CHRISTMAS
CORPORATION

PBV RATIO VALUATION MODEL ENHANCEMENT

EVIDENCE FROM S&P 500 COMPANIES

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ABSTRACT

This study aims to establish a valuation model, based on the fair price to book value (PBV) ratio of 448 stocks data from S&P 500 listed companies during the period of 2005-2014. This valuation formula is established with the thesis that investors value stocks based book value of equity and premium of book value. This study finds the proposed formula is useful to determine the fair price of a stock by using book value of equity, return on equity, cost of equity, and sustainable growth rate. Further testing is done by selecting undervalued stocks portfolio based on this model to prove that these stocks are able to beat both average total returns of total observed portfolio and average return of overvalued stocks portfolio in the same period. Not only the portfolio generates a better than average return, it also implies a better risk-adjusted return as shown by Sharpe Ratio and a lower risk as shown by relatively low standard deviation and coefficient of variation.

Keywords: *PBV, ROE, Valuation, Asset Pricing, Residual Income*

1. INTRODUCTION

Research on valuation using equity and book value of equity was introduced by Edward and Bell (1961), Peasnell (1982) and Ohlson (1995), which is also known as the residual income valuation method. This valuation theory explains that if a company has return on equity (ROE) greater than the required return on equity or so-called equity charge, then the stock of that company is qualified to be valued above its book value because it has a positive residual income. The amount of premium over book value is calculated from the value of residual income divided by the required return. In the discussion on asset-based valuation, White, Sondhi, and Fried (2002) explains that the value of the shares would be more than the value of equity if ROE greater than required return. A company will be valued higher than other companies if it has a potential for growth in the future.

The main goal of this study is to prove the ability of a stock valuation formula which can be used practically by investors to get a better than average portfolio investment result on annual basis. This study tries to solve some issues on existing theoretical models.

The model in this research is aimed to see whether investors are seeking these two factors in stock investment. First, the value obtained when the company is liquidated, as reflected in the current book value per share (BVS); second, abnormal earnings or residual income, as reflected in the company's ability to generate a return on equity higher than the cost of equity. Cost of equity (k) is calculated by risk-free interest rate and risk premium. Third, whether the sustainable growth (g) rate of equity affects valuation. Sustainable growth rate is a function of ROE and income retention ratio. Findings of the model will lead us to our main objective – to determine fair price to book value (PBV) ratio of a stock and build a portfolio that will beat average market return.

This study back tests stocks based on the fair PBV generated from both theoretical and proposed formula. This is done to prove that the method of fair PBV proposed in this research can find undervalued stocks that are able to beat the market. Undervalued portfolio is expected to generate better than average

total return and significantly better than overvalued portfolio. It is also expected that this valuation creates a higher risk-adjusted return as measured by Sharpe Ratio (Sharpe, 1994).

2. LITERATURE REVIEW

Necessary frameworks for this study are based on previous studies about price to book value ratio, residual income, and growth.

2.1 Price to Book Value Ratio

PBV ratio is one of relative valuation ratio that can be used to assess whether the stock is undervalued, overvalued, or fairly valued. The PBV ratio is obtained from current stock price divided by the book value per share of the company

$$PBV = \frac{P}{BVS} \tag{2.1}$$

Damodaran (2002) explained that the PBV ratio is strongly influenced by the return on equity. A stock traded at low PBV does not mean it is undervalued. Instead, PBV ratio should reflect the ability of a company to earn a return on equity capital that exceeds its cost of equity (Riley and Brown, 2006). This means, we need to consider PBV ratio as a function of ROE and the cost of equity capital or required return.

FIGURE 1:
PBV AS A FUNCTION OF RETURN DIFFERENTIAL

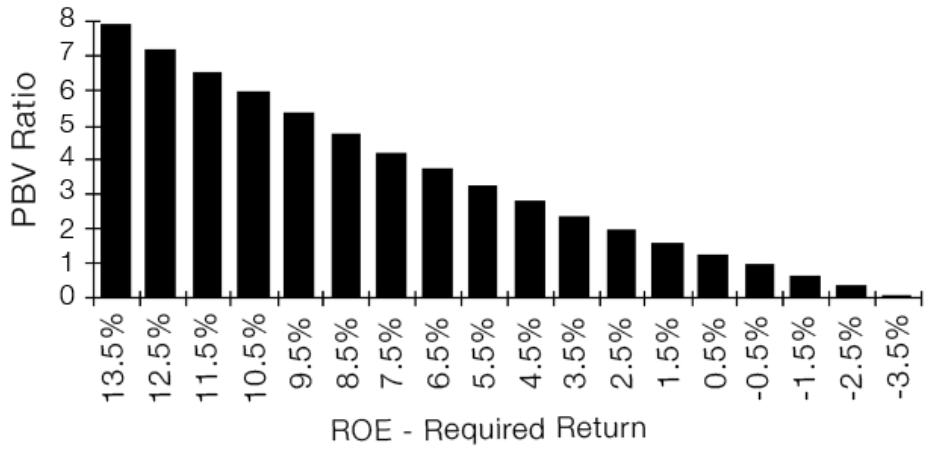

Image Source: www.pages.stern.nyu.edu

In Gordon growth model, the value of equity for a stable firm can be computed as

$$V = \frac{DPS}{k - g} \tag{2.2}$$

where DPS is dividend per share.
Using the *DPS = EPS * Dividend Payout Ratio* and *EPS = ROE * PBV*, then

$$V = \frac{ROE \ BVS \ DPR}{k - g} \tag{2.3}$$

where DPR is dividend payout ratio. Adjusted to PBV model, then

$$\frac{V}{BVS} = \frac{ROE \ DPR}{k - g} \tag{2.4}$$

Growth in equation 2.4 can be determined as sustainable growth rate which can be calculated by using plow back ratio or retention rate. Ross, Westerfield, and Jaffe (2010) suggest that sustainable growth rate is the maximum growth rate a firm can achieve with no external equity financing (no new shares) while it maintains a constant debt-equity ratio. In general, sustainable growth rate is

$$g = ROE \ (1 - DPR) \tag{2.5}$$

2.2 Residual Income Valuation Model

Residual income valuation is a stock valuation approach by calculating the cost of equity capital. Means, residual income should be reduced with equity charge. In contrast to the discounted cash flow valuation, residual income is calculated by taking accounting numbers from the balance sheet and income statement. Mathematically, residual income can be calculated as follows

$$RI = ROE \ BVS - k \ BVS \tag{2.6}$$

where:
RI = residual income
BVS = book value of equity per share
k = equity charge = cost of equity capital

White, Sondhi, and Fried (2002) explained in asset-based valuation method that the value of the stock is resulting from the value of the book value of equity plus the residual income. The implication of the model is that the stock will be traded at a value equal to the book value when ROE is equal to the required return (r = k). If the company has ROE greater than the required return on equity (r > k), then the company has a positive residual income and it means the company is worth more than its book value.

The amount of the premium over book value is calculated from the residual income divided by the required return.

Residual income valuation model is calculated from the book value of equity plus the present value of future's residual income. The residual income is calculated from the present value of residual income earned in the future.

$$V_0 = BVS_0 + \sum_{t=1}^{T} \frac{RI_t}{(1+k)^t} + \frac{TV_T}{(1+k)^T} \tag{2.7}$$

where:
V_0 = value of stock
BVS_0 = current book value of equity per share
RI_t = residual income at period-*t*

TV_T = terminal value at the end of holding period
k = cost of equity capital

Present value of residual income is the value of residual income in perpetuity or period known as the terminal value at the end of the holding period (TV_N). Terminal value reflects the present value of residual income generated in the future. The equation is as follows

$$TV_T = \frac{ROE_T BVS_T - kBVS_T}{k - g} \quad (2.8)$$

Variable g in the equation 2.3 and 2.8 is terminal growth or perpetual growth. Thus, the PBV ratio at the time of the terminal value is

$$\frac{TV_T}{BVS_T} = \frac{ROE_T - k}{k - g} \quad (2.9)$$

If it is assumed that perpetual growth = 0, then

$$\frac{TV_T}{BVS_T} = \frac{ROE_T - k}{k} \quad (2.10)$$

2.4 Equity Charge

The required rate of return of a financial asset is determined by the magnitude of the risk-free interest rate plus a risk premium. The greater the uncertainty over the return generated by an asset, then the required return on these assets will increase. Basic formula of the required rate of return is

$$k = R_F + R_P \quad (2.11)$$

R_F is the risk- free interest rate and R_P is the risk premium. Risk premium is generated from

$$R_P = \beta\ (R_M - R_F) \quad (2.12)$$

R_M is the rate of return of the market portfolio, such as stock market index's rate of return, while *beta* measures A volatility, or systematic risk, of a security or a portfolio in comparison to the market as a whole (Reilly and Brown, 2006).

2.5 Test of ROE and PBV on Stock Return

A research by Damodaran (2011) screened all NYSE stocks from 1981 to 1990, on the basis of both price-book value ratios and returns on equity and creating two portfolios - an 'undervalued' portfolio with low price-book value ratios (in bottom 25% of universe) and high returns on equity (in top 25% of universe) and an overvalued portfolio with high price-book value ratios (in top 25% of universe) and low returns on equity (in bottom 25%) each year, and then estimating excess returns on each portfolio in the following year.

The undervalued portfolio made an average annual return on 25.60% over the ten year period compared to the overvalued portfolio that made 10.61% annually. Meanwhile, the S&P 500 made a return of 17.49% in that same period.

3. MODEL DEVELOPMENT

There are three possible things that investors look for to determine fair value of stocks using PBV ratio. First, the amount of money per share obtained by shareholders when the company is liquidated after deducting all liabilities as reflected in the book value of equity per share or BVS. Second, the company's return on equity above company's cost of equity. Third is the company's BVS growth.

3.1 Problems with Theoretical Models

An *ROE > k* represents a company with positive growth opportunities. The price of the stock is a sum of its book value and economic goodwill (White, Sondhi and Fried, 2002), denoted as

$$V = BVS + \left[\frac{ROE - k}{k}\right]BVS \tag{3.1}$$

Change it into PBV format, then

$$\frac{V}{BVS} = 1 + \frac{ROE - k}{k} \tag{3.2}$$

Equation 3.2 may not be able to capture the growth of a company. So if the model includes sustainable growth rate of BVS with perpetuity growth, then the premium of book value as explained in equation 2.8 can be applied, and PBV can be denoted as

$$\frac{V}{BVS} = 1 + \frac{ROE - k}{k - g} \tag{3.3}$$

There are some issues on equation 3.3. First, the denominator *k–g* leads into a problem when a company is on its high growth period and *g>k*, so that PBV is less than 1. In fact, a growing stock is usually traded at more than its book value, except when a financial crisis arrives. Meanwhile if *k=g*, stock value will be undefined, which is impossible. Now, the second problem is, lets assume *ROE=k* but the stock pays no dividend. Theoretically, when payout ratio equals zero, then *g* equals *ROE* so the company actually has a growth factor and yet it is not captured by the equation. Another model called abnormal earnings growth model has been developed by Ohlson and Juettner-Nauroth (2005). But a study by Jorgensen, Lee, and Yoo (2011) finds that abnormal earnings growth model has less accuracy than ordinary residual income models, even using a five-year forecast horizon.

3.2 Proposed Formula

To eliminate problems found in theoretical models, I propose a formula to determine fair PBV ratio, where

$$\frac{V}{BVS} = 1 + \frac{ROE + g - k}{k} \tag{3.4}$$

First, it is expected to be able to value a high-growth stock, where *g>k* . There is also no issue when *g=k*. Second, this formula produces the same result with equation 3.3 if a company has a 100% payout ratio and *g=0*. Third, when *ROE=k* but it has a growth factor (*g>0*), a stock can still be valued above its book value. Furthermore, when *k/k* is inserted in equation 3.4 to replace “1”, then the model says that PBV ratio of a company reflects both its present value of ROE and present value of sustainable growth rate:

$$\frac{V}{BVS} = \frac{ROE + g}{k} = \frac{ROE}{k} + \frac{g}{k} \tag{3.5}$$

4. METHODOLOGY

The objectives of this research are to prove that the ROE, growth rate, and the cost of equity can be used practically in determining fair PBV of stocks and to construct a portfolio of stocks that can generate above average return using proposed formula. To achieve the goals, this study is supported by regression using panel data. After getting convincing results of the regression analysis, two portfolio sets each consists of undervalued stocks and overvalued stocks can be constructed. The portfolios return later will be compared with average return of 448 stocks data.

4.1 Data

The panel data in this study consists of 448 US companies listed in S&P 500 index. The coverage period is 10 years, from the beginning of 2005 to the end of 2014. Stock data used in this research are companies listed on the S&P 500 index as of 2015 and have financial reports since 2000. Thus, not all 500 companies can be taken. The data used for each company are ROE, BVS at the end of the year, stock price at the beginning and at the end of the year, and dividend payout ratio. Selected companies should have positive earnings per share during an observed year. Cost of equity for each company is calculated by adding the risk-free rate and risk premium, based on the equation 2.11 and 2.12. Risk-free interest rate is based on 10-year Treasury bond yield. Meanwhile, risk premium is calculated by multiplying beta to market risk premium. In this study, market risk premium is set at 5%, based on Damodaran (2015) findings on historical market risk premium of S&P 500. BVS growth rate is calculated using its sustainable growth rate. A total of 4,165 total observations can be done for each regression.
By looking at equation 3.2 and 3.4, it can be said that PBV is a function of ROE, sustainable growth rate of BVS (*G*), and required return (*k*). The regression model then can be developed as

$$PBV_{it} = \beta_0 + \beta_1 ROE_{it} + \beta_2 K_{it} + \varepsilon_{it} \tag{4.1}$$

and the second regression is

$$PBV_{it} = \beta_0 + \beta_1 ROE_{it} + \beta_2 G_{it} + \beta_3 K_{it} + \varepsilon_{it} \tag{4.2}$$

Regressions are done with panel data for 10 years. The hypothesis is that all independent variables will significantly affect PBV ratio. The *ROE* and sustainable growth rate (*G*) will have a positive impact on PBV, and the cost of equity (*K*) will have a negative impact.

4.3 Test of PBV Formula

Evidence of the hypothesis on the regression formula will be followed by testing on equation 3.2 and 3.4. To do so, those equations need to be simplified as follows

$$\frac{V}{BVS} = 1 + \frac{ROE - k}{k} = 1 + RIF \tag{4.3}$$

And

$$\frac{V}{BVS} = 1 + \frac{ROE + g - k}{k} = 1 + RIFG \tag{4.4}$$

where *RIF* is residual income factor without sustainable growth rate, and *RIFG* is residual income factor with sustainable growth rate. Based on those formulas, two regressions will be done

$$PBV = \beta_0 + \beta_1 RIF_{it} + \varepsilon_{it} \quad (4.5)$$

and

$$PBV = \beta_0 + \beta_1 RIFG_{it} + \varepsilon_{it} \quad (4.6)$$

4.4 Using the Model to Build a Portfolio

A more suitable formula between equation 4.3 or 4.4 will be chosen to find fair PBV ratio for each stock. The portfolio simulation is made with rebalancing process every year. Of the 448 stocks, a portfolio of undervalued stocks (which has upside potential > 0) is constructed in the beginning of each year. Upside potential for each stock is calculated by:

$$Upside = \frac{FairPBV_1}{PBV_0} - 1$$

(4.5)

where:

Upside = the potential price return of a stock
$FairPBV_1$ = fair PBV ratio for the end of the year
PBV_0 = PBV at the beginning of the year

There are two types of stock selections. First, pick stocks with upside potential > 0 to get the undervalued portfolio. Second, pick stocks with upside potential < 0 to get overvalued portfolio. Stocks trading is conducted every year's beginning, so a stock that is purchased in the beginning of a year can be held or sold at the end of the year. Proportion of the buying value and weight of total return in a portfolio is based on market capitalization. The annual total return of a company is calculated as

$$TR_{it} = (P1_{it} - P0_{it} + D_{it})S_{it}$$

(4.6) where:

$P1_{it}$ = stock price at the end of the year
$P0_{it}$ = stock price at the beginning of the year
D_{it} = total dividend per share for the particular year
S_{it} = weighted average issued shares of a company

and then the annual total return for a portfolio is

$$TR_{Pt} = \sum TR_{it} \quad (4.7)$$

In order to get number in percentage format, then

$$Percent\ TR_{Pt} = \frac{TR_{Pt}}{\sum (P0_{it}S_{it})} \quad (4.8)$$

Rebalancing is done every year, changing the proportion of the cost of investment in a portfolio. Cash from dividends are reinvested on annual basis. This test assumes that all stocks are liquid, no dividend and capital gain taxes, and no transaction fee.

5. RESULTS AND DISCUSSION

5.1 Regression Results

5.1.1 Test of Independent Variables

The regression result shows that both ROE and sustainable growth rate have positive and significant effect on the PBV, while cost of equity has a negative and significant effect on the PBV. Test is done only for companies with positive net income during an observed year.

TABLE 1 - TEST OF INDEPENDENT VARIABLES [a]

Independent Variables	Dependent Variable PBV	PBV
CONSTANT	1.73***	1.97***
	(0.28)	(0.26)
ROE	12.47***	9.34***
	(0.06)	(0.10)
K	-6.69***	-16.81***
	(2.56)	(2.29)
G		8.22***
		(0.24)
R2	0.91	0.93

***p<0.01, [a] beta coefficients with standard errors in parenthesis

5.1.2 Test of PBV Formula

The regression results show positive and significant effect of both *RIF* and *RIFG* to the PBV (both p<0.01). However, the proposed *RIFG* formula indicates more informative results. Surprisingly, it is in line with the theory. The coefficient of constant is approximately 1, means that if there is no residual income factor, the PBV will be equal to 1. The coefficient of *RIFG* is also approximately 1. The proposed formula perfectly shows that the PBV ratio of a stock is equal to 1 plus the residual income factor. Calculation of sustainable growth rate has a great influence on this formula. All numbers can be seen on Table 2.

TABLE 2: TEST OF PBV FORMULA [a]

Independent Variables	Dependent Variable PBV	PBV
CONSTANT	1.86***	1.02***
	(0.26)	(0.23)
RIF	1.49***	
	(0.023	
RIFG		1.01***
		(0.01)
R2	0.89	0.92

*** p<0.01, [a] beta coefficients with standard errors in parenthesis

Based on empirical evidence on Table 2, the proposed model

$$\frac{V}{BVS} = 1 + \frac{ROE + g - k}{k}$$

will be utilized to pick undervalued stocks as exposed further in the next section.

5.2. Undervalued Portfolio Result

Based on its accuracy, the proposed formula is used to pick stocks annually. The result is as expected. As seen on Table 3, a portfolio of undervalued stocks yields 13.08% compound annual total returns, while a portfolio of overvalued stocks yields only 4.80%. Overall 448 stocks selected in this study yield 8.52% average annual total return. Note that the portfolio weights stocks by market capitalizations.

This test proves that portfolio of undervalued stocks defeated the portfolio of overvalued stocks and all stocks in 8 consecutive years during 2005-2012 and also in year 2014. When stocks generally fell in 2008 due to Great Recession, stock selection with this method would lower the risk, so the decline was not steep compared to overvalued shares or average market return. Only during 2013 this portfolio could not defeat the average market return. If investors put their funds in early 2005 and followed this portfolio building method, a hypothetical $1,000,000 investment would become $3,417,386 at the end of 2014.

According to this research, the standard deviation of total return of undervalued portfolio is lower than the average standard deviation of overall market. Relative risk which is reflected by the coefficient of variation (CV) was also lower. The CV is 0.99 compared to 2.96 for overvalued stocks portfolio and 1.78 for the market. Valuation model in this study not only provides a higher level of return than the average market but also imposes a lower level of risk. The Sharpe Ratio concludes that risk-adjusted return of undervalued portfolio is the highest one compared to others.

TABLE 3:
WEIGHTED ANNUAL RETURNS INCLUDING DIVIDENDS

YEAR	ALL STOCKS (BENCHMARK)	UNDERVALUED PORTFOLIO	OVERVALUED PORTFOLIO
2005	6.83%	**11.69%**	4.51%
2006	16.11%	**20.43%**	13.13%
2007	9.85%	**17.02%**	4.65%
2008	– 34.48%	**– 19.95%**	– 43.10%
2009	26.86%	**27.09%**	26.53%
2010	14.43%	**15.65%**	12.40%
2011	0.83%	**3.95%**	**–** 6.66%
2012	16.13%	**16.50%**	15.29%
2013	31.76%	29.65%	**35.47%**
2014	13.31%	**17.52%**	8.64%
Geometric Average	8.52%	**13.08%**	4.80%
Arithmetic Average	10.16%	**13.96%**	7.17%
Standard Deviation	0.1806	**0.1393**	0.2119
Coefficient of Variation	1.7773	**0.9984**	2.9557
Sharpe Ratio	0.39	**0.78**	0.19
Ending Value of $1,000,000	$2,265,770	**$3,417,386**	$1,597,987

TABLE 4:
UNDERVALUED PORTFOLIO COMPOSITION

YEAR	NO. OF STOCKS	TOP 20 STOCKS BY NOMINAL TOTAL RETURN	TOP 20 STOCKS BY PERCENT TOTAL RETURN
2005	**134**	XOM, AAPL, COP, VLO, ANTM, MO, CVX, HAL, GS, DVN, PRU, AET, EOG, OXY, PG, MSI, CAT, APC, LOW, MET	VLO, AAPL, EOG, CHK, TSO, MRO, ATI, DVN, HAL, CNX, HES, COG, AKAM, AET, AON, LO, APC, MLM, MO, AIZ
2006	**153**	XOM, CVX, GS, JPM, BRK.B, PFE, IBM, MS, DIS, JNJ, COP, WFC, MCD, DTV, USB, TWX, MO, MDLZ, MET	ATI, DTV, WYNN, OKE, LM, NUE, GS, BXP, MRO, VFC, HCP, SHW, LMT, MAT, LO, ES, MS, DIS, RAI, DE
2007	**156**	XOM, AAPL, GOOGL, CVX, BRK.B, PG, PEP, COP, OXY, IBM, HES, UTX, RIG, MO, NOV, HON, APA, CVS, VLO, APC	CF, OI, NOV, AAPL, CMI, HES, RIG, MUR, HP, NBL, LUK, OXY, APA, NRG, APC, PEG, XRAY, NE, PPL, PH
2008	**155**	WMT, AMGN, MCD, GIS, DLTR, PSA, AZO, FDO, HCBK, HAS, WM, ROST, SHW, ABT, KR, DTV, SO, ACT, DGX, ORLY	DLTR, FDO, AMGN, WMT, ROST, HAS, AZO, PSA, HCBK, GIS, MCD, SHW, WM, KR, ABT, DTV, SO, DGX, ACT, NSC
2009	**212**	AAPL, MSFT, IBM, GS, CSCO, JPM, HPQ, ORCL, KO, FCX, F, MMM, DIS, JNJ, MRK, UTX, GLW, WBA, EBAY, PEP	F, WDC, FCX, EXPE, KMX, CCL, SNDK, PCLN, JWN, CTSH, AAPL, FTI, IP, JOY, DISCA, CI, GLW, FOSL, GS, CAM
2010	**217**	AAPL, C, GE, BRK.B, CVX, XOM, CAT, KO, IBM, WFC, COP, MCD, DD, T, CMCSA, PG, UNP, OXY, MO, CMI	CMI, BWA, FOSL, AIG, TSCO, FDO, RCL, ENDP, DLTR, AZO, SNDK, CAT, XEC, LB, ETN, INTU, ORLY, KEY, ALTR, AME
2011	**248**	AAPL, XOM, IBM, PFE, CVX, MCD, WMT, INTC, BMY, UNH, JNJ, KO, PG, HD, BIIB, QCOM, LLY, ABT, AMGN, MDLZ	BIIB, HUM, ROST, VFC, TJX, DLTR, LO, ADS, CBS, UNH, KSU, HRB, AET, BMY, GWW, MCD, LB, MRO, CNP, ORLY
2012	**251**	AAPL, JPM, ORCL, C, GE, WFC, CMCSA, WMT, PFE, HD, BRK.B, EBAY, DIS, AIG, GS, JNJ, AMGN, XOM, QCOM, REGN	REGN, WHR, LEN, STX, TSO, GILD, SHW, STZ, GPS, EBAY, RF, PPG, STI, CMCSA, SNA, DHI, PVH, AIG, MCO, MHK
2013	**200**	MSFT, XOM, JNJ, BRK.B, WFC, JPM, DIS, BA, PG, PFE, WMT, CVX, C, AAPL, MMM, UPS, INTC, UTX, PBCT, CVS	LNC, GME, HPQ, STZ, AIZ, AMP, LUV, BA, XEC, XRX, PFG, STJ, TSN, NOC, GT, UNM, VIAB, VFC, MET, LMT
2014	**156**	AAPL, MSFT, BRK.B, WFC, INTC, JNJ, AMGN, PG, UNP, ORCL, DIS, CVS, WMT, UNH, MO, MRK, HPQ, PEP, JPM, LOW	EW, KR, ORLY, TEG, GD, MAC, HPQ, EIX, UNP, ETR, GGP, INTC, AMGN, RHI, LOW, AAPL, EXC, PCG, UNH

6. CONCLUSION

This study indicates that fair PBV ratio can be estimated by using the equation 3.4 that I proposed. It contains 3 factors, they are: ROE, sustainable growth rate of BVS, and cost of equity. Empirical evidence in this study shows that this model enhances the way PBV ratio is determined, although further research is needed. It is able to value high-growth, no-growth and steady-growth companies.

The formula demonstrates its ability to select undervalued stocks and construct a portfolio. The portfolio is able to generate above-average market returns on annual basis. Moreover, the portfolio implies a higher return while maintains a lower risk than overall market and overvalued stocks portfolio, as measured by standard deviation and coefficient of variation. The model selects hundreds of undervalued companies each year becoming a portfolio that delivers relatively better risk-adjusted return as shown by its Sharpe Ratio.

The great thing about this research is the formula does not require a long-term forecast of future financial performance. As long as investor can determine cost of equity, 1-year projected earnings, BVS, and payout ratio, the result will be approximately correct. Estimating a forward 12-month net income and dividend is much easier than forecasting net income and dividends for the next 5 years. The model is quite simple and powerful to be used by investors and low-cost mutual funds or ETFs. Instead of investing in nearly all companies of S&P 500, a manager can use this model to simply determine a bunch of undervalued stocks each year.

Limitation of this study is the inaccuracy of the formula when a company has a negative net income. Another limitation in this research is portfolio selection weights stocks buying on market capitalization. Further research can be done by weighting stocks buying on potential return, so that the portfolio is expected to beat the market with much better result. We also need to further test the model on a longer period of time and also test it in other countries.

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