

Validity Test of Implicit Capital Cost Valuation Model —Based on China's A-Share Market

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Keywords: earnings forecast, capital cost of equity, validity test

Abstract. Equity capital cost plays an important role in investment strategies and asset valuation, but there is no recognized valuation model and unified model validity test method in academia so far. This paper measures the cost of equity capital of A-share listed companies in China by using five kinds of implicit capital cost valuation models widely used by domestic scholars, and tests the validity of the model from the economic and statistical perspectives. It is found that the estimated values of the five models are significantly positively correlated with the realized returns one to three years in advance. Statistical tests show that OJ, PEG and MPEG models are more effective in explaining the time series of expected returns, while OJ models are more effective in explaining the cross-sectional changes of expected returns. Therefore, OJ model can be used as an effective model to measure the cost of equity capital of A-share listed companies in China.

1. Introduction

Capital cost plays an important role in corporate investment and financing policy, and government macroeconomic policy. Equity capital cost is the expected rate of return determined by investors according to market conditions, so it is difficult to estimate it. Therefore, foreign scholars have devoted themselves to developing appropriate cost measurement models of equity capital. Existing studies have proved that asset pricing models in the financial field can produce large estimation errors in estimating equity capital costs. In recent years, the implicit capital cost measurement model based on accounting data, namely ICC model, has been widely used in academic research (the same below). However, due to the different assumptions and input data of the model, the estimated values of the model are quite different. Up to now, there is no accepted valuation model and validity test method in academia. Domestic studies often use foreign scholars' models directly to analyze the factors affecting the cost of equity capital. Scholars are more casual in choosing the models and do not test the validity of the models in China's capital market, which greatly reduces the comparability between these documents. In view of this, this paper uses a more comprehensive and effective method to test the validity of widely used valuation models in China's capital market.

2. Review of Existing Literature

At present, the academia mainly uses three testing methods: one is to test the explanatory power of model estimates to realized earnings, that is, to regress the model estimates with realized earnings from the economic point of view, and to judge the validity of the model by regression coefficient symbols and significance, such as Houetal (2010)^[1]; Mao Xinshu, Ye Kangtao, Zhang Rong (2012)^[2]; Xu Zhi, Lin Xingqi, Zhao Yiqing (2017)^[3].

However, scholars have proved that realized earnings are biased estimates of expected earnings. There is information surprise between them. Some scholars try to study the correlation between expected earnings and realized earnings by controlling information surprise. Easton and Monahan (2005) used the linear income decomposition method developed by Vuolteenaho (2002) to test the relationship between estimates of expected earnings and realized earnings by controlling

unexpected earnings. It is found that there is no expected positive correlation between the estimated values of the seven ICC models and the realized returns ^[4]. Lee, So and Wang (2010) decomposed the unexpected information into expected earnings information and price shock information including cash flow information. It was found that ERP, GGM and AGR models could predict future realized earnings, while GGM and GLS could better explain future ICC estimates ^[5]. However, it is difficult to determine the agent variables of information accidents. Scholars have different methods of income decomposition and the determination of agent variables of information surprise, which leads to great differences in research conclusions.

Secondly, from the statistical point of view, the measurement error variance between the estimates of expected earnings and the real expected return is taken as the criterion to evaluate the model. Easton and Monahan (2005) found that the model had high measurement error variance, which was consistent with the conclusion from the economic point of view ^[4]. But Easton's and Monahan's (2005) methodologies are based on more rigorous assumptions, which make them more difficult to apply in practice. Lee, So and Wang (2010) developed a method to measure the error variance of time series, and tested the ability of model estimates to explain the time series variation of expected earnings ^[5]. Lee, So and Wang (2017) developed a simpler method to judge the validity of the model by comparing the variances of the adjusted cross section and time series measurement errors ^[6].

The third is to test the correlation between estimates of expected earnings and risk factors. Mao Xinshu, Ye Kangtao, Zhang Tong (2012) ^[2]; Gode, Mohanram (2003) ^[7] used this method to test the validity of the model. But the effectiveness of this method depends on whether these risk factors can fully reflect the real risk of the enterprise.

3. The Theoretical Basis of Measurement of Equity Capital Cost

3.1 Residual Income Valuation Model

In 2001, Gebhardt, Lee & Swaminathan assumed a 12-year earnings forecast period on the basis of residual earnings. In the first three years, the earnings per share and book value per share accorded with market expectations. In the next nine years, the return on net assets of the company linearly decreased to the return on net assets of the industry. Maintain the industry average return on net assets unchanged after the forecast period. The formula is as follows:

$$P_0 = BV_0 + \sum_{t=1}^{11} \frac{(ROE_t - r)BV_{t-1}}{(1+r)^t} + \frac{(ROE_{12} - r)BV_{11}}{r(1+r)^{11}} \quad (1)$$

At the same time, Claus and Thomas assumed that the earnings forecast period was five years, and after five years, earnings per share would continue to grow at a fixed long-term growth rate g , and set it as a risk-free interest rate minus 3%. The CT model was obtained.

$$P_0 = BV_0 + \sum_{t=1}^5 \frac{E_t - r * BV_{t-1}}{(1+r)^t} + \frac{(E_5 - r * BV_4)(1+g)}{(r-g)(1+r)^5} \quad (2)$$

4. Abnormal Earning Growth Model AEGM

The abnormal earning growth model replaces the initial net assets of the residual income model with the first expected return of capitalization (the first expected return divided by the cost of equity capital), and assumes that the expected value of abnormal earning will grow continuously at the growth rate of g .

Easton (2004) further assumes that the growth rate of abnormal returns g equals zero, and obtains the MPEGM model.

¹ P_0 is the initial share price; BV_t is the expected book value of each share in the t period. ROE_t is predicting return on net assets for t period. $BV_t = BV_{t-1} + (E_t - D_t) = [BV_{t-1}(1 + ROE_t * (1 - k))]$, E_t is earnings per share in period t . D_t is the dividend per share of the period t

$$r_{MPEG} = \frac{D_1 + \sqrt{D_1^2 + 4P_0(E_2 - E_1)}}{2P_0} \tag{3}$$

Easton (2004) assumes that the dividend per share of the first period is 0, and then obtains the PEG model [16], that is, the dividend per share of the first period is 0.

$$r_{PEG} = \sqrt{\frac{E_2 - E_1}{P_0}} \tag{4}$$

Ohlson and Juettner-Nauroth (2005) introduced the earnings forecast value of the first and second periods, the short-term growth rate and the long-term sustainable growth rate of earnings on the basis of dividend discount model. Through mathematical deduction, OJ model, namely

$$r_{OJ} = (g + \text{dps}1/p_0)/2 + \sqrt{((g + \text{dps}1/p_0)/2)^2 + \frac{E_1}{P_0}(g_2 - g)} \tag{5}$$

5. Measuring the Cost of Equity Capital of Listed Companies

5.1 Data sources and sample selection

This paper takes all A-share listed companies from 2010 to 2016 as the primary research sample, excluding financial, ST, ST* companies, and the negative sample of owner's equity in the balance sheet, and finally gets 1459 listed companies.

Estimation of earnings forecast is the critical part of ICC model measurement. Scholars have proved that analysts have optimistic tendencies, and their information lags behind. Therefore, this paper uses RI model based on residual income model developed by Li and Mohanram (2014).

$$E_{t+i} = \beta_0 + \beta_1 * \text{Neg}E_t + \beta_2 * E_t + \beta_3 * \text{Neg}E_t * E_t + \beta_4 * B_t + \beta_5 * \text{TACC}_t + \varepsilon^2 \tag{6}$$

In this paper, the mixed regression method is used to estimate the earnings forecast value 1, 2 and 3 years ahead of 2010 to 2016, which ensures the number of observable samples. The final regression results are shown in Table 1.

From the table, we can see that the earnings of one to three years in advance are significantly positively correlated with the current earnings, indicating that the earnings are sustainable and the current earnings have the ability to predict future earnings. The earnings forecast value of one to three years in advance is not significant negatively correlated with neps, which indicates that the sustainability of negative earnings is weak. Regression coefficient of accrued items is significantly negative, which indicates that the accrued items and future accounting income change in reverse. Net asset per share is negatively correlated with future earnings, which indicates that small companies expect to have higher profitability under other conditions unchanged.

For r^2 , we can see that the model can explain 49.97%, 29.99% and 17.67% of the expected return in the next 1, 2 and 3 years respectively. In the next 1-3 years, the number of r parties decreases year by year, which meets the expectation that the longer the prediction period is, the weaker the prediction effect is.

² E_{t+i} is the income after deducting the current account ($i = 1, 2, 3, 4, 5$); $\text{Neg}E_t$ is the virtual variable of negative income; B_t is the book value of the owner ship; TACC_t is the accrual item. Accrued items equal to the difference between net profit and net cash flow from operating activities. All variables are divided by the number of common shares.

Table 1 Regression Coefficient of RI Model

variables	E ₁	E ₂	E ₃
eps	0.7413*** (-54.7447)	0.5529*** (-36.6923)	0.4260*** (-27.7634)
B _t	-0.0123*** (-6.0951)	-0.0129*** (-5.5956)	-0.0156*** (-6.9734)
TACC	-0.0553*** (-9.6394)	-0.0549*** (-9.6977)	-0.0517*** (-7.9947)
neps	-0.0506 (-1.2244)	-0.0041 (-0.1320)	0.0219 -0.4563
neps*eps	-0.7096*** (-14.1394)	-0.5496*** (-9.9773)	-0.3520*** (-6.3597)
cons	0.1420*** -12.6756	0.2217*** -17.259	0.2909*** -19.9655
N	7057	6997	6667
r ²	0.4997	0.2999	0.1767
F	1464.167	590.2143	295.7571

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

5.2 Measuring the Cost of Equity Capital

This paper estimates GLS, CT, OJ, PEG and MPEG models, in which the short-term growth rate $g_2 = \frac{E_3 - E_2 + E_2 - E_1}{2} \frac{1}{|E_2| + |E_1|}$ (g_2 set to 0 when g_2 is less than 0 and g_2 set to 1 when g_2 is greater than 1). The earnings forecast value needed in the CT model for 4 or 5 years in advance is obtained by using the formulas $E_4 = |E_3| * g_2 + E_3$, $E_5 = |E_4| * g_2 + E_4$. The dividend payment rate k is replaced by the historical average dividend payment rate of the first three years. ROE_{12} is the rate of return on net assets of the industry. Long-term growth rate uses the average inflation rate in the past ten years.

Table 2 shows the average cost of equity capital estimated by five models. the cost of equity capital estimated by OJ, PEG and MPEG is higher. This is basically consistent with the findings of Xu Zhi, Lin Xingcen and Zhao Yiqing (2017)^[1]. However, Mao Xinxu, Ye Kangtao and Zhang Ting (2012) found that there were significant differences in the estimated values of different models, with the greatest difference reaching 12.13%. This may be related to the year of measurement and the choice of earnings forecast model.

Table 2 2010-2016 Descriptive Statistics of Equity Capital Cost

date	CT	GLS	MPEG	OJ	PEG	mean
2010	5.59%	5.11%	5.83%	7.27%	5.71%	3.66%
2011	7.98%	6.84%	9.51%	9.81%	9.22%	6.03%
2012	8.47%	6.77%	10.40%	10.64%	10.15%	6.95%
2013	8.23%	6.66%	9.94%	10.29%	9.70%	6.27%
2014	7.22%	5.39%	8.96%	9.04%	8.73%	5.69%
2015	6.71%	4.40%	7.78%	7.37%	7.64%	4.72%
2016	7.81%	5.26%	7.40%	7.95%	7.19%	4.85%
Mean	7.43%	5.79%	8.67%	9.03%	8.46%	5.45%
median	5.99%	5.40%	8.12%	8.77%	7.89%	4.81%
sd	0.071	0.0262	0.0432	0.0306	0.0435	0.0368
Min	2.94%	0.44%	0.14%	1.56%	0.14%	0.22%
max	40.39%	42.18%	35.59%	27.08%	35.59%	25.46%

5.3 Validity Test of Four Implicit Equity Capital Cost Measurements

This paper examines Equity Capital Cost Measurements from the economic and statistical point of view. First, from the economic point of view, the realized returns and estimates are regressed to select the eligible models. Then, from the statistical point of view, the cross-sectional and time series SVAR methods developed by Lee, So and Wang (2017) are used to judge the validity of the models.

5.4 Regression analysis of cost estimates of equity capital and realized returns

This paper examines the explanatory power of ICC estimates to realized earnings 1, 2 and 3 years in advance. See Table 3. From the symbols and significance of regression coefficients, we can see that the five valuation models and their average values are significantly positively correlated with realized returns at the level of 1%. This is in line with previous research results.

Table 3 Regression results of ICC estimates and realized returns

	return1	return2	return3
GLS	2.410*** (11.784)	2.575*** (11.328)	1.764*** (6.439)
CT	0.481*** (6.332)	1.285*** (10.868)	0.756*** (5.489)
PEG	2.024*** (12.681)	2.293*** (12.431)	1.251*** (5.695)
MPEG	2.103*** (13.093)	2.350*** (12.650)	1.273*** (5.756)
OJ	3.680*** (15.956)	4.610*** (16.573)	2.637*** (7.662)
Mean	2.129*** (15.460)	2.238*** (15.063)	1.462*** (8.589)

5.5 Analysis of adjusted measurement error variance (SVAR) of each model

Lee, So, Wang (2017) developed the method of indirectly testing estimation error variance, that is, the adjusted measurement error variance. This method is simple to calculate and implement. The formula is as follows:

The average adjusted variance of measurement errors for a model in T years

$$\text{AvgSVar}_t(\omega_{i,t})^{\text{CS}} = \frac{1}{T} \sum_t \text{SVar}_t(\omega_{i,t}) = \frac{1}{T} \sum_t [\text{Var}_t(\text{ger}_{i,t}) - 2\text{Cov}_t(r_{i,t+1}, \text{ger}_{i,t})]. \tag{7}$$

The average adjusted variance of measurement errors for all companies is:

$$\text{AvgSVar}_i(\omega_{i,t})^{\text{TS}} = \frac{1}{N} \sum_i \text{SVar}_i(\omega_{i,t}) = \frac{1}{N} \sum_i [\text{Var}_i(\text{ger}_{i,t}) - 2\text{Cov}_i(r_{i,t+1}, \text{ger}_{i,t})]. \tag{8}$$

From the above equation, it can be seen that if the variance of the model estimation of the same company in different years is the same as that of the measurement error of the real expected return, or that of the model estimation of different companies in the same year is the same as that of the measurement error of the real expected return. At this time, $\text{Var}(\omega_{i,t})$ is zero, and then the model is the optimal model. Because $\text{Var}(\omega_{i,t}) = \text{SVar}(\omega_{i,t}) + \text{Var}(er_{i,t})$, Namely when $\text{SVar}(\omega_{i,t}) = -\text{Var}(er_{i,t})$, mode is optimal. Because $\text{Var}(\omega_{i,t})$ is greater than 0 and $\text{Var}(er_{i,t})$ is greater than 0, The smaller the value of $\text{SVar}(\omega_{i,t})$ is, the better the model is.

5.5.1 Comparative analysis of cross-sectional SVar values of different models

The adjusted variance of cross-sectional measurement error for each model estimate (multiplied by 100 for easy observation) is shown in Table 4. Due to fewer years of measurement, the annual SVAR values are listed in this paper.

Table 4 Cross-sectional SVar values for each model

date	OJ	PEG	MPEG	GLS	CT	mean
2010	-0.0728	0.0120	0.0037	-0.0332	0.0104	-0.0010
2011	-0.2366	-0.1729	-0.1555	-0.1745	-0.0631	-0.0467
2012	0.3741	0.6788	0.6405	0.3322	0.3544	0.4176
2013	-0.4938	-0.3274	-0.3432	-0.6285	-0.2773	-0.5322
2014	-0.0395	0.1657	0.2091	0.5408	0.4044	-0.2257
2015	-0.1128	-0.2632	-0.2649	-0.1038	0.6249	-0.0470
2016	-0.2678	-0.1975	-0.2338	-0.2748	1.3412	0.2898
mean	-0.1213	-0.0149	-0.0206	-0.0488	0.3421	-0.0207

It can be seen from the table that the average SVar value of CT model is greater than 0, which indicates that the difference between CT model estimates and real expected earnings is large. While the average SVar value of OJ model is -0.1213, which is much smaller than the average value of others. It shows that the estimation value of OJ model has the smallest variance of measurement error with real expected earnings, it can better predict the cross-sectional variation of the real expected returns

5.5.2 Comparative analysis of Time Series SVar values of different models

Table 5 lists the adjusted time series measurement error variances (mean, median, maximum, minimum multiplied by 100) for each model estimate. It can be seen from the table that the SVar values of OJ, PEG and MPEG models based on abnormal earning growth rate are the smallest, and the standard deviation is also small, indicating that the SVar values fluctuate little. It can be seen that OJ, PEG and MPEG models have the smallest variance of measurement errors with real expected returns, which can better explain the time series changes of real expected returns. The CT model showed poor performance.

Table 5 Time series SVar values of each model

variable	n	mean	p50	sd	min	max	skewness
GLS	1444	-0.4408	-0.4242	0.0082	-4.4567	13.9290	5.2466
CT	1445	-0.1408	-0.3788	0.0400	-34.4336	46.4908	4.3202
OJ	1001	-0.8085	-0.7451	0.0129	-12.7754	5.2384	-1.9029
PEG	1036	-0.8394	-0.7600	0.0179	-15.7650	7.7102	-1.3849
MPEG	1037	-0.8740	-0.7908	0.0177	-15.6838	7.7102	-1.4062
mean	1459	-0.6913	-0.5558	0.0117	-9.6211	4.8940	-0.8377

From the statistical point of view, OJ model is the most effective model for explaining the cross-sectional and time series changes of real expected earnings, while PEG and MPEG models are effective for explaining the time series changes of expected earnings.

This is different from Lee, So and Wang (2017). They take the average value of ICC model as the representative of ICC model and calculate the cross-section and time series SVar values of ICC model and expected returns, and find that they are all greater than 0. Therefore, they conclude that ICC model cannot explain the cross-section and time series changes of expected returns. However, from Table 4 and Table 5, we can see that the average performance of the five ICC models is relatively general, indicating that the average value of the five ICC models can not represent the level of each ICC model. Namely, there is an effective valuation model in the ICC model.

6. Summary

This paper measures five commonly used capital cost valuation models, and tests the validity of the models from the economic and statistical perspectives. The study found that:

Firstly, the estimated values of OJ, PEG and MPEG models are basically the same, and higher than those of GLS and CT models. However, the cost of equity capital estimated by the five models is not very different, basically stable at 5% to 10%.

Secondly, the estimated values of each model are significantly positively correlated with the realized returns one to three years in advance, which indicates that the models satisfy the basic conditions of validity.

Thirdly, from the statistical point of view, OJ model is superior to other models in explaining cross-sectional and time series changes of real expected earnings, and PEG and MPEG models are also superior in explaining time series changes of real expected earnings.

Finally, based on the above conclusions, this paper argues that OJ model can effectively estimate the cost of equity capital of A-share listed companies in China.

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