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'Is Residual Income Model (RIM) REALLY Superior to Dividend Discount Model (DDM)?' – A Misconception

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Abstract: *The development of the residual income model (RIM) has potential implications for the empirical researchers as the model specifies relationship between earnings and book values as proxies for equity values and accounting variables. Although researchers have supported RIM as an alternative to the dividend discount model (DDM), some empirical studies on RIM have triggered arguments on the superiority of the RIM over DDM. In theory, both models give the same value estimates; empirically, these value estimates changes with the changes in the assumption sets. In this paper, we show that both models provide the same values estimates when the terminal value can be forecasted. Although, under the perpetual growth rate model, the researchers have shown that empirically RIM outperforms DDM. We have shown that this superiority of RIM is misleading, as the transversality condition, a necessary assumption for deriving the RIM, is void under the perpetual growth rate scenario.*

Keywords: *Book Value, Clean Surplus Relation (CSR), Dividend Discount Model (DDM), Residual Income Model (RIM), Valuation.*

I. Introduction

How do we best measure value creation in companies, and how do we best summarize our expectations about future value creation into an estimate of equity value?

Residual Income Model (RIM) and *Dividend Discount Model* (DDM) are the two most widely used valuation techniques in finance, and in accounting. Researchers have been arguing on the superiority of one model over the other, however. Yet, none of them have investigated the reason behind this difference in the empirical tests of the models.

The RIM is an algebraic derivation of the DDM under some robust assumptions. The RIM is based on simplified accounting relationship as well as on the assumption of DDM. The RIM is seductive because it purports to provide assessments of performance at any given point in time. The rejection of RIM is logically equivalent to prices not being equal to the present value of expected future dividends. The researchers deny the fact that the RIM is at fault, rather they have been arguing on the empirical testing methods. Bernard (1995), Penman and Sougiannis (1998), Francis *et al.* (2000), Frankel and Lee (1998) have argued that RIM provides a better measure of the asset value than that of DDM.

Although in theory, both DDM and RIM yield identical value estimates of the intrinsic value; in practice, they will differ if the sets of assumptions differ. In this paper, we focus on the reason behind getting different value estimates from DDM and RIM. We show that the presence of terminal value provides the same value estimates of the models. With the perpetual growth rate, the RIM is regarded as a better measure for valuing an asset. We show that this belief is misleading and both of the models will provide the same value estimate if the transversality condition of RIM holds.

The paper is organized as follows. Section II provides a brief discussion on the asset valuation. Section III and IV incorporate residual income model and its development. Arguments over the empirical studies are included in section V. The argument of this paper, the simulation of the RIM under perpetual growth rate is introduced in section VI. The implication of the empirical analysis of this paper is discussed in section VII. Section VIII follows the conclusion.

II. Asset Valuation

What determines the value of an asset? How do both investors and the researchers value an asset? Most of the valuation methods used in finance have steamed from the primitive assumption that the price is the discounted value of the future stream of flows. These flows can either be, for example, forecasted dividend, forecasted cash flows, forecasted earnings, residual earnings or forecasted profits. In theory, all of these models work for an ongoing concern for infinite period.

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Williams (1938) was one of the first economists to view stock price as determined by the *intrinsic value*, and he is recognized as a founder and developer of the fundamental analysis. In his paper, Williams had proposed that the value of an asset should be calculated using the "*evaluation by the rule of present worth*". For an asset, the intrinsic long-term worth is the present value of its future net cash flows, in the form of dividend distributions and selling price. Rather than forecasting stock price directly, Williams emphasized future corporate earnings and dividends. In so doing, he changed the focus from the time series of the market to the underlying components of asset value.

Rubinstein (1976)'s dividend discount model is regarded as the traditional approach to value a single firm. The idea of dividend discount model implies that one should forecast dividends in order to estimate the stock price. While direct mention of the dividend discount model (DDM) did not show up in research until the last few decades, investors and analysts have long linked equity values to dividends. In his book, *The Theory of Investment Value*, John Burr Williams (1938) has explicitly connected the present value concept with dividends. He stated that:

> '*A stock is worth the present value of all the dividends ever to be paid upon it, no more, no less… Present earnings, outlook, financial conditions, and capitalization should bear upon the price of a stock only as they assist buyers and sellers in estimating future dividends.*'

The dividend discount model has disadvantages because dividends are arbitrarily determined, and many firms do not pay dividends. As a result market participants tend to focus on accounting information, specially on earnings. Starting from the dividend discount model, Peasnell links dividends to fundamental accounting measurements such as book value of equity and earnings. Gradually the researchers have changed their focus from the cash-flow based valuation approach to accounting based approach, for example, residual income model (RIM).

The RIM states that the firm value is the sum of the book value and the present value of expected future residual income. Thus, forecasting future residual income is critical to RIM's implementations. Although the derivation of RIM was originated in Preinreich (1938), the work was mostly ignored until the revival of the model by Ohlson (1995). By using book value, and the clean surplus equation to carry the dividend information, one can re-write the DDM as a discounting of accounting numbers. Derivations of this model have surfaced dated back in 1930s and developed throughout the accounting, finance and economics literatures. The basic hypothesis of the RIM is that the price is the present value of the expected future dividend flows. Preinreich (1938, p-240) can be regarded as the origin of RIM.

III. The Residual Income Model (RIM)

Textbooks and articles are too numerous to mention caution against attempting to derive the economic value of a firm or investment by means of discounting future accounting profit numbers. The studies by Ohlson on RIM have led the researchers to reexamine the relation between the accounting numbers and the firm value. Ohlson (1995)'s RIM has shifted the perception of the researchers from the present value of expected dividends (PVED) to book value plus the present value of expected abnormal earnings. One can obtain explicit and basic expressions relating value and the present value of the expected abnormal earning without violating the PVED percepts.

The primitive adaptation of valuation was that stock value equals the present value of expected dividends (Rubinstein (1976)). The core of the valuation function expresses value as a weighted average of capitalized current earnings (adjusted for dividends), and current book value. Ohlson incorporated the accounting values (such as, book value, earnings and dividends) into valuation through *clean surplus relation* (CSR) Ohlson (1995). CSR relies on the assumption that the change in the book value is equal to the earnings minus dividends (net of capital contribution). The clean surplus Relation (CSR) is:

$$SE_t = SE_{t-1} + x_t - d_t$$

where, SE_t and SE_{t-1} are the book values at t and (t-1) respectively, x_t is the net income at t, and d_t is the dividend at t.

The development of RIM shows the relevance of abnormal (or residual) earnings as a variable that influences a firm's value. This abnormal return can be defined as the *goodwill* of the firm as it bears the difference between the market value and the book value.[1] One of the benefits of Ohlson's model is that it forces

[1] As the PVED and the clean surplus relation imply that the market value equals the book value plus the present value of future expected abnormal earnings (see, Peasnell (1981)), the valuation analysis can focus on the prediction of abnormal earnings rather than dividends. Book values are unbiased estimators of the market values in that the (unconditional) expected

to think about the relation between earnings and dividends. It also provides assumption that specifies the relation between dividends and earnings in such a way that one can safely ignore the dividend policy (Lundholm (1995)).

The development of the Olhson model has potential implications for empirical researchers as the model specifies the relationship between earnings and books values as proxies for equity values and accounting variables. Although researchers have supported Olhson model as an alternative to the DCF model, some studies on the RIM have triggered arguments on the relationship between the firm value and the accounting numbers.[2]

IV. Development Of RIM:

The *residual income model* (RIM) depicts the relation between a firm's market value and accounting numbers concerning operating and financial activities within a clean surplus context. RIM is based on the basic hypothesis that stock's intrinsic value, V_0^*, is defined as the present value of its expected future dividends.

$$V_0^* = \sum_{t=1}^{\infty} \frac{E(d_t)}{(1+r_e)^t} \qquad (1)$$

where, $E(d_t)$ is the expected future dividends for period t, and r_e is the cost of equity capital. The cost of equity capital is assumed to be constant. Considering a zero-sum identity of the form:

$$0 = SE_0 + \frac{SE_1 - (1+r_e)SE_0}{(1+r_e)} + \frac{SE_2 - (1+r_e)SE_1}{(1+r_e)^2} + \cdots + \frac{SE_T - (1+r_e)SE_{T-1}}{(1+r_e)^T} + \cdots \qquad (2)$$

where, $\lim_{t\to\infty} \frac{SE_t}{(1+r_e)^t} = 0$. The clean surplus relation dictates that entries to retained earnings are limited to record only periodic earnings and dividends which follows:

$$SE_t = SE_{t-1} + x_t - d_t \qquad (3)$$

where, SE_t and $SE_{t-1}$are the book values at *t* and (*t*+1) respectively, x_t is the net income and d_t is the dividend at *t*. If the Clean Surplus Relation (CSR) holds, adding equation (1) and equation (2), we get:[3]

$$\text{RIM:} \qquad V_0^* = SE_0 + \sum_{t=1}^{\infty} \frac{E[x_t - r_e SE_{t-1}]}{(1+r_e)^t} \qquad (4)$$

where, SE_t is the book value at time t and x_t is the net income at t. In equation (4), $[x_t - r_e SE_{t-1}]$ can be defined as the '*residual income*' or '*abnormal earnings*', $x_{t+\tau}^a$, where $[x_{t+\tau}^a = x_t - r_e SE_{t-1}]$.[4] Equation (4) is known as the *residual income model* (RIM). RIM implies that a firm's value equals its book value of equity and the present value of anticipated abnormal earnings. One of the interesting properties of the RIM is that a firm's value based on the RIM is believed to be unaffected by accounting choices.

Although equation (1) and equation (4) are identical to the dividend discount model, equation (4) is derived from the accounting numbers instead of dividends. Researchers have claimed that rejecting RIM means rejecting present value of expected dividends (PVED) model in the sense that RIM is only a mathematically modified version of the PVED model. However, in empirical tests, both of these models differ from each other

goodwill (abnormal earnings) equals zero. In other words, though goodwill generally has positive serial correlation, over very long periods the average goodwill approximates zero (Ohlson (1995)).

[2] See, for example, Ohlson (1990,1991,1995), Feltham and Ohlson (1995) and Dechow and Sloan (1997).

[3] Equation (4) is just a restatement of the DDM which is in no way depends on the properties of accounting numbers other than through the clean surplus relation. For example, given a stream of future dividends, the value of $SE_t$and the values all the x_t could be picked as random numbers. So long as the SE_t is updated following clean surplus relation, the valuation relation in equation (4) will yield the present value of the dividend stream.

[4] The firms whose expected ROE is higher (lower) than $r_e$will have values greater (lesser) than their book values. In general, If a firm earns future accounting income at a rate exactly equal to its cost of equity capital, then the present value of future residual income is zero, and $V_t = b_t$. The firms those neither create nor destroy wealth relative to their accounting-based shareholders' equity will be worth only their current book value.

$$p_t = SE_t + \sum_{\tau=1}^{\infty} \frac{E_t[(ROE_{t+\tau} - r_e)\, SE_{t-1}]}{(1+r_e)^\tau} \qquad (F1)$$

In a competitive equilibrium, a typical firm's ROE should be close to its cost of equity capital ($ROE \equiv r_e$).

(Courteau *et al.* (2000), Francis *et al.* (2000) and Penman and Sougiannis (1998)). This gave rise to arguments on the superiority of one model over the other. Lundholm and O'keefe (2001) took a step forward to argue on the equivalence of the models. They have found that with the presence of the terminal values (TV), the intrinsic values of the equity coincide as long as CSR holds. For the perpetual growth stock, they have attained the same value estimates with modifications in the starting point of the perpetual growth. Still the question remains, *why the empirical valuation models give the same estimates for terminal value, but differs for a perpetual growth model? Do we really need to modify the growth estimate that would lead to perpetual growth rate in order to get the same value estimates?*

Although the RIM is popular over the PVED model, the acceptability of RIM is debatable among the researchers. One of the major shortcomings of RIM is its assumption about the CSR. *Is CSR really necessary to derive RIM from PVED model?* The straightforward answer would be 'Yes'. But any two variables, other than earnings and book value, which satisfy the CSR, can derive the RIM from PVED. These variables need to have accounting meanings, however.

V. Arguments Over RIM And DDM:

From an empirical standpoint, the RIM leaves the researchers in much the same position as the DDM. The valuation relation cannot be implemented without estimates of future book values. In order to estimate future book values, the researchers must estimate future dividends. However, once the future dividends are estimated, the book value and earnings estimates become redundant, and the researcher may just as well have used the DDM.

Dechow *et al.* (1999) have argued on the validity of the RIM as the empirical research relying on Ohlson's model is similar to past research relying explicitly on the DDM. The estimation of the future book values is the basic of the valuation models and the researchers estimate future dividend in order to estimate the future book values. These estimated future dividends can easily be used in DDM resulting in the redundancy of the RIM. Some researchers have argued that although the residual income model has intuitive appeal because of its focus on accounting numbers, the residual income valuation model is interpretable in the context of the standard dividend-discounting framework. Penman (1997), Frankel and Lee (1998) and Francis *et al.* (2000) have concluded that, empirically, the RIM is similar to the traditional earnings capitalization models like DDM or DCF.

Although RIM is merely a simple derivation of present value of expected dividend model into a book value model, a number of researchers do argue on how the model really works. Although in theory, both DDM and RIM yield identical value estimates of the intrinsic value; in practice, they will differ if the sets of assumptions differ. At the beginning, empirical researchers had provided support for the model, and the model was treated as an alternative to the discounted cash flow model in equity valuation (for example, Palepu *et al.* (1996)). Some researchers have supported that the residual income model (RIM) predicts and explains stock prices better than the models based on discounting short-term forecasts of dividend and cash-flows (Bernard (1995), Penman and Sougiannis (1998), Frankel and Lee (1998) and Francis *et al.* (2000)). They have concluded that RIM provides more complete valuation approach than popular alternatives.

While some researchers have argued on the superiority of one model over the other as a result of incorporating the assumptions underlying the model, others have supported their superiority in empirical analysis. The violation of the clean surplus relation (CSR) or the inconsistent growth rate might lead to the different intrinsic values. Lundholm and O'Keefe (2001) have argued on the reasons for getting different value estimates even when the researchers use the same sets of information and assumptions.

Several studies have evaluated RIM's ability to explain stock prices. Penman and Sougiannis (1998) have implemented variations of the model using *ex-post* realization of earnings to proxy for *ex-ante* expectations. They have argued that the GAAP accrual earnings yield lower forecasting errors than that based on the dividends or cash flows. They have found that valuation errors are lower when accrual earnings techniques are used rather than cash flow and dividend discounting techniques. They have concluded that the superiority of RIM over the cash flow model is a result of the forecasting techniques used in RIM. Lee *et al.* (1999) have operationalized the RIM for 30 stocks in the Dow Jones Industrial average and examined time-series properties of the model. Frankel and Lee (1998) have employed the model in an international context and have found that the value has high explanatory power for prices in 21 countries. Dechow and Sloan (1997) have examined the empirical properties of the RIM under alternative specifications, and they have also examined the predictive power of the model for cross-sectional stock return in the US.

Francis *et al.* (2000) have used the Value Line's estimates to compare the RIM and the cash flow model (DCF). They have estimated the intrinsic value from an investor's standpoint, assuming a terminal growth rate either zero or 4 percent, and have concluded that the RI value estimates dominate the free cash flow or the dividend discount model's (DDM) value estimates. Courteau *et al.* (2000) have also compared the RIM

with the cash flow models by using the price-based terminal value estimates, and they have concluded on the superiority of RIM over DCF when the terminal price forecasts are not available.

Although the researchers have argued on the superiority of the RIM over the DDM in predicting the stock value, Lundholm and O'Keefe (2001) have argued that all the papers that compared the superiority of one model over another were mostly affected by either or a combination of *inconsistent forecasts error*, *incorrect discount rate errors* or *missing cash flow error*. Lundholm and O'Keefe (2001) have further argued that all models should provide the same value estimates because of the inherent assumptions and the origin of the models. Besides, they have shown that with the terminal value (TV), both of the models give the same value estimates as long as the clean surplus relation holds.

Is the enthusiasm on the Ohlson model justified? Lo and Lys (2000) believed that the excitement on the superiority of RIM is at a minimum, premature, and more likely unjustified. The RIM is seductive because it purports to provide assessments of performance at any given point in time. RIM is based on simplified accounting relationship as well as on the assumptions of present value of expected dividend model (PVED). The rejection of RIM in empirical tests is logically equivalent to prices not being equal to the present value of expected future dividends. Most of the researchers have denied the fact that the RIM is at fault, rather they have argued on the empirical testing methods of RIM.

The redundancy of the residual income valuation model applies more generally to studies that generate explicit forecasts of earnings and book values (and hence dividends) for several periods, and then use a terminal value assumption to complete the valuation (e.g., Frankel and Lee (1998), Francis et al. (1997)). Penman (1997) demonstrated how some of the more common terminal value assumptions employed in the residual income valuation model are readily interpretable in the context of the standard dividend discounting framework. Thus while the residual income formulation of the dividend discounting model may have intuitive appeal because of its focus on accounting numbers, it provides no new empirical implications in and of itself.

VI. Empirical Analysis of RIM And DDM:

Although the dominance of the Dividend discounted model (DDM) was well understood, the introduction of the residual income model (RIM) has raised the controversies on the superiority of one model over the others. This argument on the superiority of a particular model aroused as the models provided different estimates of the intrinsic value even when the inputs are the same for both the models.

The valuation model explains price in terms of infinite series, but for the empirical purposes, we need a finite series. Thus the estimation of the Terminal value is a must. The controversy remains over the estimation of the terminal value, however. Although a number of researches are dedicated to RIM, very few have provided any formal test of the model. Rather most of the researches were aimed at establishing the usefulness of RIM in security valuation. Non-specification of the benchmark is treated as one of the major reasons for the lack of formal testing of RIM. Instead researchers are more concerned on comparing the superiority of RIM over other valuation models.

In this paper, we investigate the settings and the assumptions underlying the RIM. To our surprise, the crack was found at the foundation of the model. We have found that the assumption of transversality condition becomes void in the empirical tests. Thus, whenever the model based on this transversality condition was tested, researchers were moved away from their expected value. We conclude that empirically the transversality condition fails; as a result RIM provides superior estimates of the asset value.

One of the most essential elements in the equity valuation is the forecasting of the financial performances of the firm. In practice, analysts generally split the forecasting into two steps. Firstly, relatively detailed forecasts of financial statement line items up to some preselected horizon date are developed. The second stage considers the forecasts beyond the horizon date. The portion of the value due to the post-horizon period is generally referred to as the continuing (or terminal) value. In practice, analysts/researchers make finite forecasts, and this truncation of the forecasted period requires a 'terminal value' at the horizon. The difference among these valuation models is mainly resulted from the differences in calculating the terminal value. Researchers mostly used ad hoc methods or rely on different assumptions, focusing on the goal of their research.[5]

For a better understanding of our argument, we followed the example provided in Lundholm and O'Keefe (2001) for empirical analysis in this paper. We have started with the Home Depot 1999 Value Line

[5] Penmam (1998) provided the terminal value calculation for the dividend discount model. This is somewhat ironic that discounted cash flow and residual income techniques (for example) have been proposed to get over the difficulty in determining a terminal value for the dividend discount model. Dividend discounting, it is said, does not work for finite horizons. Thus something more fundamental (like cash flows or earnings) must be forecasted instead of dividends. The dividend discount model is the umbrella model over the other models and they are compared in terms of their prescriptions for the terminal value for the dividend discount model.

forecasts and gradually expand our arguments.[6] Starting with one set of forecasted pro-forma financial statements as is uniformly done in practice, there is only one implied series of future net dividends, discounting these series at the exogenously given cost of equity capital results in a unique value estimates.

Table 1: Home Depot 1999 Value Line forecasts

where, SE_t, x_t, and d_t are shareholders' equity, net income, and net dividends at time t, respectively, and $E_0(p_5)$ is the forecasted price *at* $t = 5$

	$t=1$	$t=2$	$t=3$	$t=4$	$t=5$	$E_0(p_5)$
SE_{t-1}	5.36	6.45	7.82	9.80	11.79	80.00
$+x_t$	1.25	1.55	2.16	2.17	2.85	
$-D_t$	0.16	0.18	0.18	0.18	0.24	
$=SE_t$	6.45	7.82	9.80	11.9	14.40	

We have found that with the terminal value, both RIM and DDM provides the same value estimates. Courteau *et al*. (2000) have stated that the equivalence of the models might not hold empirically if the forecasted earnings, cash flows or dividends are not efficiently priced by the market. As the market's stock price expectations are not readily observable, the use of Value Line's terminal value forecasts might lead to ambiguity in the empirical tests. Lundholm and O'keefe (2001) have shown that both of the models provide same value estimates with the forecasted terminal value. Although changing the terminal value forecast changes the resulting value estimate, the change is exactly the same for both RIM and DDM. They have stated:

> '….. we can insert *anything* for the five years of d_t, x_t and SE_t estimates;…. As long as the estimates satisfy $SE_t = SE_{t-1} + x_t - d_t$, the algebra holds and the value estimates will be the same for each model.'

Although previous valuation studies based on RIM have focused more on determining value relevance, the equivalence of the models has nothing to do with how efficiently the market prices earnings or dividends. When the RIM results are applied for forecasting, it yields large errors, although the RIM is found to produce more accurate forecasts than alternatives such as the dividend discount model and the free cash flow model (Penman and Sougiannis (1998) and Francis *et al.* (2000)). These forecast errors are disturbingly large, and valuation tend to understate stock price (Frankel and Lee (1998) and Dechow *et al.* (1999)). The large errors could be due to many factors, including inappropriate terminal value, discount rates and growth rates (Lundholm and O'Keefe (2001)).

Why the value estimates of DDM and RIM differ from each other? In the more common situation, there is no forecasted terminal value. The researchers use their perceptions and beliefs in determining the nature of growth of the asset under consideration. Researchers have argued on the empirical comparison of the models when the terminal value forecast is unavailable and the asset has a perpetual growth rate. Lundholm and O'keefe have shown that regardless of when the market believes the firm has a perpetual growth rate, as long as the correct starting values are used in the perpetuity expressions, the models will yield identical estimates Lundholm and O'keefe (2001).

We also support Courteau *et al.* (2000) and Lundholm and O'keefe (2001), in that, with the forecasted terminal value, RIM and DDM will provide same value estimates. However, we refute them that in the perpetual growth rate model, the use of RIM in asset valuation will mislead the researchers. The simulation in table 2 provides explanation on our argument.

The simulation of the empirical calculation of the Home Depot's stock value in table 2 is based on the Home Depot 1999's *Value Line* forecasts. In addition, we follow the basic assumptions for the DDM. We assume that the dividend is growing at the rate of 4% per annum. We provide a simulation of the value generations for 598 years. Following Lundholm and O'keefe (2001), when the residual income (RI) is assumed to be growing at 4% forever, the RIM provides greater estimate of the asset value compared to the DDM. Our focus in this paper is on finding the reason for getting greater value estimate of an asset in RIM. We assume that clean surplus relation holds and the cost of capital 10%.

[6] This example is also adopted by Francis *et al.* (2000), Courteau *et al.* (2000), Penman and Sougiannis (1998) and Lundholm and O'Keefe (2001)

Table 2: Simulation of DDM and RIM based on the example provided in Lundholm and O'Keefe (2001)

SE_{t-1} and SE_t are beginning and ending *book value* at $(t-1)$ and t respectively. x_t is the *net income* at t whereas d_t is the *dividend* at t. RI_t is the *residual income* at t. DDM and RIM refer to *dividend discount model* and *residual income model* respectively. The cost of capital is assumed as 10%. Both d_t and RI_t are assumed to increase at 4% forever from year 6 onward.

1	2	3	4	5	6	7	8	9	10	11
Year	SE_{t-1}	x_t	d_t	SE_t	g_{SE_t}	RI_t	P(DDM)	P(RIM)	P(RIM) – P(DDM	PV(SE_t)
1	5.36	1.25	0.16	6.45		0.714				
2	6.45	1.55	0.18	7.82		0.905				
3	7.82	2.16	0.18	9.8		1.378				
4	9.8	2.17	0.18	11.79		1.190				
5	11.79	2.85	0.24	14.4		1.671	3.284	27.627	24.342	8.941
6	14.4	3.17784	0.2496	17.3282		1.737	3.284	27.627	24.342	9.781
7	17.32	3.54018	0.25958	20.6088	0.189	1.807	3.284	27.627	24.342	10.57
8	20.60	3.94053	0.26997	24.2794	0.178	1.879	3.284	27.627	24.342	11.326
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
44	1356.3	143.344	1.10793	1498.54	0.105	7.713	3.284	27.627	24.342	22.614
45	1498.5	157.876	1.15224	1655.26	0.105	8.022	3.284	27.627	24.342	22.708
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
73	22918.3	2315.88	3.45524	25230.7	0.101	24.057	3.284	27.627	24.342	24.002
74	25230.7	2548.09	3.59345	27775.2	0.101	25.019	3.284	27.627	24.342	24.021
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
175	$3.9 \times e^{8}$	$3.9x\ e^{7}$	188.747	$4.3x\ e^{8}$	0.10	1314.15	3.284	27.627	24.342	24.342
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
231	$8.1x\ e^{10}$	$8.1x\ e^{9}$	1697.25	$8.9x\ e^{10}$	0.10	11817.1	3.284	27.627	24.342	24.342
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
597	$1.1x\ e^{26}$	$1.1x\ e^{25}$	$2.9x\ e^{9}$	$1.3x\ e^{9}$	0.10	$2x\ e^{10}$	3.284	27.627	24.342	24.342
598	$1.3x\ e^{26}$	$1.3x\ e^{25}$	$3x\ e^{9}$	$1.4xe^{26}$	0.10	$2.1x\ e^{10}$	3.284	27.627	24.342	24.342

Since the introduction of the RIM, researchers are testing the empirical validity of the models. Although both of the models are derived from the same sets of assumptions, in empirical tests, the models provided different value for the same asset. As a result, the researchers are arguing over the superiority of on valuation model over the other.

We focus on the difference between the value estimate of DDM and RIM. In column 10, the difference of value estimate between these two models is 24.342. If we look closely on column 6, the growth rate in the ending book value is 18.9% in year 7. This growth rate in the ending book value decreases with the increase in time. In year 44, this growth rate comes closer to 10%, which is closer to the cost of capital. And from the 175th year onward, the growth rate in the book value matches the cost of capital, 10% per year.

Column 11 shows that the present value of the ending book value of SE_T. The present value of ending book value increases from 8.941 in year 5 as the time increases. From year 175 onward, the present value of the ending book value becomes a constant at 24.342 till 598th year.

The interesting point here is that, from year 175 onward, the present value of the ending book value in column 11 coincide the difference between the present value of RIM and DDM in column 10. The simulation in table 2 proves the superiority of RIM over DDM when the growth rate is perpetual. As mentioned before, in this scenario, the present value of the ending book value for RIM provides a constant estimate. Does this constant estimate have any implication on the difference between the value estimates of these two models?

VII. Implication of The CONSTANT Present Value Of Ending Book Value

The claim that the RIM is superior to the DDM in valuation is puzzling because the RIM is simply an interesting algebraic rearrangement of the DDM. Since the same information is used in both the models, it is not unexpected that both the models should give the same valuation results in Valuation. *Why RIM provides superior value estimate than DDM when the terminal value is unavailable or when the growth rate is perpetual?*

Looking back to the basic assumptions of the RIM, the *transversality condition*, that the book value of the equity moves closer to zero as the time reaches infinity; i.e., $R^{-t}E(SE_t) \overset{t\to\infty}{\longrightarrow} 0$. Does this assumption holds in

empirical test of the RIM? As seen from the simulation in table 2, at the time increases, the ending book value also increases and from year 175 onward the present value of this ending book value becomes constant. This proves that the transversality condition becomes void under perpetual growth rate. Why the transversality condition fails in empirical tests?

Column 6 depicts the growth rate of the ending book value, g_{SE_t}, over time. When residual income and dividends are assumed to grow at 4% forever, the growth rate in the ending book value, g_{SE_t}, starts off with a larger rate and gradually coincides with the cost of capital. As a result, as the time increases the ending book value becomes larger and the present value of the ending book value becomes constant.

What necessary assumption will make the present value of ending book value zero, and will also provide same value estimate as DDM? The zero sum identity,

$$0 = SE_0 + \frac{SE_1 - (1+r_e)SE_0}{(1+r_e)} + \frac{SE_2 - (1+r_e)SE_1}{(1+r_e)^2} + \cdots + \frac{SE_T - (1+r_e)SE_{T-1}}{(1+r_e)^T} + \cdots$$

leaves $\frac{SE_T}{(1+r_e)^T}$ at T. When $g_{SE_t} > r_e$, as in table 2, the zero-sum identity will provide a constant present value of ending book value. In contrast, when $g_{SE_t} < r_e$, the zero sum equality results in:

$$\lim_{t\to\infty} \frac{SE_t}{(1+r_e)^t} = 0$$

Both RIM and DDM will provide same value estimates for the scenario with no terminal value and with perpetual growth rate when $g_{SE_t} < r_e$. The inherent assumption in zero-sum equality is that, $R^{-t}E(SE_t) \underset{t\to\infty}{\longrightarrow} 0$. And, any violation of this relationship will make zero-sum void.

VIII. Conclusion

From an empirical stand point, RIM in equation (4) leaves the researchers in much the same position as the DDM. The valuation relation cannot be implemented without estimating the future book values. In order to estimate future book values, researchers must estimate future dividends. However, once future dividends are estimated, the book value and the earnings estimates become redundant, and the researchers may have just as well have used the DDM in equation (1). Researchers have been arguing on the superiority of one model over the other, we focused on the empirical reason for this difference between the models.

We have shown that with the terminal value, both models provide same value estimates. In the absence of the terminal value or when the asset grows at a perpetual growth rate, residual income model fails to provide true value estimate. Our paper is the first one to show that if the growth rate in the ending book value is not less than the cost of capital, the transversality condition in the ending book value becomes void. As a result, RIM provides a constant present value of the ending book value which makes RIM a superior technique over DDM in the empirical analysis of valuation.

Although studies demonstrated the *theoretical* equivalence of valuation models, this equivalence depends primarily on the assumption of ideal conditions. RIM is easy to use in empirical analysis because of the availability of the necessary information related to the model. In the empirical tests of RIM we have to focus on the growth rate of the ending book value to get the proper value estimate.

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