

What's Wrong with PEG?

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Abstract

PEG is a newer investment ratio measure of a security's PE ratio divided by the firm's growth rate as a percentage. It is examined and contrasted with other investment valuation measures. PEG is shown to be problematic in terms of its units of measure, in what it purports to appropriately determine, and it is non monotonic for relatively profitable firms and is only slightly indicative of correct security selection for relatively unprofitable firms.

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A price earnings ratio is a measure of relative value of a security's price divided by the same firm's annual earnings or:

$$1) \quad PE = P/E$$

where P is the security price and E is the firm's earnings which may be the firm's current earnings E_0 or the firm's expected earnings E_1 . An interesting measure is to take the firm's PE ratio and divide it by the firm's growth rate as a percentage or:

$$2) \quad PEG = PE/100g$$

where g is the firm's growth rate. It's a relatively new investment measure:

The PEG ratio is considered to be a convenient approximation. It was originally developed by Mario Farina who wrote about it in his 1969 Book, *A Beginner's Guide to Successful Investing in the Stock Market*. It was later popularized by Peter Lynch, who wrote in his 1989 book *One Up on Wall Street* that "The P/E ratio of any company that's fairly priced will equal its growth rate", i.e., a fairly valued company will have its PEG equal to 1. (Wikipedia, "PEG Ratio")

As basis for analysis, an earlier and more basic valuation is the (Myron) Gordon Growth Model (*Review of Economics and Statistics* [1959]):

$$3) \quad P_0 = D_1/(k-g)$$

where P_0 is the current price of a firm's security, D_1 is next year's dividend, k is the appropriate risk adjusted discount rate, and g is the growth rate of the firm. It is at this point that I take the opportunity to demonstrate this valuation in a manner that is economic in development and provides an insight into a **growth** adjusted discount rate (see Craine 2005). Consider a perpetuity valuation of:

$$4) \quad P_0 = \sum D/(1+k)^t = D/k$$

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for all identical dividends D discounted infinitely at a **risk** adjusted discount rate k. Now consider dividends growing infinitely at rate g:

5a) $P_0 = \sum D_0(1+g)^t/(1+k)^t$ let z be a **growth** adjusted discount rate:

5b) $P_0 = \sum D/(1+z)^t = D/z$

and since 4) and 5a) are equivalent in valuation with $D = D_0$ then $1/(1+z)$ equals $(1+g)/(1+k)$ or $(1+z)$ equals $(1+k)/(1+g)$ and thus:

6) $z = (1+k)/(1+g) - 1 = (1+k-1-g)/(1+g) = (k-g)/(1+g)$

and thus z can be regarded as a **growth** adjusted discount rate substituted into 5b) which becomes the Gordon Growth Model (see Investing Answers):

7) $P_0 = D_0(1+g)/(k-g)$.

Not obvious to many at first, the return to the holder of security will receive the discount rate k regardless of valuation. Consider net return R (or yield):

8a) $R_1 = (P_1 - P_0 + D_1)/P_0$

8b) $R_1 = (D_1[1+g]/[k-g] - D_1/[k-g] + D_1)/(D_1/[k-g])$

8c) $R_1 = ([1+g]/[k-g] - 1/[k-g] + 1)/(1/[k-g])$

8d) $R_1 = ([1+g] - 1 + [k-g])$

8e) $R_1 = k$

Here are some various examples discounted at a 10 percent discount rate:

Growth Rate	Current Dividend	Current Price	Next Dividend	Next Price	Yield
0	2.00	20.00	2.00	20.00	10
4	1.00	17.33	1.04	18.03	10
6	4.00	106.00	4.24	112.36	10
8	1.00	54.00	1.08	58.32	10

Now consider that dividends come from a firm's earnings, or:

9) $D_1 = E_1(1-b) = A_0r(1-b)$

where E_1 is the expected earnings to a firm, A_0 is the book value of the firm's assets, r is the return that the firm achieves, and $(1-b)$ is the firm's payout ratio where b is the firm's retention rate for reinvestment. If a firm achieves a return r greater (or less) than its risk adjusted discount rate k, then the firm will be valued at a premium (or at a discount) from the firm's book valuation. For many firms, its growth rate g equals the firm's achieved return r times the firm's reinvestment rate b or $g = br$. Note that the firm's retention rate b and its achieved rate of return r determine growth rate g and not the other way around (see Wikipedia "Dividend Discount Model").

Now consider various retention rates, payout ratios, growth rates, and dividends for a firm with a book value asset valuation of 100, an achieved rate of return r equal to .12 and thus expected earnings of 12 in all of the following cases but where there are differing risk adjusted discount rates:

Security prices given various discount and retention rates

b	1-b	g	D_1	$k=.14$	$k=.12$	$k=.10$
0	1	.00	12	85.7	100.0	120.0
¼	¾	.03	9	81.8	100.0	128.6
½	½	.06	6	75.0	100.0	150.0
¾	¼	.09	3	60.0	100.0	300.0

As noted previously a higher (lower) achieved return increases (decreases) valuations, but now add that a valuation will further be increased when a firm chooses an optimal dividend payout and a correspondingly opposite retention growth policy that depends upon whether the firm achieves a higher return than its risk adjusted discount rate with lower dividends and more growth for over achieving firms and vice versa.

It was shown that the risk adjusted discount rate is reflected in the return to the holder of a security and not say the firm's achieved return. However, there's a risk of change in security valuation and the holder's return given an unexpected change in parameters. For a bond, this called **duration** and is determined by its price elasticity:

$$10) \quad e = ([V_1 - V_2] / \{[V_1 + V_2]/2\}) / ([k_2 - k_1] / \{1 + [k_1 + k_2]/2\})$$

where V is the valuation and the two k's are the discount rates before and after a contemplated change therein. A duration may be used as a multiplier for each percentage point change in valuation for each percentage point change in discount rates with notable ones being nominally equal to the maturity date (hence the name duration) for any single payment instrument and equal to $1 + 1/k$ for perpetuities. Now consider a common stock valuation is given by $V = D(1 + g)/(k - g)$ as before. Thus:

$$10a) \quad e = \{[D(1+g)/(k_1-g) - D(1+g)/(k_2-g)] / [D(1+g)/(k_1-g) + D(1+g)/(k_2-g)] / 2\} / \{(k_2 - k_1) / [1 + (k_1 + k_2)/2]\}$$

$$10b) \quad e = (k_2 - k_1) / [(k_1 - g)(k_2 - g)] / \{(k_2 - g + k_1 - g) / [(k_1 - g)(k_2 - g)] / 2\} / \{(k_2 - k_1) / [1 + (k_1 + k_2)/2]\}$$

$$10c) \quad e = (k_2 - k_1) / [(k_2 + k_1 - 2g) / 2] / \{(k_2 - k_1) / [1 + (k_1 + k_2)/2]\}.$$

$$10d) \quad e = [1 + (k_1 + k_2)/2] / [(k_2 + k_1 - 2g) / 2].$$

Recognizing that the mean k is $(k_1 + k_2)/2$, then:

$$11) \quad e = (1 + k) / (k - g) = 1 + (1 + g)/(k - g).$$

One should recognize that a stock's duration becomes a mere substitution of the **growth** adjusted discount rate into the perpetuity duration. Further one should note that the duration is sensitive to lower **risk** adjusted discount rates with higher growth rates.

Here the reader may begin to wonder, where's the PEG in all of this? And the response preliminarily is to show that there already are sufficient measures extant and that they'll provide contrast to the PEG. Recall that a PEG measures PE/100g and a PE ratio is

$$12) \quad PE = P/E = (1-b)/(k-g).$$

In equilibrium k equals r and thus a security price will equal its book value and the PE will equal the reciprocal of the going risk adjusted discount rate, or:

$$13) \quad P = Ar(1-b)/(k-br) \text{ with } k = r \text{ then } P = A \text{ and}$$

$$14) \quad PE = (1-b)/(k-br) \text{ with } k = r \text{ then } PE = 1/k.$$

But PEG in equilibrium is:

$$15) \quad PEG = (1-b)/([k-br][br]) \text{ with } k = r \text{ then } PEG = 1/(bk^2)$$

which is very strange in terms of its units.

Consider a world of similarly computed rates and assumptions as previously examined with a book value of 100, an achieved rate of return of 12 percent, earnings of 12 but now with differing discount rates, payout ratios, dividends, retention rates, and rates of growth shown below in three tables, namely security valuation, followed by the respective PE ratio, then followed by the respective PEG:

1-b	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
D	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8
b	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
g=br	0.108	0.096	0.084	0.072	0.06	0.048	0.036	0.024	0.012
k	P								
0.08				600.00	300.00	225.00	190.91	171.43	158.82
0.09			600.00	266.67	200.00	171.43	155.56	145.45	138.46
0.10		600.00	225.00	171.43	150.00	138.46	131.25	126.32	122.73
0.11	600.00	171.43	138.46	126.32	120.00	116.13	113.51	111.63	110.20
0.12	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
0.13	54.55	70.59	78.26	82.76	85.71	87.80	89.36	90.57	91.53
0.14	37.50	54.55	64.29	70.59	75.00	78.26	80.77	82.76	84.38
0.15	28.57	44.44	54.55	61.54	66.67	70.59	73.68	76.19	78.26
0.16	23.08	37.50	47.37	54.55	60.00	64.29	67.74	70.59	72.97
	PE								
0.08				50.00	25.00	18.75	15.91	14.29	13.24
0.09			50.00	22.22	16.67	14.29	12.96	12.12	11.54
0.10		50.00	18.75	14.29	12.50	11.54	10.94	10.53	10.23
0.11	50.00	14.29	11.54	10.53	10.00	9.68	9.46	9.30	9.18
0.12	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33
0.13	4.55	5.88	6.52	6.90	7.14	7.32	7.45	7.55	7.63
0.14	3.13	4.55	5.36	5.88	6.25	6.52	6.73	6.90	7.03
0.15	2.38	3.70	4.55	5.13	5.56	5.88	6.14	6.35	6.52
0.16	1.92	3.13	3.95	4.55	5.00	5.36	5.65	5.88	6.08
	PEG								
0.08				6.94	4.17	3.91	4.42	5.95	11.03
0.09			5.95	3.09	2.78	2.98	3.60	5.05	9.62
0.10		5.21	2.23	1.98	2.08	2.40	3.04	4.39	8.52
0.11	4.63	1.49	1.37	1.46	1.67	2.02	2.63	3.88	7.65
0.12	0.77	0.87	0.99	1.16	1.39	1.74	2.31	3.47	6.94
0.13	0.42	0.61	0.78	0.96	1.19	1.52	2.07	3.14	6.36
0.14	0.29	0.47	0.64	0.82	1.04	1.36	1.87	2.87	5.86
0.15	0.22	0.39	0.54	0.71	0.93	1.23	1.71	2.65	5.43
0.16	0.18	0.33	0.47	0.63	0.83	1.12	1.57	2.45	5.07

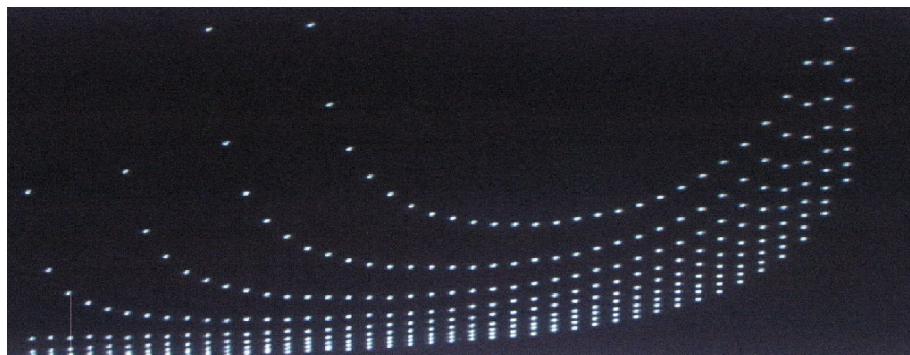


Fig. 1 Graphic of the PEG for discount rates .08 through .16

An examination shows that the PEG rises with lower discount rates, but that for discount rates below the firm's achieved rate of return (here below 12 percent), the PEG falls then rises as dividends and payout ratios rise while retention and growth rates fall which does not seem to make any sense. And one could even take the stranger first derivative set to zero, or:

$$16) \quad \partial \text{PEG} / \partial b = (rb^2 - 2rb + k) / (r^3b^4 - 2kr^2b^3 + k^2rb^2) = 0$$

$$17) \quad b^2 - 2b + k/r = 0 \text{ and thus}$$

$$18) \quad b = (2 \pm [4 - 4k/r]^{1/2}) / 2 = 1 \pm (1 - k/r)^{1/2}$$

which indicates that a non monotonic minimum PEG per retention policy exists when k is less than r and which was observed. But is this appropriate policy for firms achieving returns greater than their discount rates? The users of the PEG cite its value as an optimum valuation when it is close to one. And to be fair, it does work poorly—but only for under performing firms but in no case is it is neither desirable nor feasible for over performing firms.

In contrast to the bizarre treatment that the PEG presents to the PE ratio, there exists a more straightforward one which is the payout ratio. It can be determined from available investment data. Consider generally found public data such as:

Company	Div.	Yield	PE	Vol.	High	Low	Close	Change
LMU	2.00	4.0	10	237	50.5	45.5	50.0	+.75

One could impute the firm's earnings from the PE and the firm's share price or here that the PE of 10 equals the price of 50 divided by earnings which here must be 5. Thus one could deduce that the payout ratio is D/E or here is $2/5$ or 40 percent. But the PE ratio multiplied by the yield is a more direct approach noting that the PE times D/P cancels the price components or here 4.0 times 10 which equals again 40 percent. And the payout ratio is more indicative of a firm's health in that low payout ratios are associated with riskier firms of both kinds—those that unhealthy *per se* and those which are more speculative in terms of being newer and/or more aggressive in regards to reinvestment policy. Likewise high payout ratios are more indicative of more staid firms albeit at the same time can portend a not so fortuitous future decline in dividends. Moreover, if one knows the PEG then one can determine the firm's growth rate which here if the PEG was 1.67 then the growth rate must be 6 percent from $g = PE/PEG$. If one knows the firm's growth rate, then one can infer the firm's rate return to be achieved from $g = br$ or here $r = g/b$. Thus, if one knew that the growth rate was 6 percent then since the payout ratio is 40 percent then the retention rate is 60 percent and therefore here the firm's inferred rate of return expected to be achieved is 10 percent.

Independent of the payout ratio, one can also use the growth rate to determine the market's risk adjusted discount rate for the firm from:

$$19) \quad k = D/P + g$$

which here would be the yield of 4 percent plus the growth rate of 6 percent or 10 percent. And here since r equals k then this security is likely trading near book value which would involve a discussion of Modigliani-Miller proposition that dividends do not matter as shown in equation 13 (see Investopedia, Wikipedia, and Modigliani & Miller). Lest one think that this result is likely or invariable consider some other growth rates and other PEGs:

Price	P		50	50	50
Dividends	D		2	2	2
Yield	D/P		4%	4%	4%
Price/Earnings	PE		10	10	10
PEG	PE/g		1.67	2	1
Earnings	E	= P/PE	5	5	5
Payout	1-b	= D/E	.4	.4	.4
		= YieldxPE	40%	40%	40%
Retention	b	= 1-b	60%	60%	60%
Growth	g	= PE/PEG	6%	5%	10%
Return Achieved	r	= g/b	10%	8.3%	16.7%
Discount Rate	k	= D/P + g	10%	9%	14%
Book Value	A	= E/r	50	60	30

In conclusion, it seems that the PEG was an attempt to undo the growth component of the PE ratio which rises as growth increases. It would seem a more useful procedure to instead use the PE and PEG ratios in a more productive manner to directly determine the firm's payout ratio and with the growth rate to infer the firm's risk adjusted discount rate and the firm's expected rate of return to be achieved.

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