirical assessment of the residual income valuation model. *Journal of Accounting and Economics*, *26*(1–3), 35–42. https://doi.org/10.1016/S0165-4101(98)00042-1

Beaver, W., Lambert, R., & Morse, D. (1980). The information content of security prices. *Journal of Accounting and Economics*, *2*(1), 3–28. https://doi.org/10.1016/0165-4101(80)90013-0

Beaver, W., Lambert, R., & Ryan, S. (1987). The information content of prices: A second look. *Journal of Accounting and Economics*, *9*(2), 139–158. https://doi.org/10.1016/0165-4101(87)90003-6

Beaver, W., McAnally, M., & Stinson, C. (1997). The information content of earnings and prices: A simultaneous equations approach. *Journal of Accounting and Economics*, *23*(1), 53–81. https://doi.org/10.1016/S0165-4101(96)00424-7

Callen, J. L., & Segal, D. (2005). Empirical tests of the Feltham–Ohlson (1995) model. *Review of Accounting Studies*, *10*(4), 409–429. https://doi.org/10.1007/s11142-005-4208-3

Choi, Y.-S., O'Hanlon, J., & Pope, P. (2006). Conservative accounting and linear information valuation models. *Contemporary Accounting Research*, *23*(1), 73–101. https://doi.org/10.1506/7Y8H-C8PP-8HFR-831W

Claus, J., & Thomas, J. (2001). Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and International stock markets. *The Journal of Finance*, *56*(5), 1629–1666. https://doi.org/10.1111/0022-1082.00384

Dechow, P. M., Hutton, A. P., & Sloan, R. G. (1999). An empirical assessment of the residual income valuation model. *Journal of Accounting and Economics*, *26*(1–3), 1–34. https://doi.org/10.1016/S0165-4101(98)00049-4

Easton, P. D., & Monahan, S. (2016). Review of recent research on improving earnings forecasts and evaluating accounting-based estimates of the expected rate of return on equity capital. *Abacus*, *52*(1), 35–58. https://doi.org/10.1111/abac.12064

Easton, P. D., & Monahan, S. J. (2005). An evaluation of accounting-based measures of expected returns. *The Accounting Review*, *80*(2), 501–538. https://doi.org/10.2308/accr.2005.80.2.501

Easton, P. D., Taylor, G., Shroff, P., & Sougiannis, T. (2002). Using forecasts of earnings to simultaneously estimate growth and the rate of return on equity investment. *Journal of Accounting Research*, *40*(3), 657–676. https://doi.org/10.1111/1475-679X.00066

Echterling, F., Eierle, B., & Ketterer, S. (2015). A review of the literature on methods of computing the implied cost of capital. *International Review of Financial Analysis*, *42*, 235–252. https://doi.org/10.1016/j.irfa.2015.08.001

Edwards, E., & Bell, P. (1961). *The theory and measurement of business income*. University of California Press.

Fama, E., & French, K. (1992). The cross-section of expected stock returns. *Journal of Finance*, *47*(2), 427–465. https://doi.org/10.1111/j.1540-6261.1992.tb04398.x

Fama, E., & French, K. (1993). Common risk factors in the returns of stocks and bonds. *Journal of Financial Economics*, *33*(1), 3–56. https://doi.org/10.1016/0304-405X(93)90023-5

Fama, E., & French, K. (1997). Industry costs of equity. *Journal of Financial Economics*, *43*(2), 153–193. https://doi.org/10.1016/S0304-405X(96)00896-3

Fama, E. F., & MacBeth, J. D. (1973). Risk return and equilibrium: Empirical tests. *Journal of Political Economy*, *71*, 607–636.

Feltham, G. A., & Ohlson, J. A. (1995). Valuation and clean surplus accounting for operating and financial activities. *Contemporary Accounting Research*, *11*(2), 689–732. https://doi.org/10.1111/j.1911-3846.1995.tb00462.x

Feltham, G. A., & Ohlson, J. A. (1996). Uncertainty resolution and the theory of depreciation measurement. *Journal of Accounting Research*, *34*(2), 209–234. https://doi.org/10.2307/2491500

Francis, J., Olsson, P., & Oswald, D. (2000). Comparing the accuracy and explainability of dividend, free cash flow, and abnormal earnings equity value estimates. *Journal of Accounting Research*, *38*(1), 45–70. https://doi.org/10.2307/2672922

Frankel, R., & Lee, C. (1998). Accounting valuation, market expectation, and cross-sectional stock returns. *Journal of Accounting and Economics*, *25*(3), 283–319. https://doi.org/10.1016/S0165-4101(98)00026-3

Frazzini, A., & Pedersen, L. H. (2014). Betting against beta. *Journal of Financial Economics*, *111*(1), 1–25. https://doi.org/10.1016/j.jfineco.2013.10.005

Gao, Z., Myers, J. N., Myers, L. A., & Wu, W. (2019). Can a hybrid method improve equity valuation? An empirical evaluation of the Ohlson and Johannesson (2016) model. *The Accounting Review*, *94*(6), 227–252. https://doi.org/10.2308/accr-52415

Gebhardt, W., Lee, C., & Swaminathan, B. (2001). Toward an implied cost of capital. *Journal of Accounting Research*, *39*(1), 135–176. https://doi.org/10.1111/1475-679X.00007

Gode, D., & Mohanram, P. (2003). Inferring the cost of capital using the Ohlson-Juettner model. *Review of Accounting Studies*, *8*(4), 399–431. https://doi.org/10.1023/A:1027378728141

Guay, W., Kothari, S., & Shu, S. (2011). Properties of implied cost of capital using analysts' forecasts. *Australian Journal of Management*, *36*(2), 125–149. https://doi.org/10.1177/0312896211408624

Holthausen, R., & Watts, R. (2001). The relevance of value relevance studies for financial accounting standard setting. *Journal of Accounting and Economics*, *31*(1–3), 3–75. https://doi.org/10.1016/S0165-4101(01)00029-5

Lee, C. M. C., Myers, J., & Swaminathan, B. (1999). What is the intrinsic value of the Dow? *The Journal of Finance*, *54*(5), 1693–1741. https://doi.org/10.1111/0022-1082.00164

Lo, K., & Lys, T. (2000). The Ohlson model: Contribution to valuation theory, limitations, and empirical applications. *Journal of Accounting, Auditing & Finance*, *15*(3), 337–367. https://doi.org/10.1177/0148558X0001500311

Lyle, M. R., Callen, J. L., & Elliott, R. J. (2013). Dynamic risk, accounting-based valuation and firm fundamentals. *Review of Accounting Studies*, *18*(4), 899–929. https://doi.org/10.1007/s11142-013-9227-x

Miller, M., & Modigliani, F. (1961). Dividend policy, growth and the valuation of shares. *Journal of Business*, *34*(4), 411–433. https://doi.org/10.1086/294442

Myers, J. (1999). Implementing residual income valuation with linear information dynamics. *The Accounting Review*, *74*(1), 1–28. https://doi.org/10.2308/accr.1999.74.1.1
Nekrasov, A., & Ogneva, M. (2011). Using earnings forecasts to simultaneously estimate firm-specific cost of equity and long-term growth. *Review of Accounting Studies*, *16*(3), 414–457. https://doi.org/10.1007/s11142-011-9159-2
O'Hanlon, J., & Steele, A. (2000). Estimating the equity risk premium using accounting fundamentals. *Journal of Business Finance & Accounting*, *27*(9–10), 1051–1083. https://doi.org/10.1111/1468-5957.00346
Ohlson, J. A. (1995). Earnings, book values, and dividends in security valuation. *Contemporary Accounting Research*, *11*(2), 661–687. https://doi.org/10.1111/j.1911-3846.1995.tb00461.x
Ohlson, J. A. (1999). On transitory earnings. *Review of Accounting Studies*, *4*(3/4), 145–162. https://doi.org/10.1023/A:1009653114699
Ohlson, J. A. (2003). Positive (zero) NPV projects and behavior of residual earnings. *Journal of Business Finance and Accounting*, *30*(1–2), 7–15. https://doi.org/10.1111/1468-5957.00480
Ohlson, J. A., & Johannesson, E. (2016). Equity value as a function of (eps1, eps2, dps1, bvps, beta): Concepts and realities. *Abacus*, *52*(1), 70–99. https://doi.org/10.1111/abac.12065
Ohlson, J. A., & Juettner-Nauroth, B. (2005). Expected EPS and EPS growth as determinants of value. *Review of Accounting Studies*, *10*(2), 349–365. https://doi.org/10.1007/s11142-005-1535-3
Ohlson, J., & Gao, Z. (2006). Earnings, earnings growth and value. *Foundations and Trends in Accounting*, *1*(1), 1–70. https://doi.org/10.1561/1400000001
Peasnell, K. (1982). Some formal connections between economic values and yields in accounting numbers. *Journal of Business Finance and Accounting*, *9*(3), 361–381. https://doi.org/10.1111/j.1468-5957.1982.tb01001.x
Penman, S. (2016). Valuation: Accounting for risk and the expected return. *Abacus*, *52*(1), 106–130. https://doi.org/10.1111/abac.12067
Penman, S. H., & Yehuda, N. (2019). A matter of principle: Accounting reports convey both cash-flow news and discount-rate news. *Management Science*, *65*(12), 5584–5602. https://doi.org/10.1287/mnsc.2018.3187
Penman, S. H., & Zhu, J. (2014). Accounting anomalies, risk, and return. *The Accounting Review*, *89*(5), 1835–1866. https://doi.org/10.2308/accr-50799
Penman, S., & Zhang, X.-J. (2020). A theoretical analysis connecting conservative accounting to the cost of capital. *Journal of Accounting and Economics*, *69*(1), 101–236. https://doi.org/10.1016/j.jacceco.2019.101236
Pope, F. P., & Wang, P. (2003). Discussion of positive (zero) NPV projects and the behavior of residual earnings. *Journal of Business Finance Accounting*, *30*(1–2), 17–24. https://doi.org/10.1111/1468-5957.00481
Pope, F. P., & Wang, P. (2005). Earnings components, accounting bias and equity valuation. *Review of Accounting Studies*, *10*(4), 387–407. https://doi.org/10.1007/s11142-005-4207-4
Vuolteenaho, T. (2002). What drives firm-level stock returns? *The Journal of Finance*, *57*(1), 233–264. https://doi.org/10.1111/1540-6261.00421
Wang, P. (2018). Future realized return, firm-specific risk and the implied expected return. *Abacus*, *54*(1), 105–132. https://doi.org/10.1111/abac.12109
Zhang, G. (2000). Accounting information, capital investment decisions, and equity valuation: Theory and empirical implications. *Journal of Accounting Research*, *38*(2), 271–295. https://doi.org/10.2307/2672934

Appendices

Appendix 1. Definition of the Variables with the Relevant Mnemonics

Variable/notation	Definition
LID	Linear information dynamic
OI	'Other information' in LID
ω	The persistence of abnormal earnings in LID
γ	The persistence of OI in LID
P_t	Stock price at time t
b_t	Book value of equity at time t
x_t	Earnings at time t
d_t	Dividends at time t
x_t^a	The abnormal earnings (residual income) at time t
feps_{t+1}	The one-year ahead analysts' forecasts of earnings
R	One plus cost of equity capital
$\text{E}_\text{t}[.]$	Expectation operator based on time t information
ICC	Implied cost of capital
RIV	Residual income valuation model
ω_{it}	The persistence of abnormal earnings in LID for industry i in year t
γ_{it}	The persistence of OI in LID for industry i in year t
$R_{it} - 1$	The cost of equity capital for industry i in year t
Ψ	Coefficient of x_t in valuation after controlling for b_t, d_t and x_{t+1}.
B	Coefficient of b_t in valuation after controlling for x_t, d_t and x_{t+1}.
Δ	Coefficient of d_t in valuation after controlling for x_t, b_t and x_{t+1}.
Φ	Coefficient of x_{t+1t} in valuation after controlling for x_t, b_t and d_t.
CSR	Clean surplus relation
CFN	Cash flow news
DRN	Discount rate news
RET_t	The realized one-period ahead stock returns at time t
R_t	$\ln(1 + RET_t)$
MPR_t	The model predicted rate of returns
ER_t	$\ln(1 + MPR_t)$
$resER_{t+1}$	The residual in the firm level model predicted return regression
XRET	The one-year ahead excess realized stock returns
XER	The model predicted excess returns
λ	The inverse Mills ratio

Appendix 2.

Proof of Proposition 1. '**Sufficiency**.' Given RIV: $P_t = b_t + \sum_{j=1}^{\infty} R^{-j} E_t[x_{t+j}^a]$, abnormal earnings dynamic (1) and information dynamic (2), Ohlson (1995) shows that the present value of all expected future abnormal earnings is a function of current abnormal earnings and 'other information' (OI) regardless of the model's parameter restrictions: $0 \le \gamma < 1$ or $0 \le \gamma < R$.

'**Necessity**.' Assume equations (3) and (2). From (3) and clean surplus relation (CSR): $b_{t+1} + d_{t+1} = Rb_t + x_{t+1}^a$, we have

$$P_{t+1} + d_{t+1} = b_{t+1} + d_{t+1} + \alpha_1 x_{t+1}^a + \alpha_2 OI_{t+1} = Rb_t + (1 + \alpha_1) x_{t+1}^a + \alpha_2 OI_{t+1}$$

Assumption 1 and (2) then imply that $Rb_t + (1+\alpha_1)E_t[x^a_{t+1}] + \alpha_2\gamma OI_t = RP_t$. (3) further implies $Rb_t + (1+\alpha_1)E_t[x^a_{t+1}] + \alpha_2\gamma OI_t = R(b_t + \alpha_1 x^a_t + \alpha_2 OI_t)$, or

$$Rb_t + \left(1 + \frac{\omega}{R-\omega}\right)E_t[x^a_{t+1}] + \frac{R}{(R-\gamma)(R-\omega)}\gamma OI_t$$
$$= R\left(b_t + \frac{\omega}{R-\omega}x^a_t + \frac{R}{(R-\gamma)(R-\omega)}OI_t\right)$$

Reorganizing terms, the expected future abnormal earnings can be written as $E_t[x^a_{t+1}] = \omega x^a_t + OI_t$. Therefore, information dynamic (1) holds. ■

Proof of Proposition 2. First, I show that (1) and (3) imply (4). Equation (1) can be rewritten as

$$E_t[x^a_{t+1}] = \omega x^a_t + OI_t = \frac{\omega\gamma}{R}x^a_t + \frac{(R-\omega)(R-\gamma)}{R}\left[\frac{\omega}{R-\omega}x^a_t + \frac{R}{(R-\omega)(R-\gamma)}OI_t\right].$$

(3) further implies that the above can be rewritten as $E_t[x^a_{t+1}] = \delta_1 x^a_t + \delta_2(P_t - b_t)$, where $\delta_1 = \omega\gamma/R$ and $\delta_2 = (R-\omega)(R-\gamma)/R$. That is, information dynamic (4) holds.

Next, I show (4) and (1) imply (3) or (4) and (3) imply (1). From (4), we have

$$E_t[x^a_{t+1}] = \frac{\omega\gamma}{R}x^a_t + \frac{(R-\omega)(R-\gamma)}{R}(P_t - b_t)$$
$$= \omega x^a_t + \frac{(R-\omega)(R-\gamma)}{R}\left[P_t - (b_t + \frac{\omega}{(R-\omega)}x^a_t)\right]. \quad (*)$$

If information dynamic (1) holds, the left-hand side of $(*)$,$E_t[x^a_{t+1}]$ can be replaced by $\omega x^a_t + OI_t$. Reorganizing terms in $(*)$, we have:$P_t = b_t + \alpha_1 x^a_t + \alpha_2\vartheta_t$, where $\alpha_1 = \omega/(R-\omega), \alpha_2 = R/((R-\gamma)(R-\omega))$. That is, valuation equation (3) holds.

If valuation model (3) holds, the right-hand side of $(*)$ $P_t - (b_t + \frac{\omega}{(R-\omega)}x^a_t) = \frac{R}{(R-\gamma)(R-\omega)}OI_t$. Therefore, $(*)$ implies information dynamic (1): $E_t[x^a_{t+1}] = \omega x^a_t + OI_t$. ■

Proof of Equation (10): Given (3) and the clean surplus relation, the total stock return can be expressed as

$$\frac{P_{t+1} + d_{t+1}}{P_t} = R\frac{b_t}{P_t} + \frac{R}{R-\omega}\frac{x^a_{t+1}}{P_t} + \frac{R}{(R-\omega)(R-\gamma)}\frac{OI_{t+1}}{P_t}$$

Note from (3), $\frac{R}{(R-\omega)(R-\gamma)}OI_t = P_t - b_t - \frac{\omega}{R-\omega}x^a_t$. It follows from (2) that

$$\frac{P_{t+1} + d_{t+1}}{P_t} = \gamma + (R-\gamma)\frac{b_t}{P_t} + \frac{R}{R-\omega}\frac{x^a_{t+1} - x^a_t}{P_t} + \frac{R-\omega\gamma}{R-\omega}\frac{x^a_t}{P_t} + \frac{R}{(R-\omega)(R-\gamma)}\frac{\varepsilon_{OI,t+1}}{P_t}.$$

Note $E_t[x^a_{t+1}] = E_t[x_{t+1}] - (R_{it} - 1)b_t$ and $x^a_t = x_t - (R_{it} - 1)b_{t-1}$. For firm j in industry i at time t, if we use industry-year specific parameters $(\omega_{it}, \gamma_{it}, R_{it})$ as proxies for firm-specific parameters, we have the expected return for firm j at time t:

$$E_t\left[\frac{P_{t+1}+d_{t+1}}{P_t}\right]=\gamma_{it}+\frac{E_t[x_{t+1}]-(\gamma_{it}-1)b_t}{P_t}+\frac{\omega_{it}}{R_{it}-\omega_{it}}\frac{E_t[x_{t+1}]-\gamma_{it}x_t}{P_t}$$
$$-\frac{(R_{it}-1)\omega_{it}}{R_{it}-\omega_{it}}\frac{b_t-\gamma_{it}b_{t-1}}{P_t},$$

or

$$E_t\left[\frac{P_{t+1}+d_{t+1}}{P_t}\right]=\gamma_{it}+\frac{R_{it}}{R_{it}-\omega_{it}}\frac{E_t[x_{t+1}]}{P_t}-(\gamma_{it}-1)\frac{b_t}{P_t}-\frac{\omega_{it}\gamma_{it}}{R_{it}-\omega_{it}}\frac{x_t}{P_t}$$
$$-\frac{(R_{it}-1)\omega_{it}}{R_{it}-\omega_{it}}\frac{b_t-\gamma_{it}b_{t-1}}{P_t}.$$

■