Value Relevant Information Beyond Analysts' Forecasts: The Role of Growth Potential and Bankruptcy Risk

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ABSTRACT

This paper explores the value relevant information beyond analysts' forecasts in residual income dynamics and equity valuation. More specifically, we incorporate Growth Potential (GP) and Bankruptcy Risk (BK) into the residual income dynamics beyond analysts' forecasts. Among the various proxies, we find the Present Value of Growth Potential (PVGO) of Kester (1984) and the Loss Given Default (LGD) of Merton (1974) best capture GP and BK effects. We demonstrate that GP and BK provide additional information content beyond lagged residual income and analysts' forecasts in the residual income dynamics. Moreover, incorporating GP and BK in residual income dynamic beyond analysts' forecasts reveals superiority in equity valuation in terms of forecast accuracy and explainability. The subsample analysis shows that the improvement of this model is mainly reflected in the high potential growth subsample and high financial risk subsample, in line with growth potential and bankruptcy risk theories.

JEL classification: M40, M41, G14

Keywords: Equity Valuation, real options, linear information dynamics, value relevant information, analysts' forecast, growth potential, bankruptcy risk

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1. Introduction

Residual Income Models (RIM) have become prominent in market-based accounting research (MBAR) over the past decade. The work of Ohlson (1995) develops the residual income model by integrating early normative approach with modern finance theory and is considered to be one of the most important developments in capital market research (Bernard, 1995, pp. 733). The forecasting of future residual income is important for implementing RIM (Dechow et al. 1999; Ohlson 2001; Cheng 2005). Analysts' forecasts are commonly used to deduce other information in the residual income dynamics. By capturing forward-looking information, the analysts' forecasts are reasonable and easy to incorporate in various valuation models. Dechow et al. (1999) use analysts' earnings forecasts to backwardly deduce the other value relevant information in Ohlson (1995). Their results generally support the information dynamics in Ohlson (1995) and confirm the superior predictive ability of the Ohlson model with analysts' forecasts. Further research on the information content of analysts' forecasts (Cheng, 2005; Ramnath et al. 2008) suggests that analysts' forecasts might not fully includes certain types of public information. According to Cheng (2005), analysts' forecasts do indeed incorporate substantial information in the explicit information items and even unique information beyond such items. However, it also reveals its deficiency in underestimating or ignoring 'the effects of conservative accounting and transitory earnings when predicting future earnings, and the effects of economic rents, conservative accounting and risk when explaining the market-to-book ratio' (Cheng, 2005, pp. 6).

The aim of this paper is to examine value relevance information beyond analysts' forecasts in predicting residual income, and to further explore the valuation effect of such value relevant information. We include Growth Potential (GP) and Bankruptcy Risk (BK) parameters beyond analysts' forecasts in the Ohlson (1995) dynamics. More specifically, we respectively incorporate R&D intensity, the direct and indirect measure of Present Value of Growth Option (PVGO) suggested in Trigeorgis and Lambertides (2014) and the PVGO of Kester (1984) as proxies for GP; we respectively use Altman's Z-Score (1968) and the Loss Given Default (LGD) implied in the Merton Model (1974) as proxies for BK. Following Cheng (2005) and Tsay et al. (2008), this paper contributes to findings on value relevance information beyond analysts' forecasts in equity valuation. We demonstrate that GP and BK do yield incremental information in the residual income dynamic, and incorporating GP and BK in the residual income dynamic can improve the valuation performance of the equity valuation model in terms of forecast bias, forecast accuracy and explainability. Moreover, this thesis contributes to the literature of non-linear equity valuation with real options through bringing the parameters with option characteristics directly into linear information dynamics. In the non-linear accounting-based equity valuation literature, models with real options are always developed from the recursion value (Hwang and Sohn, 2000; Ashton et al. 2003) or the decision-making process (Zhang, 2000; Yee,2000). In other words, the option value is defined as an attachment to the estimated equity value from linear models (the value outside the linear valuation function). We investigate from a different perspective, and explore the possibility of introducing the parameters with option characteristics directly into the residual income dynamics. The results suggest that the linear model including option parameters inside outperforms the original linear models in equity valuation.

2. Valuation Models

Traditional Residual Income Model

Ohlson (1995) with other information is expressed in LID1. It assumes that the time-series behavior of residual income is as follows:

$$\tilde{x}^a_{t+1} = \omega_{11} x^a_t + v_t + \tilde{\varepsilon}_{1t+1}, \qquad \text{(LID1)}$$

$$\tilde{v}_{t+1} = \omega_{22} v_t + \tilde{\varepsilon}_{2t+1}.$$

Residual income $\tilde{x}^a_{t+1}$ and the other information variable $\tilde{v}_{t+1}$ both follows first order auto regression. The persistence parameter of residual income ω_{11} is predicted to lie in the range of $0 \leq \omega_{11} < 1$. ω_{22} represents the persistence parameter of other information and also has a range of $0 \leq \omega_{22} < 1$. $\tilde{\varepsilon}_{1t+1}$ and $\tilde{\varepsilon}_{2t+1}$ are unpredictable disturbances with a mean of zero. Combining the LID1 and the RIM valuation equation, Ohlson (1995) with other information derives equity value as a function of book value, residual income and other information as follows:

$$V1_t = B_t + \alpha_1 x^a_t + \alpha_2 v_t, \qquad \text{(V1)}$$

where

$$\alpha_1 = \frac{\omega_{11}}{R - \omega_{11}},$$

$$\alpha_2 = \frac{R}{(R - \omega_{11})(R - \omega_{22})}.$$

Residual income is represented as $x_t^a = x_t - (R-1)B_{t-1}$, where x_t is earnings and B_{t-1} is the year beginning book value of equity. R equals one plus the cost of capital. Ohlson (1995) with other information is consistent with Modigliani–Miller dividend irrelevance. It assumes that the expected goodwill is zero and that book value is an unbiased estimator of market value.

Following Dechow et al. (1999), we adopt the analysts' consensus forecasts for future residual income as a measure of value relevant information variable. The other information variable is deduced from analysts' forecasts for future residual income:

$$v_t = E_t[x_{t+1}^a] - \omega_{11}x_t^a = f_t^a - \omega_{11}x_t^a,$$

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

This other information variable, v_t, in Ohlson (1995), is used in all the models in this study as a proxy for analysts' forecasts.

Residual Income Model with Growth Potential

Growth potential reflects accounting conservatism in accounting-based valuation research. The accounting literature identifies two broad forms of conservatism, namely conditional conservatism and unconditional conservatism (Ruch and Taylor, 2015). Conditional conservatism refers to the asymmetric recognition of positive and negative economic news while unconditional conservatism arises through the consistent under-recognition of accounting net assets. Research built on linear information dynamics in the residual income model mostly focuses on unconditional conservatism, such as accelerated depreciation methods, expensing R&D costs and failure to recognize future positive NPV profits

(Feltham and Ohlson, 1995; 1996). Investment opportunities might bring positive goodwill if they are characterized by positive NPV investment projects (Feltham and Ohslon, 1996; Richardson and Tinaikar, 2004). Such investment opportunities reveal the growth potential of a company. The growth prospect of a specific company is rationally reflected in the current stock markets, but not recognized in the current accounting net assets. The importance of growth option in determining equity value has increasingly been addressed in the literature (Zhang, 2000; Cao et al. 2008). Thus, we include the growth potential beyond analysts' forecasts in forecasting next period residual income:

$$\tilde{x}_{t+1}^{a} = \omega_{11}x_t^a + \omega_{12}v_t + \omega_{13}GP_t + \tilde{\varepsilon}_{1t+1}, \qquad \text{(LID2)}$$

$$\tilde{v}_{t+1} = \omega_{22}v_t + \tilde{\varepsilon}_{2t+1},$$

$$\widetilde{GP}_{t+1} = \omega_{33}GP_t + \tilde{\varepsilon}_{3t+1}.$$

In LID2, the GP_t represents the growth potential and ω_{33} signifies the persistence parameter of the growth potential. The implied valuation function is:

$$V2_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t, \qquad \text{(V2)}$$

where

$$\alpha_1 = \frac{\omega_{11}}{(R-\omega_{11})},$$

$$\alpha_2 = \frac{R\omega_{12}}{(R-\omega_{11})(R-\omega_{22})},$$

$$\alpha_3 = \frac{R\omega_{13}}{(R-\omega_{11})(R-\omega_{33})}.$$

We respectively utilize four variables to capture growth potential. The first is R&D intensity[1], which reflects a firm's systematic determination to cultivate multistage growth options. It is frequently used in the literature to capture expected economic rents in future earnings (Cheng, 2005; Shah et al. 2009). The second and third growth potential variables are proxied by the direct and indirect measure of PVGO of Trigeorgis and Lambertides (2014), while the fourth measure of growth potential is the PVGO suggested by Kester (1984).

Residual Income Model with Bankruptcy Risk

Literature on bankruptcy risk (Ferris et al. 1997; Rose-Green and Dawkins, 2000) indicates that a firm's probability of bankruptcy has a significant effect on its stock price. High financial risk exposes adverse information, which in turn lowers the market value of the assets (Cornett and Travlos, 1989). According to Lim and Tan (2007), high value-at-risk (VAR) tends to result in a weaker earnings-return relationship. Meanwhile, a company's decision to alter the degree of financial leverage has a significant impact on equity value (Cornett and Travlos, 1989). Following Tsay et al. (2008), this empirical study considers the role of financial risk in predicting next period residual income beyond analysts' forecasts:

$$\tilde{x}^a_{t+1} = \omega_{11} x^a_t + \omega_{12} v_t + \omega_{14} BK_t + \tilde{\varepsilon}_{1t+1}, \qquad \text{(LID3)}$$

$$\tilde{v}_{t+1} = \omega_{22} v_t + \tilde{\varepsilon}_{2t+1},$$

[1] We also alternatively test R&D expenses, and average R&D expenses for the past three year instead of R&D intensity. In all cases, the main results do not change.

$$\widetilde{BK}_{t+1} = \omega_{44} BK_t + \tilde{\varepsilon}_{3t+1}.$$

BK_t is the bankruptcy risk and ω_{44} is the parameter representing the persistence of financial risk from one period to the next. The implied valuation function is:

$$V3_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_4 BK_t, \quad \text{(V3)}$$

where

$$\alpha_1 = \frac{\omega_{11}}{(R - \omega_{11})},$$

$$\alpha_2 = \frac{R\omega_{12}}{(R - \omega_{11})(R - \omega_{22})},$$

$$\alpha_4 = \frac{R\omega_{14}}{(R - \omega_{11})(R - \omega_{44})}.$$

Bankruptcy risk is respectively proxied by two variables, the first of which is the Z-Score of Altman (1968) and second of which is the Loss Given Default (LGD) inferred from the Merton Model (1974).

Residual Income Model with both Growth Potential and Bankruptcy Risk

We also consider both the growth potential and bankruptcy risk beyond analysts' forecasts in predicting residual income and equity value:

$$\tilde{x}_{t+1}^a = \omega_{11} x_t^a + \omega_{12} v_t + \omega_{13} GP_t + \omega_{14} BK_t + \tilde{\varepsilon}_{1t+1}, \quad \text{(LID4)}$$

$$\tilde{v}_{t+1} = \omega_{22} v_t + \tilde{\varepsilon}_{2t+1},$$

$$\widetilde{GP}_{t+1} = \omega_{33} GP_t + \tilde{\varepsilon}_{3t+1},$$

$$\widetilde{BK}_{t+1} = \omega_{44} BK_t + \tilde{\varepsilon}_{4t+1}.$$

GP_t represents the growth potential and BK_t represents the bankruptcy risk. The implied valuation function is:

$$V4_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t + \alpha_4 BK_t, \qquad \text{(V4)}$$

where

$$\alpha_1 = \frac{\omega_{11}}{(R - \omega_{11})},$$

$$\alpha_2 = \frac{R\omega_{12}}{(R - \omega_{11})(R - \omega_{22})},$$

$$\alpha_3 = \frac{R\omega_{13}}{(R - \omega_{11})(R - \omega_{33})},$$

$$\alpha_4 = \frac{R\omega_{14}}{(R - \omega_{11})(R - \omega_{44})}.$$

3. Research Methodology

3.1 Empirical Estimation Models

To examine value relevance information beyond analysts' forecasts in predicting residual income, the parameters of the residual income dynamics are estimated in pooled time-series cross-sectional regressions (Fama-Macbeth regressions) using all historically available UK data in Datastream. The Fama-Macbeth approach is widely used in the existing empirical accounting research (Dechew et al., 1999; Easten and Pae, 2004; Cheng, 2005). It is designed to address concerns about cross-sectional correlation (Gow et al. 2010). Newey-West corrected Fama-MacBeth standard errors are also used in the regression to correct for serial correlation in addition to cross-sectional correlation. To reduce the influence of heteroscedasticity, following Choi et al. (2006), all the regression variables in LID are deflated by the beginning book value of equity. It is found that of the various deflaters, book value is the most widely used in the UK empirical accounting research (Akbar and Stark, 2003; Dedman et al., 2010; Rees and Valentincic, 2013), and it provides the lowest bias in valuation (Shen and Stark, 2013).

3.1.1 Growth Potential

We comparatively utilize four variables to measure growth potential: R&D intensity, the direct and indirect measure of PVGO of Trigeorgis and Lambertides (2014), and the PVGO suggested in Kester (1984).

$$\frac{x_{j,t}^{a}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^{a}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t-1}^{RD}}{B_{j,t-1}} + \varepsilon_t. \tag{GP1}$$

$$\frac{x_{j,t}^{a}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^{a}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t-1}^{TLDirect}}{B_{j,t-1}} + \varepsilon_t. \tag{GP2}$$

$$\frac{x_{j,t}^{a}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^{a}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t}^{TLIndirect}}{B_{j,t-1}} + \varepsilon_t. \tag{GP3}$$

$$\frac{x_{j,t}^{a}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^{a}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t-1}^{Kester}}{B_{j,t-1}} + \varepsilon_t. \tag{GP4}$$

In (GP1), $GP_{j,t-1}^{RD}$ represents the R&D intensity for company j at time $t-1$, and it is measured as the average research and development expenses for the past three years divided by sales. In (GP2), $GP_{j,t-1}^{TLDirect}$ represents the PVGO directly calculated in Trigeorgis and Lambertides (2014) for company j at time $t-1$. The PVGO signifies the firm's value arising from future potential growth and it is calculated by directly subtracting the perpetual discounted operating cash flow from the market value of the firm. More specifically, the direct PVGO of Trigeorgis and Lambertides (2014) can be calculated as follows:

$$PVGO_{j,t}^{Direct} = F_{j,t} - \frac{CF_{j,t}}{k_{j,t}},$$

where $F_{j,t}$ is the market value of the firm, $CF_{j,t}$ is the cash flow from operating activities and $k_{j,t}$ is the cost of capital. The indirect measure of the PVGO of Trigeorgis and

Lambertides (2014) is used as the third potential growth variable. As illustrated below, the growth in capital investment and yet-unexercised growth options is related to eight dimensions based on real options theory (Trigeogis, 1996; Smit and Trigeorgis, 2004; Ioulianou et al. 2017):

$$Market\ GO = f(firm - specific\ volatility, managerial\ flexibility/asymmetry,$$

$$organizational\ flexibility, financial\ flexibility, cash\ flow\ coverage,$$

$$R\&D\ intensity, cumulative\ growth, market\ power, fixed\ effects,$$

$$industry\ effects, interactions).$$

In the above Growth Option (GO) equation, $Market\ GO$ represents market growth option score and it is measure as direct PVGO divided by market value of the firm. Firm-specific volatility is obtained as the residuals of the regression of the equity's returns on the FTSE 100 index return based on the market model. Skewness is estimated from the monthly stock returns over the previous three years. R&D intensity is obtained as the average R&D percentage (R&D divided by sales) over the previous three years. Organizational flexibility is measured as Selling, General, and Administrative (SGA) expenses divided by sales. Financial Leverage is estimated as book value of total liabilities divided by market value of the firm. Cumulative Sales Growth (SG) is calculated as the percentage change in firm revenues for the past three years. The firm's market power is measured as the square root of the Herfindahl-Hirschman Index (HHI) if the firm's Tobin's q is above the industry average in the specific year, otherwise as 0. Cash Flow Coverage (CFC) is measured as cash flow from operating activities divided by total liabilities. The above equation is regressed using the Fama-Macbeth approach from the earliest year all the required variables are available through year t to obtain the yearly cross-sectional coefficients loadings to the eight option-driven variables. An interaction term between Skewness and Leverage is included, and industry dummies are included in the regression. Following this, the current data for these variables for each firm is utilized with the coefficients to determine a predicted $GO_{j,t}$ for each firm. The indirect PVGO is then calculated as the product of predicted GO and the market value of the firm:

$$PVGO_{j,t}^{Indirect} = \frac{GO_{j,t}^{Predicted}}{F_{j,t}}.$$

In (GP2) and (GP3), the direct and indirect PVGO of Trigeorgis and Lambertides (2014) is set to be zero if cash flow from operations is negative or the market value of the firm is lower than the capitalized cash flow from operations.

In (GP4), $GP_{j,t-1}^{Kester}$ represents the PVGO suggested in Kester (1984). It is determined by subtracting the capitalized earnings from the market value of equity:

$$PVGO_{j,t}^{Kester} = V_{j,t} - \frac{E_{j,t}}{r_{j,t}},$$

where $V_{i,t}$ is the market value of equity; $E_{i,t}$ represents earnings; and $r_{i,t}$ represents the cost of equity. One year lagged analysts' forecasts earnings were used to calculate the PVGO of Kester (1984). By using lagged anticipated earnings, Kester (1984) avoid the one-off company-specific surprises that may affect earnings outcomes. The PVGO of Kester (1984) is set to be zero if anticipated earnings are negative or the market value of equity is lower than the capitalized anticipated earnings.

3.1.2 Bankruptcy Risk

Two variables are used to measure the bankruptcy risk: Altman's Z-Score and the LGD in the Merton Model.

$$\frac{x_{j,t}^{a}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^{a}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK_{j,t-1}^{Z-Score}}{B_{j,t-1}} + \varepsilon_{t}. \qquad \text{(BK1)}$$

$$\frac{x_{j,t}^{a}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^{a}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK_{j,t-1}^{Merton}}{B_{j,t-1}} + \varepsilon_{t}. \qquad \text{(BK2)}$$

In (BK1), $BK_{j,t-1}^{Z-Score}$ represents the reciprocal of Altman's Z-Score (1968). Altman's Z-Score is the output of a credit-strength test which is based on five key financial ratios. It measures the likelihood of bankruptcy for a company. The calculation used to determine the Altman Z-score is as follows:

$$ZSCORE_{t} = (3.3)\frac{EBIT_{t}}{TA_{t}} + (1.0)\frac{Sales_{t}}{TA_{t}} + (1.4)\frac{RE_{t}}{TA_{t}} + (0.6)\frac{MV_{t}}{TD_{t}} + (1.2)\frac{WC_{t}}{TA_{t}},$$

where $EBIT_t$ is the earnings before interest and tax of the firm; TA_t is the total assets; $Sales_t$ is the net sales; RE_t is the retained earnings; MV_t is the market value of equity; TD_t is the total liability; and WC_t is the working capital. The second proxy for the bankruptcy risk is the LGD in the Merton (1974) Model. The loss given default is equal to the Expected Loss (EL) divided by the Probability of Default (PD). LGD works better in the regression than PD for two reasons. First, LGD is the conditional expectations and it reflects the financial risk. Second, it is similar in amount terms to other regression variables. The empirical implementation of the Merton model is similar to Charitou et al. (2013).

$$LGD(F,T) = K * N(-d_2) - Fe^{(rf-D)T}N(-d_1),$$

$$d_1 = \frac{\ln\left(\frac{F}{B}\right) + (\mu - D + 0.5\sigma_v^2)T}{\sigma_V\sqrt{T}},$$

$$d_2 = d_1 - \sigma_V\sqrt{T} = \frac{\ln\left(\frac{F}{B}\right) + (\mu - D - 0.5\sigma_v^2)T}{\sigma_V\sqrt{T}}.$$

In the model, K is the face value of debt; F is the firm value and it equals the sum of the market value of equity and the face value of debt; D is the total payout yield; σ_V is the standard deviation of firm value; T is the time-to-debt maturity; rf is risk-free interest rate; and μ is the actual firm value return. Due to the lack of monthly and quarterly debt data, the volatility of the firm is calculated as the standard deviation of the firm return in the past 5 years. The time-to-debt maturity calculation is similar to Charitou et al. (2013). The total figure for long term debt is assumed to have a common maturity of 5 years, while the short-term debt has a maturity of 1 year.

3.2 Estimation of Out-of-Sample Valuation Performance

Yearly regressed LID parameters are used to calculate the cross-sectional theoretical implied coefficients in equity valuation (various α in each model). These coefficients are applied to all the firms with the necessary data to calculate the estimated market value. We contrast the valuation performance of the models which build on various LID in terms of out-of-sample forecast bias, forecast accuracy and explainability, following Francis et al. (2000). The mean and median Proportional Valuation Error (PVE) measures the forecast bias while the median Absolute Proportional Valuation Error (APVE) measures the forecast accuracy.

$$PVE_t = \frac{MV_t^{Est} - MV_t^{Act}}{MV_t^{Act}},$$

$$APVE_t = \frac{|MV_t^{Est} - MV_t^{Act}|}{MV_t^{Act}},$$

where MV_t^{Est} represents the estimated market value for firm j at time t and MV_t^{Act} represents the market value for firm j at time t. The central tendency of the value estimates is also reported, defined as the percentage of observations with the estimated value lying within 15% of the security price. Following Cheng (2005), the Fama-Macbeth adjusted R Square is used to measure the ability of the estimated equity value in explaining the market value (explainability).

3.3 Samples and Data

The sample includes all UK non-financial companies listed on the London Stock Exchange. Dead companies are included to avoid survivorship bias. Market data are collected from Datastream, accounting variables are collected from Worldscope, and analysts' forecasts data are retrieved from I/B/E/S. All databases are accessed through Thomson Reuters Datastream. To ensure the integrity of the dataset, all variables are collected from the earliest year UK data are available on Thomson Reuters Datastream. The estimation of LID parameters uses pooled time-series cross-sectional regressions with all historically available data from 1980. The final comparison of residual income dynamics and equity valuation performance consist of 21 years of annual data from 1995 to 2015.

Table 1 provides the definition for each variable used in empirical analysis. The estimation of LID parameters and equity valuation are conducted on a per share basis. The market value of equity is collected six months after the financial year end (ensuring there is sufficient time for UK companies to publish accounting reports). Following Begley and Feltham (2002), earnings are before extraordinary items and it is assumed that they are transitory and therefore unlikely to affect the residual income. We use the median of one year ahead forecast EPS to measure analysts' forecasts of earnings. The eight option-motivated variables are measured according to their definitions in Trigeorgis and Lambertides (2014). In terms of the Merton model, due to the lack of monthly debt data, we calculate the volatility of firm using past 5 period yearly data following Hwang and Sohn (2010). The definition of variables in the Merton model follows Charitou et al. (2013). As for the risk-free rate, the British Government Securities Ten Year Nominal Par Yield is used. The cross-sectional cost of equity has been widely used in relative empirical accounting literature (Ahmed et al. 2002; Choi et al. 2006). Following O'Hanlan and Steele (2000) and Copeland et al. (2000), the cost of equity equals the risk-free rate plus a constant risk premium of 5%. We estimate the cost of debt to be 4% lower than the cost of equity similar to Trigeorgis and Lambertides (2014). According to Cao et al. (2008), the estimation of the PVGO is insensitive to the discount rate.

Table 1. Variable Definitions

Variables	Label	Data Items and Definition
Market Value of Equity	MV_t	Market Value = Market Value Capital **(MV)** For accounting periods ending before the 20th January 2007, UK firms had up to six months after the financial year-end to publish accounting data. This was reduced to four months for accounting periods ending after that date following the implementation of the Transparency Directive 2004/109/EC. To maintain consistency, we collect the market value of equity (MV) six months after the financial year-end (6 months after time t).
Book Value	B_t	Book Value = Common Equity **(WC03501)**
Earnings	x_t	Earnings = Net Income Available to Common **(WC01751)**
Residual Income	x_t^a	$x_t^a = x_t - r_t * B_{t-1}$
Analysts' Forecasts of Earnings	f_t	Analysts' forecasts of Earnings = Forecast Earnings Per Share Median Value FY1 **(EPS1MD)** * Common Shares Used to Calculate Earnings Per Share **(WC05191)**
Cash Flow from Operating Activities	CF_t	Cash Flow from Operating Activities = Net Cash Flow Operating Activities **(WC04860)**
R&D Expenses	$R\&D_t$	Research and Development Expenses = Research & Development **(WC01201)**
SGA expenses	SGA_t	SGA expenses = Selling, General & Administrative Expenses **(WC01101)**
Sales	$Sales_t$	Sales = Net Sales or Revenues **(WC01001)**
Total Assets	TA_t	Total Assets **(WC02999)**
Total Liabilities	TL_t	Total Liabilities **(WC03351)**
Market Value of Firm	F_t	Market Value of Firm = Market Value Capital **(MV) +** Total Assets **(WC02999) -** Common Equity **(WC03501) –** Deferred Taxes **(WC03263)**
Tobin's Q	Q_t	Tobin's Q = Market Value of Firm / Total Assets **(WC02999)**

Table 1. (Continued)

Firm Specific Volatility **(Trigeorgis and Lambertides, 2014)**	σ_t	Firm Specific Volatility = The residual of the regression of the equity's returns on the FTSE 100 index return based on the market model using previous 3 years' monthly return data
Asymmetry **(Trigeorgis and Lambertides, 2014)**	$Skewness_t$	Asymmetry = The skewness of the monthly stock returns for the previous three years
R&D Intensity **(Trigeorgis and Lambertides, 2014)**	$R\&D\_INT_t$	R&D Intensity = Average R&D Expenses for recent three years / Sales
Organizational Flex **(Trigeorgis and Lambertides, 2014)**	SGA_PER_t	Organizational Flex = SGA expenses / Sales
Financial Flex **(Trigeorgis and Lambertides, 2014)**	$Leverage_t$	Financial Flex = Total Liability / Market Value of Firm
Cumulative Sales Growth **(Trigeorgis and Lambertides, 2014)**	SG_t	Cumulative Sales Growth = Percentage of Change in Sales over recent 3-year period
Market Power **(Trigeorgis and Lambertides, 2014)**	HHI_t	Market Power = The square root of the Herfindahl-Hirschman Index (HHI) for the company if the firm's Tobin's q is above the industry average in the specific year, and 0 otherwise. HHI for company = {[(Sales – International Sales) / Sum of Company Sales in the Industry]*100}^2
Cash Flow Coverage **(Trigeorgis and Lambertides, 2014)**	CFC_t	Cash Flow Coverage = Cash Flow from Operating activities / Total Liability
EBIT	$EBIT_t$	EBIT = Earnings Before Interest and Taxes (EBIT) **(WC18191)**
Retained Earnings	RE_t	Retained Earnings **(WC03495)**

Table 1. (Continued)

Working Capital	WC_t	Working Capital **(WC03151)**
Residual Income	x_t^a	$x_t^a = x_t - r_t * B_{t-1}$
Face Value of Total Debt	K_t	Face Value of Total Debt = [Short term debt **(WC03501)** + Long term debt **(WC03251)**]
Total Payout Yield	D_t	Total Payout Yield = Ln {[1 + Total Payout] / Market Value of Equity in the previous year} Total Payout = [Cash Dividends **(WC05376)** + Interest Expense **(WC01251)**]
Market Value of Firm in Merton Model [2]	F_t^{Merton}	Market Value of Firm in Merton = Market Capitalization **(WC08001) +** Total Debt **(WC03255)**
Volatility of Firm in Merton Model	$\sigma_{F,\ t}$	Volatility of Firm is calculated as the Standard Deviation of Firm Return in the previous 5 Years following Hwang and Sohn (2010) Firm Return = Ln {[Firm Value + Total Payout] / Firm Value in the previous year}
Time to Maturity	T	Time to Maturity = [Present Value of Short Term Debt * 1 + Present Value of Long Term Debt * 5] / [Present Value of Short Term Debt + Present Value of Long Term Debt] Present Value of Short Term Debt = Short Term Debt / Risk-free Rate Present Value of Long Term Debt = Long Term Debt / (Annual Average of British Government Securities Five Year Nominal Par Yield) ^ 5
Cost of Equity	r_t	Cross Sectional: An annual Average of British Government Securities Ten Year Nominal Par Yield (10 Year Par Yield) plus average risk premium rate of 5%

[2] This definition of market firm value has the advantage of focusing directly on the market cap and debt. It is used only in Merton Model. We also use the previous definition of Market Value of Firm to test the Merton Model. The main results remain unchanged.

Table 1. (Continued)

Risk-free Rate	rf_t	Cross Sectional: An annual Average of British Government Securities Ten Year Nominal Par Yield (10 Year Par Yield)
Cost of Equity	r_t	Cross Sectional: An annual Average of British Government Securities Ten Year Nominal Par Yield (10 Year Par Yield) plus average risk premium rate of 5%
Cost of Capital	k_t	Cost of Capital = Cost of Equity * (1 – Debt Ratio) + Cost of Debt * Debt Ratio * (1 – Tax Rate) Cost of Debt = Cost of Equity – 3% Debt Ratio = Total Liability / Total Assets Tax Rate = Income Taxes **(WC01451)** / Pretax Income **(WC01401)**

4. Results

4.1 Results on Residual Income Dynamics

In comparing the results on value relevance information beyond analysts' forecasts in the residual income dynamic, we respectively incorporate four growth potential proxies and two bankruptcy risk proxies. In order to present the results in a simplified and clear manner, the following sequences are used: (1) comparing the residual income dynamics incorporating various growth potential proxies (section 5.4.1.1); (2) comparing the residual income dynamics incorporating various bankruptcy risk proxies (section 5.4.1.2); (3) through using the best proxies for GP and BK, testing the residual income dynamic with both growth potential and bankruptcy risk beyond analysts' forecasts (section 5.4.1.3).

4.1.1 LID with Growth Potential

Table 2 provides a summary of value estimates of regression variables in the residual income dynamic with GP and analysts' forecasts, based on the joint sample. All variables are stated on a per share basis and deflated by one year lagged book value. The median residual income is around 0.01, close to zero. This suggests that nearly half the sample has positive residual income. The median of other information variable is around 0.04, which indicates that, on average, analysts have an optimistic view regarding the future prospect of companies. With respect to the GP variables, GP^{RD} represents the R&D intensity and it has a mean of 0.44 and median of around zero. Further analysis on the R&D expenses reveal that nearly half the sample observations reveal zero research and development expenses, similar to the descriptive statistics in Trigeorgis and Lambertides (2014). $GP^{TLDirect}$, $GP^{TLIndirect}$ and GP^{Kester} all measure the present value of growth options. It can be inferred from the table that the direct PVGO of Trigeorgis and Lambertides provides the largest median (around 0.77), followed by the indirect PVGO of Trigeorgis and Lambertides (about 0.51). Kester's PVGO has the lowest median at around 0.41.

Table 2. Value Estimates of Growth Potential Variables

	N	0.25	Median	0.75	Mean	S.D.
x^a	10419	-0.08	0.01	0.09	-0.08	0.49
v	10419	-0.01	0.04	0.10	0.08	0.21
GP^{RD}	10419	0.00	0.00	0.01	0.44	2.99
$GP^{TLDirect}$	10419	0.00	0.77	1.98	1.48	2.34
$GP^{TLIndirect}$	10419	0.15	0.51	1.01	0.79	1.05
GP^{Kester}	10419	0.00	0.41	1.26	1.02	1.73

Notes: Table 2 reports the value estimates of relative GP variables in the residual income dynamic, based on a joint sample of 10419. x^a stands for residual income and v stands for other information variable. GP^{RD}, $GP^{TLDirect}$, $GP^{TLIndirect}$ and GP^{Kester} respectively represent the growth potential proxies of R&D intensity, direct and indirect PVGO of Trigeorgis and Lambertides (2014), and PVGO of Kester (1984). All variables are stated on a per share basis and deflated by one year lagged book value.

To estimate the indirect PVGO of Trigeorgis and Lambertides, the coefficients from the GO equation are needed to calculate the predicted GO. We regress the GO equation in Trigeorgis and Lambertides (2014) utilizing Fama-Macbeth regression approach from the earliest year that all the required variables are available through year t to obtain the yearly cross-sectional coefficients loadings to the eight option-driven variables[3]. Panel A in Table 3 reports the summary statistics of market GO and the eight option-motivated variables. The mean of market GO is around 0.59, which indicates that on average, the direct PVGO occupies 59% of the market value of the firm. Panel B in Table 3 presents the Fama-Macbeth coefficients over the period 1983-2015. The signs of the coefficients loadings to the option-motivated variables are the same as the findings in Trigeorgis and Lambertides (2014). Among the variables, firm specific volatility, organizational flexibility, cumulative sales growth and market power are significantly and positively related to growth option. It suggests that higher idiosyncratic risk, SGA expenses, sales growth and market competitive power contribute to larger growth option value. Meanwhile, skewness has a significant relationship to growth option, and reveals a positive interaction with financial leverage.

[3] This Fama-Macbeth approach follows both Dechow et al. (1999) and Choi et al. (2006). We also directly use 1, 3, 5 years' estimation window instead of the Fama-Macbeth approach to estimate the coefficients. The signs of the coefficients are similar, and the predicted GO score are not that sensitive to the estimation approach. In all cases the main results of the study do not change.

Table 3. Summary Statistics and Coefficient Estimates of GO Equation

Panel A Summary Statistics of Growth Option Variables

Variable	Mean	Std.Dev.	Q1	Median	Q3
Market GO	0.59	1.28	0.15	0.50	0.85
Firm-specific volatility	0.12	0.09	0.07	0.10	0.14
Asymmetry	0.57	1.04	-0.05	0.45	1.06
R&D Intensity	0.19	4.07	0.00	0.00	0.01
Organizational Flex	0.81	10.87	0.13	0.22	0.37
Financial Flex	0.16	0.16	0.03	0.11	0.24
Cumulative Sales Growth	0.16	0.59	-0.00	0.08	0.20
Market Power	10.24	246.10	0.00	0.00	0.02
Cash Flow Coverage	7.43	235.61	0.06	0.37	1.18
N	18248				

Panel B Coefficients Estimates of Growth Option Variables

	Dependent Variable: Market GO	
Independent Variables	Coef.	t-Stat.
Firm-specific volatility	3.294***	7.65
Asymmetry	-0.071***	-5.45
R&D Intensity	0.097	0.16
Organizational Flex	0.132***	2.70
Financial Flex	-0.223	-1.48
Cumulative Sales Growth	0.068**	2.55
Market Power	0.001*	1.65
Cash Flow Coverage	-0.009***	-8.60
Skewness× Leverage	0.180**	2.02
N	18248	
R^2	0.169	

Notes: Table 3 reports summary statistics and coefficient estimates of GO equation. The GO euqation is regressed using Fama-Macbeth regression utilizing all available UK data from 1983 to 2015. Average R^2 is the average R statistic and t value (in parentheses) is based on Newey-West corrected Fama-MacBeth standard errors. The most extreme 1% of the regression variables are winsorized in estimating the coefficients. $Market\ GO$ represents market growth option score and it is measured as direct PVGO divided by market value of the firm. Firm-specific volatility is obtained through the residuals of the regression of the equity's returns on the FTSE 100 index return based on the market model. Skewness is obtained from the monthly stock returns for the previous three years. R&D intensity is meausred as the average R&D percentage (R&D divided by sales) for the past three years. Organizational flexibility is measured as Selling, General, and Administrative (SGA) expenses divided by sales. Financial Leverage is estimated as book value of total liabilities divided by market value of the firm. Cumulative Sales Growth (SG) is calculated as the percentage change in firm revenues for the past three years. The firm's market power is measured as the square root of the Herfindahl-Hirschman Index (HHI) should the firm's Tobin's q be above the industry average in the specific year, and 0 otherwise. Cash Flow Coverage (CFC) is measured as cash flow from operating activities divided by total liabilities. An interaction term between Skewness and Leverage is included. Industry dummies are included in the regression

To examine value relevance of GP variables in the residual income dynamic, regressions of the residual income dynamic are initially conducted incorporating various GP proxies excluding analysts' forecasts. These results are summarized in Table 4. Except for the R&D intensity, all other GP proxies significantly provide incremental explanatory power beyond lagged residual income in forecasting next period residual income. More specifically, the residual income dynamic incorporating relative PVGO significantly provides a higher Fama-Macbeth average R square then the traditional residual income dynamic in O95. There is an incremental R square of 4.4% for the direct PVGO of Trigeorgis and Lambertides, 4.4% for the indirect PVGO of Trigeorgis and Lambertides, and 5.4% for the PVGO of Kester (1984). It can be inferred from the results that the three PVGO proxies are value relevant with regards to forecasting next period residual income.

Table 5 provides the regression results of the residual income dynamics including various GP variables as well as the other information variable inferred from analysts' forecasts. The coefficients on lagged residual income and other information variable in each model are significant at the 0.01 level. The coefficient on lagged residual income in each model is around 0.5, which is consistent with the findings in Dechow et al. (1999) and Callen and Segal (2005). Among all GP proxies, only R&D intensity is not significant in explaining next period residual income. This finding is similar to Cheng (2005), which suggests that R&D intensity fails to provide significant value relevant information beyond analysts' forecasts in the residual income dynamic. In terms of PVGO proxies, the PVGO of Kester (1984) fits best in the residual income dynamic beyond analysts' forecasts. With a coefficient of 0.049, this suggests that the current PVGO of Kester (1984) contributes positively to next period residual income beyond analysts' forecasts. Moreover, the Fama-Macbeth average R square of GP4 is around 0.450, higher than the 0.428 R square in the traditional O95 model with analysts' forecasts. It demonstrates that including the PVGO of Kester (1984) in residual income dynamic beyond analysts' forecasts does indeed improve the dynamic explainability. In other words, the PVGO of Kester (1984) provides additional value relevant information beyond the lagged residual income and analysts' forecasts. Compared with PVGO of Kester (1984), the direct and indirect PVGO of Trigeorgis and Lambertides are also significant in revealing value relevance in the residual income dynamic beyond lagged residual income and analysts' forecasts, but with lower incremental explanatory power. This is due to the fact that the PVGO of Kester focuses directly on the growth option of equity, while the PVGO of Trigeorgis and Lambertides emphasize the growth option of the firm. As residual income is more closely related to the cost of equity and earnings, this suggests that the PVGO of Kester is better for proxying the growth potential in the residual income dynamic.

Table 4. Residual Income Dynamics with Growth Potential Excluding Analysts' Forecasts

	N	ω_{10}	ω_{11}	ω_{12}	ω_{13}	Average R^2
O95: $\frac{x_{j,t}^a}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^a}{B_{j,t-1}} + \varepsilon_t.$						
Traditional Linear Model						
Estimations	11589	-0.010	0.467^{***}			0.328
		(-1.35)	(6.61)			
GP1: $\frac{x_{j,t}^a}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^a}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t-1}^{RD}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by R&D intensity						
Estimations	11589	-0.007	0.446^{***}		0.083	0.344
		(-0.81)	(6.34)		(1.17)	
GP2: $\frac{x_{j,t}^a}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^a}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t-1}^{TLDirect}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by PVGO Directly Measured in Trigeorgis and Lambertides (2014)						
Estimations	11589	-0.055^{***}	0.440^{***}		0.031^{***}	0.372
		(-7.03)	(6.60)		(9.09)	
GP3: $\frac{x_{j,t}^a}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^a}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t-1}^{TLIndirect}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by PVGO Indirectly Measured (estimated coefficients) in Trigeorgis and Lambertides (2014)						
Estimations	11589	-0.063^{***}	0.439^{***}		0.069^{***}	0.373
		(-7.17)	(6.81)		(8.06)	
GP4: $\frac{x_{j,t}^a}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x_{j,t-1}^a}{B_{j,t-1}} + \omega_{13,t}\frac{GP_{j,t-1}^{Kester}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by PVGO of Kester (1984)						
Estimations	11589	-0.058^{***}	0.419^{***}		0.049^{***}	0.382
		(-6.92)	(7.36)		(9.76)	

Notes: Table 4 shows the coefficients and R square of the residual income dynamics excluding analysts' forecasts in various GP models based on Fama-Macbeth regression from 1988 to 2015. Following Choi et al. (2006), the most extreme 1% of the deflated variables are winsorized in estimating the LID parameters. Average R^2 is the average R statistic and t value (in parentheses) is based on Newey-West corrected Fama-MacBeth standard errors. The superscripts *, **, *** respectively indicate significance at the 10%, 5% and 1% level.

Table 5. Residual Income Dynamics with Growth Potential Beyond Analysts' Forecasts

	N	ω_{10}	ω_{11}	ω_{12}	ω_{13}	Average R^2
O95 with Analysts' Forecasts: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
Traditional Linear Model with analysts' forecasts						
Estimations	10419	-0.042***	0.501***	0.607***		0.428
		(-8.22)	(16.34)	(14.77)		
GP1: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP^{RD}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by R&D intensity						
Estimations	10419	-0.040***	0.491***	0.592***	0.016	0.434
		(-7.20)	(15.93)	(14.14)	(0.48)	
GP2: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP^{TLDirect}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by PVGO Directly Measured in Trigeorgis and Lambertides (2014)						
Estimations	10419	-0.061***	0.473***	0.528***	0.015***	0.442
		(-10.58)	(14.12)	(10.87)	(4.50)	
GP3: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP^{TLIndirect}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by PVGO Indirectly Measured (estimated coefficients) in Trigeorgis and Lambertides (2014)						
Estimations	10419	-0.057***	0.487***	0.555***	0.024***	0.435
		(-8.71)	(16.30)	(13.50)	(4.73)	
GP4: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP^{Kester}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
GP proxied by PVGO of Kester (1984)						
Estimations	10419	-0.066***	0.456***	0.503***	0.027***	0.450
		(-9.06)	(11.87)	(9.07)	(5.21)	

Notes: Table 5 shows the coefficients and R square of the residual income dynamics including the other information variable (analysts' forecasts) in various GP models based on Fama-Macbeth regression from 1991 to 2015. Following Choi et al. (2006), the most extreme 1% of the deflated variables are winsorized in estimating the LID parameters. Average R^2 is the average R statistic and t value (in parentheses) is based on Newey-West corrected Fama-MacBeth standard errors. The superscripts *, **, *** respectively indicate significance at the 10%, 5% and 1% level.

4.1.2 LID with Bankruptcy Risk

Table 6 reports the value estimates of regression variables in the residual income dynamics with BK and analysts' forecasts, based on the joint sample. The value estimates use all available data in the UK over the period 1995-2015. All variables are stated on a per share basis and deflated by one year lagged book value. The descriptive statistics of residual income and other information variable in this sample is similar to those in growth potential. With respect to the BK variables, $BK^{Z-Score}$ represents the reciprocal of Altman's Z-Score (1968) and has a mean of 0.89 and median of around 0.34. BK^{Merton} stands for the LGD in the Merton model. The Loss Given Default (LGD) reflects financial risk as it involves the conditional expectations on the probability of default. The mean of BK^{Merton} is 0.03 and its median is also centered around zero. It is hypothesized that bankruptcy risk provides additional information beyond analysts' forecasts and it reveals a negative relationship with the next period residual income.

Table 6. Value Estimates of Bankruptcy Risk Variables

	N	0.25	Median	0.75	Mean	S.D.
x^a	8448	-0.05	0.03	0.10	-0.05	0.47
v	8448	0.01	0.05	0.11	0.10	0.20
$BK^{Z-Score}$	8448	0.17	0.34	0.79	0.89	6.06
BK^{Merton}	8448	0.00	0.00	0.002	0.03	0.11

Notes: Table 6 reports the value estimates of relative BK variables in the residual income dynamic. x^a stands for residual income and v stands for other information variable. $BK^{Z-Score}$ and BK^{Merton} respectively represent the bankruptcy risk proxies of Altman's Z-Score and LGD in the Merton Model. All variables are stated on a per share basis and deflated by one year lagged book value.

Table 7 presents the results on the residual income dynamics including various BK proxies excluding analysts' forecasts. It can be inferred from this table that including the Merton's LGD significantly improves the explainability of the O95 residual income dynamic. It raises the Fama-Macbeth average R square from 0.278 to 0.289. The significantly negative coefficient on Merton's LGD suggests this BK proxy has a negatively effect in forecasting next period residual income. Z-Score fails to provide a significant coefficient beyond lagged residual income in the residual income dynamic. Thus, only the Merton's LGD reveals value relevance in forecasting next period residual income.

Table 8 summarizes the results on the residual income dynamics including various BK proxies beyond the other information inferred from analysts' forecasts. It is evident from the table that the coefficients on lagged residual income and other information variable in all models are significant at the 0.01 level. In terms of the BK variables, only the BK^{Merton} is significant. It indicates that compared with the Z-Score, the loss given default in Merton presents as the better proxy for bankruptcy risk in residual income dynamic with analysts' forecasts. The coefficient on BK^{Merton} is -0.227, which suggests that the bankruptcy risk has a significantly negative effect in forecasting next period residual income beyond analysts' forecasts. A Fama-Macbeth average R square of 0.450 is observed for the residual income dynamic with BK^{Merton}, which is higher than the 0.439 in the traditional O95 model with analysts' forecasts. As a result, it is obvious that including the bankruptcy risk proxy of Merton model's LGD improves the explainability of the traditional residual income dynamic with analysts' forecasts. In other words, Merton's LGD as a proxy for bankruptcy risk contains value-relevant information beyond analysts' forecasts in forecasting next period residual income.

Table 7. Residual Income Dynamics with Bankruptcy Risk Excluding Analysts' Forecasts

	N	$\boldsymbol{\omega_{10}}$	$\boldsymbol{\omega_{11}}$	$\boldsymbol{\omega_{12}}$	$\boldsymbol{\omega_{14}}$	Average $\boldsymbol{R^2}$
O95: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
Traditional Linear Model						
Estimations	12257	0.001	0.369***			0.278
		(0.09)	(11.37)			
BK1: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK^{Z-Score}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
BK proxied by Z-Score						
Estimations	12257	0.004	0.371***		-0.001	0.298
		(0.40)	(11.55)		(-0.62)	
BK2: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK^{Merton}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
BK proxied by Loss Given Default in Merton Model						
Estimations	12257	0.005	0.357***		-0.150*	0.289
		(0.58)	(11.72)		(-2.00)	

Notes: Table 7 shows the coefficients and R square of the residual income dynamics excluding analysts' forecasts in various BK models based on Fama-Macbeth regression from 1995 to 2015. Following Choi et al. (2006), the most extreme 1% of the deflated variables are winsorized in estimating the LID parameters. Average R^2 is the average R statistic and t value (in parentheses) is based on Newey-West corrected Fama-MacBeth standard errors. The superscripts *, **, *** respectively indicate significance at the 10%, 5% and 1% level.

Table 8. Residual Income Dynamics with Bankruptcy Risk Beyond Analysts' Forecasts

	N	ω_{10}	ω_{11}	ω_{12}	ω_{14}	Average R^2
O95 with Analysts' Forecasts: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
Traditional Linear Model with analysts' forecasts						
Estimations	8448	-0.049***	0.506***	0.738***		0.439
		(-8.50)	(18.22)	(14.48)		
BK1: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK^{Z-Score}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
BK proxied by Z-Score						
Estimations	8448	-0.048***	0.509***	0.745***	-0.001	0.453
		(-7.50)	(17.95)	(15.03)	(-0.68)	
BK2: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK^{Merton}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$						
BK proxied by Loss Given Default in Merton Model						
Estimations	8448	-0.045***	0.495***	0.741***	-0.227**	0.450
		(-9.03)	(17.78)	(14.86)	(-2.16)	

Notes: Table 8 shows the coefficients and R square of the residual income dynamics including the other information variable (analysts' forecasts) in various BK models based on Fama-Macbeth regression from 1995 to 2015. Following Choi et al. (2006), the most extreme 1% of the deflated variables are winsorized in estimating the LID parameters. Average R^2 is the average R statistic and t value (in parentheses) is based on Newey-West corrected Fama-MacBeth standard errors. The superscripts *, **, *** respectively indicate significance at the 10%, 5% and 1% level.

4.1.3 LID with Growth Potential and Bankruptcy Risk

To test the additional information content of growth potential and bankruptcy risk, we include Kester's PVGO as the growth potential proxy and Merton's LGD as the bankruptcy risk proxy beyond analysts' forecasts in the residual income dynamic. The test is based on all available UK data from 1995 to 2015. Table 9 shows the residual income regression results on the traditional linear model with analysts' forecasts, the model with GP, the model with BK and the model with both GP and BK. It can be observed that the coefficients of explanatory variables in each model's residual income dynamics are significant. Among which, the lagged residual income and other information variable are significant at the 0.01 level in all cases. For the model with both GP and BK, the coefficient on growth potential is 0.029 and the coefficient on bankruptcy risk is -0.195 which suggests that growth potential has a significantly positive impact while bankruptcy risk presents a significantly negative impact in forecasting next period residual income beyond analysts' forecasts. In terms of explanatory power, the traditional linear model presents a Fama-Macbeth average R square of 0.448. It should be further noted that including growth potential increases the R square to 0.471, including bankruptcy risk increases the R square to 0.457, and incorporating both the growth potential and bankruptcy risk increases the R square to 0.480. It can be inferred from these results that incorporating both growth potential and bankruptcy risk provides additional information content beyond lagged residual income and analysts' forecasts in the residual income dynamic. As such, these findings suggest that incorporating information with option characteristics (the growth option from Kester and the bankruptcy risk from Merton) into the residual income dynamic beyond analysts' forecasts does indeed provide incremental usefulness in predicting future residual income.

Table 9. Residual Income Dynamic with Growth Potential and Bankruptcy Risk Beyond Analysts' Forecasts

	N	ω_{10}	ω_{11}	ω_{12}	ω_{13}	ω_{14}	Average R^2
O95 with Analysts' Forecasts: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$							
Traditional Linear Model with analysts' forecasts							
Estimations	8513	-0.043***	0.508***	0.745***			0.448
		(-6.76)	(17.14)	(13.64)			
GP: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP^{Kester}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$							
GP proxied by PVGO of Kester (1984)							
Estimations	8513	-0.062***	0.457***	0.622***	0.030***		0.471
		(-8.81)	(11.46)	(8.70)	(4.87)		
BK: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK^{Merton}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$							
BK proxied by Loss Given Default in Merton Model							
Estimations	8513	-0.040***	0.495***	0.749***		-0.215**	0.457
		(-6.77)	(16.63)	(14.04)		(-2.58)	
Model with GP and BK: $\frac{x^a_{j,t}}{B_{j,t-1}} = \omega_{10,t} + \omega_{11,t}\frac{x^a_{j,t-1}}{B_{j,t-1}} + \omega_{12,t}\frac{v_{j,t-1}}{B_{j,t-1}} + \omega_{13,t}\frac{GP^{Kester}_{j,t-1}}{B_{j,t-1}} + \omega_{14,t}\frac{BK^{Merton}_{j,t-1}}{B_{j,t-1}} + \varepsilon_t.$							
GP proxied by PVGO of Kester (1984), BK proxied by Loss Given Default in Merton Model							
Estimations	8513	-0.059***	0.446***	0.628***	0.029***	-0.195**	0.480
		(-8.82)	(11.33)	(8.90)	(4.81)	(-2.46)	

Notes: Table 9 shows the coefficients and R square of the residual income dynamics in various models based on Fama-Macbeth regression from 1995 to 2015. Following Choi et al. (2006), the most extreme 1% of the deflated variables are winsorized in estimating the LID parameters. Average R^2 is the average R statistic and t value (in parentheses) is based on Newey-West corrected Fama-MacBeth standard errors. The superscripts *, **, *** respectively indicate significance at the 10%, 5% and 1% level.

4.2 Results on Valuation Performance

Following on from the previous section, we continue to test whether including GP and BK in the residual income dynamic beyond analysts' forecasts improves the equity valuation performance. We use Kester's PVGO as the growth potential proxy and Merton's LGD as the bankruptcy risk proxy. To estimate the equity value, the yearly regressed LID parameters are used to calculate the cross-sectional theoretical implied coefficients in equity valuation (various α in each valuation model). These coefficients are applied to all the firms with data necessary to calculate the estimated market value.

4.2.1 Out of Sample Forecast Bias and Forecast Accuracy

Table 10 shows the results on valuation errors regarding the traditional linear model, the model with GP, the model with BK and the model with both GP and BK. It can be observed from this table that the model with only GP and the model with both GP and BK present less forecast bias than the other models, with the mean and median PVE of -0.19 and -0.35 for the model with GP, and the mean and median PVE of -0.20 and -0.35 for the model with GP and BK. The negative mean and median PVE in the traditional model suggests that the O95 with analysts' forecasts underestimates the equity value. This finding is consistent with Dechow et al. (1999) and Gregory et al. (2005). In terms of the forecast accuracy, the model with GP alone and the model with both GP and BK provide better forecast accuracy then the other models. More specifically, the median APVE of the model with GP and the median APVE of the model with both GP and BK are both centered around 0.47, lower than the 0.48 median APVE of the traditional O95 with analysts' forecasts. The central tendency of the model with GP is 14.86% while the central tendency of the model with GP and BK is 14.83%, both of which are higher than the 14.22% central tendency of the traditional O95 with analysts' forecasts. Meanwhile, the model with BK shows a slightly better performance in forecast accuracy compared to the traditional O95 with analysts' forecasts. In summary, the model with GP only and the model with both GP and BK significantly reduce the forecast bias and increase the forecast accuracy compared with the traditional O95 with analysts' forecasts. Including GP and BK in the residual income dynamic beyond analysts' forecasts reveals superiority in equity valuation in terms of forecast bias and forecast accuracy.

Table 10. Results of Valuation Errors

	N	Mean	Significance Level Mean Difference=0	Median	Significance Level Median Difference=0	Central Tendency
O95 with Analysts' Forecasts: $\boldsymbol{V1_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t}$ *Traditional Linear Model with analysts' forecasts*						
PVE	7657	-0.24	0	-0.38	0	
APVE	7657			0.48	0	14.22%
Model with GP: $\boldsymbol{V2_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t}$ *GP proxied by PVGO of Kester (1984)*						
PVE	7657	-0.19	0	-0.35	0	
APVE	7657			0.47	0	14.86%
Model with BK: $\boldsymbol{V3_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_4 BK_t}$ *BK proxied by Loss Given Default in Merton Model*						
PVE	7657	-0.24	0	-0.38	0	
APVE	7657			0.48	0	14.25%

Table 10. (Continued)						
Model with GP and BK: $\boldsymbol{V4_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t + \alpha_4 BK_t}$						
GP proxied by PVGO of Kester (1984), BK proxied by Loss Given Default in Merton Model						
PVE	7657	-0.20	0	-0.35	0	
APVE	7657			0.47	0	14.83%

Notes: Table 10 shows the valuation errors of valuation models based on various residual income dynamics. The sample includes 7657 observations from 1997 to 2015. PVE measures the forecast bias: $\mathrm{PVE_t} = (\mathrm{MV_t^{Est}} - \mathrm{MV_t^{Act}})/\mathrm{MV_t^{Act}}$. APVE measures the forecast accuracy: $\mathrm{A\,PVE_t} = |\mathrm{MV_t^{Est}} - \mathrm{MV_t^{Act}}|/\mathrm{MV_t^{Act}}$. $\mathrm{MV_t^{Est}}$ is the estimated equity value of each model and $\mathrm{MV_t^{Act}}$ is the market equity value. Significance Level Mean Difference = 0 and Significance Level Median Difference =0 represent the significance level associated with the t-statistics of (sign rank test) of whether the mean and median valuation error equals zero. Central tendency is defined as the percentage of observations with the estimated value lying within 15% of the security price.

4.2.2 Out of Sample Explainability

Table 11 presents the results on the explanatory power of the various models. It is evident from the table that the model with both GP and BK has the highest explainability of all the models. More specifically, the traditional O95 with analysts' forecasts has a Fama-Macbeth average R square of 0.770. The model with GP and the model with BK both provide higher explanatory power than the traditional linear model, with R squares of 0.787 and 0.779 respectively. The R square for the model including both GP and BK is 0.792, which indicates that by incorporating growth potential and bankruptcy risk in the residual income dynamic, the valuation model adds 2.2% explanatory power to the traditional linear model. In summary, the results for explanatory power suggest that including GP and BK in the residual income dynamic beyond analysts' forecasts reveals significant superiority in equity valuation in terms of explainability.

Table 11. Regressions of Contemporaneous Market Equity Value on Estimated Equity Value

	N	Time Period	Average R Square	Coefficient	Standard Error	T statistics	P>t
O95 with Analysts' Forecasts: $V1_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t$							
Traditional Linear Model with analysts' forecasts							
	7657	19	0.770	1.845	0.125	14.75	0.000
Model with GP: $V2_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t$							
GP proxied by PVGO of Kester (1984)							
	7657	19	0.787	1.697	0.103	16.42	0.000
Model with BK: $V3_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_4 BK_t$							
BK proxied by Loss Given Default in Merton Model							
	7657	19	0.779	1.858	0.130	14.28	0.000
Model with GP and BK: $V4_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t + \alpha_4 BK_t$							
GP proxied by PVGO of Kester (1984), BK proxied by Loss Given Default in Merton Model							
	7657	19	0.792	1.701	0.105	16.25	0.000

Notes: Table 11 shows the results of Fama-Macbeth regressions of contemporaneous market equity values on estimated equity values, based on a joint sample of 7,657 observations and a time period of 19 years. The average R square of the Fama-Macbeth regression, Fama-Macbeth regression coefficients, and Fama-Macbeth Standard error with Newey-West adjustment are provided for each model. P>t reports the significance level of the coefficients. The regression formula is: $\mathrm{MV}_{\mathrm{j,t}}^{\mathrm{Act}} = \lambda_0 + \lambda_1 \mathrm{MV}_{\mathrm{j,t}}^{\mathrm{Est}} + \varepsilon_t$, where $\mathrm{MV}_{\mathrm{j,t}}^{\mathrm{Act}}$ is the market equity value for firm j at time t, and $\mathrm{MV}_{\mathrm{j,t}}^{\mathrm{Est}}$ is the estimated equity value of firm j at time t for different models.

To better understand the superiority of explainability in the model which includes both GP and BK, our joint sample dataset of 7,657 observations was divided into three subsamples. The first subsample includes $N_1 = 1{,}363$ firm-year observation with negative earnings. The remaining firm-year observations with positive earnings are divided into two subsamples. These two subsamples each includes 3,147 firm-year observations. The first of these subsamples, N_2, is comprised of firm-year observations with positive but relatively low PE ratios. The remaining subsample, N_3, includes firm-year observations with positive but relatively high PE ratios. Since the price-to-earnings ratio is frequently used as a measure of growth potential (Siegel, 2013; Herath et al. 2015) while negative earnings reflect financial risk, we hypothesize that the model with GP improves the explanatory power in N_3 and that the model with BK improves the explanatory power in N_1. For the model incorporating both GP and BK, we hypothesize that it dominates the traditional O95 with analysts' forecasts both in N_1 and N_3. The results in the subsample test support all our hypotheses. It is evident from Table 12 that the model with GP increases the average R square in the high positive PE subsample, while the model with BK increases the average R square in the negative earnings subsample. It is interesting to discover that the model with GP also improves the explanatory power in the negative earnings subsample. There are two reasons for this. First is the use of anticipated earnings instead of earnings in calculating the PVGO of Kester (1984). Anticipated earnings represent analysts' positive expectation for firm performance, which reveal higher median than actual earnings. The second reason is the use of one year lagged GP in valuation. Even contemporaneous observations with negative earnings may have a positive valuation effect from its past growth potential. The model incorporating both GP and BK dominates the traditional O95 with analysts' forecasts in terms of explanatory power in the high positive PE subsample and negative earnings subsample. It adds 4.8% explanatory power in N_3 and 8.3% explanatory power in N_1 when compared to the traditional linear model. In the low positive PE subsample, the traditional O95 with analysts' forecasts provides the highest R square. As a result, the superiority of explainability for the model incorporating both GP and BK is mainly reflected in the high growth potential subsample and the high financial risk subsample. It further indicates that including information with option characteristics (the growth option from Kester and the bankruptcy risk from Merton) within the residual income dynamic beyond analysts' forecasts does indeed provide incremental information in valuation.

Table 12. Subsample Test on Explainability

Model	N_1	Coefficient	R^2	N_2	Coefficient	R^2	N_3	Coefficient	R^2
O95 with Analysts' Forecasts: $V1_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t$									
Traditional Linear Model with analysts' forecasts									
		Negative Earnings			***Low Positive PE***			***High Positive PE***	
	1363	1.210***	0.538	3147	1.309***	0.811	3147	2.407***	0.760
		(5.84)			(14.87)			(12.24)	
Model with GP: $V2_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t$									
GP proxied by PVGO of Kester (1984)									
		Negative Earnings			***Low Positive PE***			***High Positive PE***	
	1363	1.168***	0.638	3147	1.228***	0.798	3147	2.152***	0.805
		(7.28)			(14.24)			(13.69)	
Model with BK: $V3_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_4 BK_t$									
BK proxied by Loss Given Default in Merton Model									
		Negative Earnings			***Low Positive PE***			***High Positive PE***	
	1363	1.408	0.556	3147	1.324	0.772	3147	2.394***	0.759
		(4.79)			(14.84)			(12.83)	
Model with GP and BK: $V4_t = B_t + \alpha_1 x_t^a + \alpha_2 v_t + \alpha_3 GP_t + \alpha_4 BK_t$									
GP proxied by PVGO of Kester (1984), BK proxied by Loss Given Default in Merton Model									
		Negative Earnings			***Low Positive PE***			***High Positive PE***	
	1363	1.127***	0.621	3147	1.197***	0.752	3147	2.144***	0.808
		(7.53)			(12.89)			(14.07)	

Notes: Table 12 shows the results of a subsample-test on Fama-Macbeth regressions of contemporaneous market equity values on estimated equity values. The joint sample dataset is divided into three subgroups: Negative Earnings, Low positive PE and High positive PE. The average R square of the Fama-Macbeth regression, Fama-Macbeth regression coefficients, and Fama-Macbeth t statistics with Newey-West adjustment are provided for each model. The superscripts *** indicate significance at the 1% level.

5. Robustness Checks

5.1 Sample Composition

To compare which are the best proxies for GP and BK, we use the joint sample for all GP proxies and the joint sample for all BK proxies respectively for the empirical analysis in the study. For robustness test, GP and BK proxies based on their individual sample dataset are used. The results suggest that the PVGO of Kester (1984) still outperforms other growth potential proxies in the residual income dynamic. It is significant at the 0.01 level with the highest Fama-Macbeth average R square of 0.465. Meanwhile, the loss given default in the Merton Model still outperforms Altman's Z-Score as it provides a higher R square of 0.442 with the coefficient of BK significant at the 0.05 level. As a result, the PVGO of Kester (1984) and the LGD of Merton (1974) are the best proxies for GP and BK both in common sample test and individual sample test.

5.2 Cost of Equity

The limitation of the assumption regarding cost of equity is an unavoidable problem in empirical accounting research (Callen and Segel, 2005). In this empirical test, following Choi et al. (2006) and Ahmed et al. (2002), a cross-sectional cost of equity which equals annual average yield of British Government security 10-year nominal par yield plus 5% risk premium is used. Other research also uses a constant cost of equity, for example 12% (Dechow et al. 1999; Begley and Fetlham, 2002; Ashton and Wang, 2013). As a result, in the sensitivity test of cost of equity, a constant cost of equity of 8%, 10% and 12% is used. The main results do not change when using these different costs of equity.

5.3 Other Robustness Test

We follow the definition of the eight option-motivated variables in Trigeorgis and Lambertides (2014) in the empirical test. Robustness tests are conducted through minor changes in the option-motivated variables, namely: changing the R&D intensity as R&D expenditure; representing market power by market share in the industry; and representing the missing CFC as the industry average. Moreover, relative regression methods are used to test the GO equation, for example, Fama-Macbeth with 1, 3 and 5 years rolling window. The signs of the coefficients are similar and the predicted GO score is not that sensitive to the estimation approach. In all cases the main results of the study do not change. We also utilize 1, 2 and 3 year averages for R&D expenditure, as opposed to R&D intensity, in proxying the growth potential. This does not yield a major increase in the significance of the coefficient, and in all cases the PVGO of Kester still outperforms all the other proxies for GP.

6. Conclusion

This empirical study explores value relevant information beyond analysts' forecasts in residual income dynamics and equity valuation. We extend the residual income dynamic through incorporating growth potential and bankruptcy risk. For growth potential, we test the proxies of R&D intensity, the direct and indirect measure of PVGO of Trigeorgis and Lambertides (2014) and the PVGO of Kester (1984). For bankruptcy risk, we examine the proxies of Altman's Z-Score (1968) and the LGD of Merton (1974). Among all the proxies, the PVGO of Kester (1984) and the LGD of Merton (1974) best represent growth potential and bankruptcy risk in the residual income dynamic beyond analysts' forecasts. Moreover, when the residual income dynamic incorporates both GP and BK beyond analysts' forecasts, the explanatory power for future residual income is significantly higher than the traditional linear model. This suggests that introducing GP and BK into the residual income dynamic beyond analysts' forecasts brings incremental value relevant information. Further, the effects of such value relevant information on equity valuation are examined. This finding suggests that the model incorporating only GP and the model incorporating both GP and BK provide similar results in terms of reducing forecast bias and increasing forecast accuracy compared to the traditional O95 with analysts' forecasts. In terms of explainability, the model incorporating GP and BK beyond analysts' forecasts provides the highest Fama-Macbeth average R square of all the models. A subsample analysis indicates that the superiority of explainability for the model incorporating both GP and BK is mainly reflected in the high growth potential subsample and the high financial risk subsample.

This empirical study contributes to the existing literature in several ways. First, we extend the residual income model through introducing value relevance information (growth potential and bankruptcy risk) beyond analysts' forecasts in the residual income dynamic. Empirical accounting literature (Cheng,2005; Ramnath et al. 2008) suggests that analysts' forecasts could not fully incorporate certain information items (e.g., conservative accounting, risk and economic rents). Our findings suggest that including growth potential and bankruptcy risk brings incremental information in residual income dynamic and improves the valuation performance in terms of forecast bias, forecast accuracy and explainability. Second, in assessing the new value relevance information, we compare the accounting-based proxies (R&D Intensity, Z-Score) and option based proxies (PVGO, LGD) in representing growth potential and bankruptcy risk in the residual income dynamic. We find that the proxies with option characteristics (PVGO of Kester and LGD of Merton) provide better performance. Last but not least, this empirical study contributes to the non-linear real option equity valuation literature by bringing the parameters with option characteristics directly into linear information dynamics. Research on accounting-based non-linear real option valuation focuses on building the option component through recursion value (Hwang and Sohn, 2000; Ashton et al. 2003) or directly building from the decision-making process (Zhang, 2000; Yee,2000). We investigate a different angle, and explore the possibility for introducing the option characteristics directly into the residual income dynamics.

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