

Investment Performance of Stocks in Relation to their PEG Ratios

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ABSTRACT

Strategies based on accounting ratios have seen attention in recent years due to their appearance of being able to create excess returns. This study aims to gain more understanding of how accounting ratios such as the Price-Earning ratio (PE) and the Price-Earnings to Growth ratio (PEG) can be used to create successful trading strategies. This study aims to replicate and improvise Basu's (1997) work by implementing a new strategy based on the PEG ratio. The paper discusses and generalizes several parameters involved to outperform the market and lower the risk involved in doing so. It tests portfolio sizes, rebalancing periods, ratio limits to come to the conclusion that the PEG strategy outperformed the P/E strategy both in terms of returns and market volatility in both normal years and during the COVID-19 pandemic.

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INTRODUCTION

Research on the predictability of accounting information on share prices has had significant attention over the years. This research was largely started from Basu's 1977 paper, *Investment Performance of Common Stocks in Relation to Their P/E ratios: A Test of the Efficient Market Hypothesis*. Basu's backtesting study finds that portfolios with low Price-Earnings (P/E) ratios on average earn significantly higher risk-adjusted rates of return than higher P/E portfolios. These findings suggest that over the years 1957 to 1971, the P/E ratio is a leading indicator of performance for portfolios (Basu 1977).

Continuing on Basu's work was Jordan R. Tilley who investigated if this phenomenon had vanished, or if it still exists (Tilley 2015). His Backtesting period spanned from June 1989 through to May 2014. Tilley concluded that, over this period, a low P/E based strategy can yield higher unexplained returns than its higher P/E counterparts. Tilley also concluded that this strategy is largely driven by low-mid priced stocks and it does not hold at higher price levels.

The primary focus of this research is on studying how a low Price-Earnings to Growth (PEG) ratio based strategy can perform. The procedure taken to implement these strategies is similar to how Basu created their portfolio with the lowest P/E ratio. From a selection of 5000 US securities, those with a stock price less than \$5, or with a negative PEG ratio, are filtered out. The remaining are sorted by their PEG ratios and split into equally sized portfolios. Each security in the newly formed portfolios have equal amounts invested in them. At each rebalancing period, the above procedure is repeated to form a new target portfolio. The target portfolio is formed by selling stocks that are held but are no longer on the target and buying stocks that aren't in the target, by investing in them equally with the remaining holdings. The results are then compared to the benchmark, the Standard & Poor's 500 (S&P 500).

Firstly, this paper looks into a P/E based strategy in the modern era only to find that while it does have substantial returns, it also exposes the investor to significant risks and can certainly be improved. Because of this, the paper moves its attention to the PEG ratio and analyses it across

three categories - low, medium, and high. Then it hypothesizes that increasing the number of portfolios the universe of stocks is split into and extending the rebalancing period will lead to better performance for the PEG strategy. Finally, the report compares a P/E against a PEG strategy, out of, and during a crisis period, such as the market crash during the COVID-19 pandemic.

“PE is a leading indicator of excess unexplained returns for low-medium priced stocks” (Tilley) this extract indicates for the first hypothesis it is expected increasing the number of portfolios would decrease the average price of the lowest PE portfolio and thus increase its performance. For the second hypothesis, it is expected that increasing the rebalancing period would allow companies to fully realise their growth and hence increase the performance of the strategy.

The structure of the paper is as follows. The next section will document the methodology used for the backtesting and the procedure used to collect the data. This is followed by the empirical results of the research, analysis of the results, conclusions, limitations and suggestions for future research.

METHODOLOGY

To investigate and compare the low PEG strategy against the benchmark and the low P/E strategy, several modifications like diversification, portfolio weights, differing time periods, price filters, etc. were used to ensure fair comparisons amongst the strategies and benchmarks.

The platform used to source the required data and test the modified algorithms was provided by QuantConnect. The data is restricted to which firms had fundamental data, this meant US firms only. With regards to the calculated ratios, the P/E ratio was given by the following formula -

$$\text{P/E Ratio} = \frac{\text{Market value per share}}{\text{Earnings per share}}$$

Where the share price and earnings were calculated from the date any portfolio was created/rebalanced while the PEG ratio was similarly calculated with the growth rate being the difference in the earnings per share over the last two years of any time period. The formula was given by –

$$\text{PEG Ratio} = \frac{\text{Price/EPS}}{\text{EPS Growth}}$$

To minimize the bias of the backtesting outcome, several decisions were made to ensure minimal impact on the results. The approach taken was to keep a low number of parameters, test across multiple time periods, use a low number of stocks, and consume publicly available data for that given time period. This was done to ensure no optimization bias, look-ahead bias, and overfitting for any given time period or parameter.

Going forward with the PEG ratio, the goal was to optimize the ratio by choosing the best parameters that generalize to a variety of situations. This meant defining an ideal PEG range, choosing the number of stocks for the strategy, deciding its rebalancing period, and choosing constants and limitations required.

The focus of the paper was to choose the low PEG strategy since it should ideally follow the small-capitalization (small-cap) premium anomaly that goes against the efficient market hypothesis as seen in the low P/E strategy. To test this, all stocks were split and classified into three categories – low, medium, and high ratios – and compared to the average returns of the benchmark across different time periods (2009-18). This also helped observe whether the PEG ratio could be an indicator of excess returns. The results of this can be seen in the analysis section.

Another variable to consider was the number of stocks within the 3 groups. Rather than selecting a particular number of stocks, the groups were further divided into 5 and 15. For every group, the lowest PEG ratio group was considered to be the ‘low PEG’ and similarly the highest for the ‘high PEG’ while the medium PEG was simply the median group. This, on its own, regulated the number of stocks per group and was tested across different time periods with the only constant being a yearly rebalancing period.

To address the rebalancing, the best number of groups were chosen from the previous analysis and applied to monthly, yearly, and 3 year periods, and this was again done over different time periods to ensure the effectiveness of the portfolio over different environments.

And finally, an overall comparison between the P/E and PEG strategy over the years including a specific breakdown of the COVID period and the rest of the analysis period to understand how the strategy performs in different situations.

The main metrics in focus were the return (unadjusted), alpha, beta, annual standard deviation, drawdown, tracking error, and a few other metrics where necessary.

EMPIRICAL RESULTS

Testing the low P/E strategy

To determine the validity of the low P/E strategy in today's world from Basu's (1977) and the extended Analysis (2014), it was implemented up until 2021 to check for abnormal returns under the small market cap premium anomaly.



Figure 1

Return	Sharpe Ratio	Alpha	Beta	Annual Std Dev	Drawdown
504.78%	0.569	-0.026	1.553	0.26	76.90%

Table 1

Figure 1 contains the comparative analysis between the low P/E strategy against the benchmark (S&P 500) and tests from the global financial crisis up until the pandemic. *Table 1* contains statistics on the same graph. The strategy was executed as per the extended analysis paper i.e. using the lowest P/E quintile after separating all stocks available into 5 groups based on their P/E ratios and filtering out stocks with a valuation of below \$5. Only positive P/E stocks were considered.

Comparing the PEG Ratios

Time period vs PEG strategy	Low PEG		Medium PEG		High PEG	
	Returns	Alpha	Returns	Alpha	Returns	Alpha
2009 - 2012	1.03	0.078	0.77	0.043	0.76	0.035
2012 - 2015	0.84	0.01	0.72	0.005	0.71	0.014
2015 - 2018	0.34	0.003	0.375	0.012	0.3	0.001
Average	0.74	0.03	0.62	0.02	0.59	0.017

Table 2

To compare the different PEG ratios amongst themselves and the benchmark, returns and alpha were collected and averaged over three time-frames ranging from 2009-2018. The stocks were not rebalanced and neither was there a fixed number of stocks for each portfolio (all stocks were chosen). The results have been summarized in *Table 2*.

Comparing the number of groups

Number of groups	Time period	Return	Sharpe ratio	Alpha	Annual Std Dev	Drawdown
5	T0	92%	0.704	0.042	0.315	39.80%
5	T1	112.90%	1.186	-0.011	0.177	21.30%
5	T2	78.33%	0.851	0.039	0.193	36.70%
15	T0	85.52%	0.694	0.037	0.294	40.80%
15	T1	95.57%	1.099	-0.023	0.166	17.90%
15	T2	80.59%	0.819	0.039	0.209	42.30%

Table 3

To find the ideal number of groups, the portfolios were rebalanced every year and tested across timeframes. As in *Table 1*, T0, T1, and T2 represent time periods from 2009-18 further for all tables below. From the above table (*Table 3*), the average values have been summarized below:

Number of stocks	Return	Sharpe Ratio	Alpha	Annual std dev.	Drawdown
5	94%	0.914	0.234	0.228	32.60%
15	87.23	0.871	0.0177	0.233	33.7%

Table 4

Comparing rebalancing period

Rebalancing	Time period	Return	Sharpe Ratio	Alpha	Beta	Annual Std Dev	Drawdown
Monthly	T0	129.81%	0.755	0.083	2.28	0.455	54.20%
	T1	130.15%	1.015	-0.042	2.263	0.251	26.10%
	T2	41.50%	0.466	-0.057	2.14	0.259	59.50%
Yearly	T0	92%	0.704	0.042	1.566	0.315	39.80%
	T1	112.90%	1.186	-0.011	1.606	0.177	21.30%
	T2	78.33%	0.851	0.039	1.51	0.193	36.70%
3 years	T0	106%	0.919	0.078	1.186	0.232	28.40%
	T1	80.10%	1.237	-0.006	1.17	0.125	16.70%
	T2	32.36%	0.625	-0.01	1.108	0.119	27.50%

Table 5

To choose the right rebalancing period, stocks were balanced over monthly, yearly, and 3 year periods from 2009-18. The constants used were the lowest PEG quintile, a price filter of above \$5, and a positive PEG ratio to keep the results consistent. The averaged results have been summarized below -

	Return	Sharpe	Alpha	Beta	Annual Std Dev	Drawdown
Monthly	100.49%	0.745	-0.005	2.228	0.322	46.60%
Yearly	94%	0.914	0.0233	1.561	0.228	32.60%
3 years	73%	0.927	0.02	1.155	0.159	24.20%

Table 6

The low P/E vs the refined low PEG strategy

The refined low PEG strategy is simply the PEG strategy using selective parameters and limitations chosen from the data seen above. It is further discussed in the analysis section. This strategy uses the lowest quintile and rebalances itself every 3 years. The prices have been filtered to include only stocks greater than \$5 and with a positive PEG. The period for which it has been tested is from 2009-18 and also will be subject to unseen data from 2019-2021. This helps understand how the strategy performs with unseen data and during crises. The results of the findings can be seen below -

2009 - 2018 P/E vs PEG Strategy

	Returns	Sharpe Ratio	Alpha	Beta	Annual Std Dev	Information ratio	Treynor Ratio	Drawdown	Tracking Error
Low P/E	661%	0.866	0.025	1.56	0.231	0.745	0.128	48.90%	0.15
Low PEG	1154%	0.825	0.028	2.34	0.354	0.755	0.125	52.10%	0.237

Table 7

2019 - 2021 P/E vs PEG Strategy

	Returns	Sharpe Ratio	Alpha	Beta	Annual Std Dev	Drawdown	Tracking Error
Low P/E	94%	0.905	0.861	0.903	113.50%	76.70%	112%
Low PEG	101.15%	0.974	0.182	1.087	39.30%	51%	32%

Table 8

ANALYSIS

Relevance of the P/E strategy in today's world

The low P/E strategy is often synonymous with the term abnormal growth as small firms with a low P/E tend to outperform larger firms since there is more runway for growth. From the results of the backtest over the years 2009-2021 shown in Figure 1, it is seen that although the returns are significantly higher than the benchmark, we obtain a negative alpha of -0.026 (*Table 1*). At first glance, this might make the impression that this strategy did not have excessive returns for its given risk and that a P/E based strategy can not reliably give investors excess returns. However, if we break the analysis down into pre-COVID and post-COVID (during), the pre-COVID numbers show promise.



Figure 2

As seen above in Figure 2, the returns are far above the benchmark portfolio at the end of 2018. A deep dive into the numbers gives us the following table.

Return	Sharpe Ratio	Alpha	Beta	Annual Std Dev	Drawdown
660.8%	0.866	0.025	1.56	0.231	48.9%

Table 9

Compared to *Table 1*, *Table 9*'s results are far superior with a higher Sharpe ratio, positive alpha, and higher return. This can be attributed to the March 2020 market crash during the pandemic that happened so quickly, and a majority of the companies are still working their way upward from this downfall.

This goes in line with the findings from Tilley's research which backtested similar portfolios. This suggests that any excess returns seen in the past exist in today's world. However, due to the pandemic, several companies have uncertain futures and this is reflected with the downsides of the low P/E strategy.

Comparing the PEG Ratios

As seen in *Table 2*, when simply comparing the returns amongst different PEG ratios, the low PEG portfolio had relatively significant returns compared to the other portfolios. And the excessive returns (alpha) for the portfolio's systematic risk were also much higher, showing that the low PE strategy had superior returns compared to the other portfolios, especially when considering the systematic risk involved. Overall, the low PEG strategy is an indication that the PEG ratio also follows the small-cap premium anomaly dictating that these undervalued companies have a high potential for rapid growth. This concludes the low PEG strategy is worth being the focus for a successful strategy.

Comparing the number of groups

To decide the optimal number of stocks in the portfolio, the number of groups needed to be understood and analysed as the number of groups dictate the number of stocks in each group. As stated earlier, for every group, the lowest PEG ratio group was considered to be the 'low PEG' and similarly the highest for the 'high PEG' while the medium PEG was simply the

median group. Varying the number of groups allowed for an easy choice of stocks in the categories. *Table 4* contains the averaged results from *Table 3* from groups of 5 and 15 stocks. As seen in *Table 4*, the groups of 5 yielded better returns compared to the groups of 15 which are seen with a considerably higher Sharpe ratio and alpha. The standard deviation and drawdown had marginal differences making the groups of 5 an ideal choice as a specified parameter for the low PEG strategy. The reason that a lower number of groups did better than larger groups is that smaller group sizes have a larger number of stocks per group. This meant that the lowest group held more stock with low PEG values which thereby increased the probability of small companies creating significant returns in the future and at the same time diversified the risk associated with holding very few companies.

Comparing rebalancing period

From *Table 6*, considering the 3 year period, though the returns over each time period on average were less than more frequent rebalancing strategies, there is much less risk involved. For the three-yearly rebalancing, the data shows that a higher Sharpe ratio is achieved, along with much less systematic risk and much less overall risk. Secondly, it shows that our drawdown period decreases dramatically from 46.6% to 24.2% when comparing monthly to a 3 year period. It is clear that from these results that a longer rebalancing period benefits a risk-averse investor and is better for the PEG strategy. The reduced risk faced by this longer rebalancing period is likely due to the strategy not continuously investing in risky securities characterized by their lower PEG ratios.

Comparing the low P/E vs the refined low PEG strategy

To compare the low P/E strategy with the refined low PEG strategy, we split our analysis into two parts. The first part tests the strategy during the ‘normal years’ from 2009-2018 which was also the time periods where the chosen parameters were tested on. For the second, the strategy is exposed to unseen data i.e. the COVID-19 pandemic starting from 2019 to 2021 to assess the impact, returns, and volatility of both strategies and consider the quality of improvisations made.



Figure 3 - The low P/E strategy (2009-18)



Figure 4 - The low PEG strategy (2009-18)

As seen in *Table 7*, the absolute returns of the PEG strategy are greater than the P/E strategy. This can clearly be seen in *Figures 3 & 4*.

Another notable difference is the beta values and the standard deviation between the two strategies. A beta value greater than 1.0 indicates that the security's price is theoretically more volatile than the market. While this is true in theory, the beta coefficient assumes that stock returns are normally distributed from a statistical perspective. A stock with a very low beta could have smaller price swings, yet it could still be a long term downtrend. Similarly, a high beta that is volatile mostly in an upwards direction (as in this case) will increase the risk of the portfolio but also add gains as well.

Other indicators such as the alpha, Sharpe ratio, information ratio, etc. are similar between the two strategies and are considered to be in ideal ranges for an investor. On the flip side, while the drawdowns are similar, they are around 50% which is considered quite large and involves substantial losses that the strategy has suffered. This shows where the strategy still lacks and could be improved upon, especially if it can time the market for optimal entry and exit.

Cumulative Returns



Figure 5 - The PEG strategy 2019-2021

Cumulative Returns



Figure 6 - The P/E strategy 2019 -2021

With regards to testing the strategies in an unseen environment, the results found are shown in *Table 8*. Again, since both strategies have similar properties and patterns, they end up having similar returns. However, there is a considerable difference in the standard deviations, drawdowns, and tracking errors. This highlights one of the biggest downfalls of the P/E strategy where it includes undervalued stocks with high potential to grow but also a high potential to fail and fall out. And with the pandemic, these small-cap stocks become poor choices with unsustainable growth. Whereas, the PEG strategy chooses stocks with established growth over the last year and does not necessarily limit itself to small-cap stocks as long as we have considerable growth potential. This makes the PEG strategy's stocks ideal champions to get through the pandemic and this behaviour is clearly reflected in *Figures 5&6*. The PEG strategy pushes through at a constant growth rate whereas the P/E strategy has large drawdowns and extreme volatility making it a strategy not worth investing in.

CONCLUSION

The purpose of this report is to understand the low P/E strategy and suggest improvements to the same. While the P/E strategy had considerable returns and profits from the past and had been studied with great detail, it was still susceptible to market volatility, contained low growth companies, did not take into account the company's future prospects, and worked poorly during crisis periods. While at the same time, the PEG strategy (with its dedicated parameters) promises superior returns with low risk, thus indicating a clear improvement and this also holds throughout the pandemic. However, the strategy does have its drawbacks where it could be improved to further reduce drawdown, risks, and increase net profits and should be considered during further study.

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