Papers

Valuing biotechnology companies using the price earnings ratio

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Abstract

The biotechnology and life sciences sectors are a source of major source of growth in the economy. However the valuation of companies in the sector is problematic owing to the long lead times and uncertainty associated with product development. This paper explores the use of the price earnings ratio as a tool for portfolio construction and valuation. Our results suggest this is a poor tool, although this may be due to being constructed over a time horizon that is too short.

Keywords: *biotechnology companies, valuation, price earnings ratio*

INTRODUCTION

Although the biotechnology and life sciences sectors are a source of major source of growth in the economy, the valuation of companies in the sector is problematic owing to the long lead times and uncertainty associated with product development. Here, the use of the price earnings ratio as a tool for portfolio construction and valuation is explored. Specifically, the construction of portfolios based on the price earnings ratio of the set of stocks that make up the *Nature Biotechnology* portfolio at time horizons of one, two and three years is analysed.

The paper aims to outline the valuation problem and areas where the price earnings ratio has been applied in portfolio construction. The methods used to construct the portfolio are also described, followed by the results of the empirical analysis.

VALUATION OF BIOTECHNOLOGY COMPANIES

Biotechnology companies are notoriously difficult to value. The problem faced by investors, bankers and investment managers who risk their capital by investing in biotechnology companies is that there is no standard methodology that can be used universally to define a biotechnology company's worth. Each method is dependent on a set of assumptions that are at best very difficult, if not impossible, to predict with any degree of confidence. Other industry-specific factors compound the uncertainty of valuing a biotechnology company. The fair value is driven by the value of the company's intellectual property. The ability of these companies to convert these intangible assets into a revenue stream is often hampered by other factors beyond their control, eg government regulations and a lengthy approval process. A high failure rate in product development is also normal. On average, the Food and Drug Administration (FDA) approves only one out of every five new molecular entities (NMEs) evaluated in human clinical trials. In addition, up to 5,000 NMEs may have been evaluated during preclinical research in the process up to the five NMEs that finally made it through to clinical trials.[1] Regulatory approval and marketing of a

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new product typically cost US$250–350m, but could cost up to US$800m. Each drug development cycle can take 7–12 years. Partnerships and strategic alliances are an important part of the valuation process, and the dollar value of such partnerships and alliances are notoriously hard to quantify.

The methods usually used by the investment community are price earnings ratio (PER) and cash flow per share multiples.[2] In the PER model, sales are projected for a date in the future, which forms the basis for an income statement and estimated earnings per share. A price earnings ratio is then applied to determine the share price at that future date. Industry analysts typically carry out projections for at least four or five years, sometimes for as much as seven to ten years, as this is the average period of time taken for young companies to develop new products. The obvious disadvantage is the inherent difficulty in predicting such long-term sales with any degree of accuracy. Selection of a suitable price earnings ratio is an additional source of error. The average PER for the sector is applied, with the differences in the different types of company, eg some companies producing life sciences tools and others involved in gene therapy for human therapeutics, not taken into account. Comparison between PER and growth rates becomes tenuous when expected growth rates are very high. PER relatives are used to determine as to whether a stock is trading at a premium or discount to its peers. The PER has long been used as an accepted method of stock picking and valuation of industrial companies.[3–6] However, this model has not been subjected to vigorous academic testing for its accuracy in valuation of biotechnology companies. This study sheds some light on this topic. The purpose of this study is to determine whether portfolios of biotechnology stocks selected on the basis of price earnings ratios out-perform a benchmark portfolio on a one, two and three year basis.

In the free cash flow model, the amount of revenue generated by the company's product is anticipated. The main difficulty with this method is that cash flow assumptions vary widely even within the investment community, particularly with research-intensive companies.[7]

METHODOLOGY

The universe of stocks from which the portfolios were constructed was the *Nature Biotechnology* list of publicly traded biotechnology companies. *Nature Biotechnology*'s definition is broad, defined as companies whose future businesses would rely heavily on R&D in the life sciences arena. Pharmaceutical companies are excluded, even though they do invest large sums in R&D and are intimately involved in the biotechnology sector. Other companies listed as biotechnology companies include those providing support services, such as database providers, manufacturers of microarrays and other high-tech equipment and clinical research service organisations. The reasons for selecting this universe are manifold. First and foremost, it is the largest selection of pure biotechnology companies possible (excluding pharmaceutical companies) and comprises 440 companies. Owing to the nature of the study, it was deemed advantageous to include companies with as wide a range of activities as possible: ranging from companies that specialise in gene therapy and molecular biology to companies that manufacture specialised drug delivery systems. The Nature list is a global one, including companies from the USA, the UK, Australia, Hong Kong and Canada. Other indices such as the Amex Biotech Index, NASDAQ Biotech Index are made up of only US companies.

Several portfolios were selected from this universe, each using different criteria:

- top 30 per cent most attractive companies from a PER perspective;

- top 10 per cent most attractive companies from a PER perspective;
- bottom 20 per cent least attractive companies from a PER perspective;
- bottom 10 per cent least attractive companies from a PER perspective.

All the portfolios were price weighted, and their performance compared against a benchmark portfolio, the Amex Biotech Index, on a one, two and three year basis. The earnings data and revenue data was collected from Bloomberg, and company websites. PER was calculated using the stock price at the start date (ie January 2001), divided by the historical earnings per share (EPS) for the same period.

Returns on each portfolio of stocks were measured against the benchmark portfolio to determine if performance was superior on a one, two and three year time horizon. Following this, volatility adjusted returns were measured for superior performance. In the final part of the study, risk adjusted returns (beta adjusted) over the market portfolio (as proxied by the MSCI Global Index) were measured.

RESULTS

The portfolio returns of all portfolios formed from the PER method were negative at both one and two year horizon. Over a three year horizon, only the absolute returns of the portfolio formed from the top 10 per cent of the most attractive PER companies proved to be positive. The benchmark portfolio also produced a small positive return over the same period. This suggests the biotechnology companies are better

Table 1: Comparison of portfolio of companies formed from top 30 per cent most attractive PER against benchmark

	1 year	2 years	3 years
PF returns			
PF1	−0.1272	−0.0020	−0.00096
Variance	0.001545	0.00143	0.0013
Skew	−1.2916	−0.8968	−0.7347
Kurtosis	4.3810	3.1746	2.3994
Max	0.05267	0.0774	0.0774
Min	−0.1739	−0.1739	−0.1739
Benchmark	−0.1232	−0.0162	−0.00101
t-test	0.7617	0.8738	0.9649
Sign test/no. positives	25/52	49/104	72/156
Return adjusted for volatility			
Average	−0.01681	−0.0031	−0.0015
Variance	0.002698	0.0035	0.0032
Skew	−1.2916	−0.8968	−0.7242
Kurtosis	4.3810	3.1746	2.3775
Max	0.06901	0.1213	0.1214
Min	−0.2298	−0.2726	−0.2726
T test	0.7706	0.7661	0.7521
Sign test/no. positives	26/52	47/104	70/156
Return adjusted for Sharpe ratio (beta = 1.1237)			
Average	−0.0074	−0.0016	−0.001185
Variance	0.00187	0.0016	0.00147
Skew	−0.5431	−0.3715	−0.3233
Kurtosis	2.9051	1.945	1.56957
Max	0.1044	0.1044	0.1044
Min	−0.1634	−0.1634	−0.1634
t-test	0.0927	0.0000	0.9471
Sign test/no. positives	26/52	24/104	76/156

investments over a slightly longer time period, which intuitively makes sense when considering the profit characteristics of the companies. Biotechnology companies typically have a long product development cycle, which can last from 9 to 15 years and a short shelf-life. Some companies, particularly those with only a few products in the pipeline, therefore, do undergo long periods of non-profitability.

In a comparison of the constructed portfolio of companies formed from the top 30 per cent most attractive PER against the benchmark, the returns of the constructed portfolio did worse than the benchmark in Year 1 (Table 1). The differences in the performances were not statistically significant by *t*-testing adjusted for volatility. The difference in the returns adjusted for the Sharpe ratio was also not statistically significant ($P = 0.0927$). In Year 2, both the constructed and benchmark portfolios performed better than they did in Year 1. In addition, the constructed portfolio performed significantly better than the benchmark portfolio in Year 2 when the returns were adjusted for the Sharpe ratio. Although the portfolio formed from top 30 per cent of the most attractive PER companies out-performed the benchmark over a three year time-frame, the result was not significant ($P = 0.9649$). Returns adjusted for volatility and risk were also not significant.

When the top 10 per cent most attractive PER were selected for analysis, the returns of the constructed portfolio did better than the benchmark in Year 1 (Table 2). However, these differences in the performances were not statistically significant by *t*-testing even after adjustments for risk. In Year 2, both the constructed and benchmark portfolios

Table 2: Comparison of portfolio of companies formed from top 10 per cent most attractive PER against benchmark

	1 year	2 years	3 years
PF returns			
PF1	−0.00682	−0.001386	0.001129
Variance	0.001066	0.001117	0.00098
Skew	−0.3504	−0.03856	−0.00749
Kurtosis	0.8375	0.5735	0.4087
Max	0.06835	0.08423	0.08423
Min	−0.1049	−0.1049	−0.1049
Benchmark	−0.1232	−0.0162	−0.00101
T test	0.7832	0.4871	0.5696
Sign test/no. positives	24/52	50/104	72/156
Return adjusted for volatility			
Average	−0.01123	0.002335	0.001688
Variance	0.00303	0.003173	0.002796
Skew	−0.3540	−0.03856	−0.06409
Kurtosis	0.8375	0.573495	0.901085
Max	0.1152	0.1420	0.1420
Min	−0.1769	−0.1769	0.1769
t-test	0.6081	0.5918	0.5940
Sign test/no. positives	25/52	48/104	71/156
Return adjusted for Sharpe ratio (beta = 0.9619)			
Average	−0.00119	0.001782	0.000775
Variance	0.001451	0.001399	0.001199
Skew	−0.1099	0.106066	0.096548
Kurtosis	0.2995	0.177055	0.287
Max	0.0867	0.097948	0.097948
Min	−0.09446	−0.09446	−0.09446
t-test	0.8239	0.5490	0.5712
Sign test/no. positives	22/52	49/104	73/156

performed better than they did in Year 1. In addition, the constructed portfolio performed better than the benchmark portfolio in Year 2. However, these differences in the performances were not statistically significant by *t*-testing even after risk adjustments. Over three years, returns were positive, in comparison to the benchmark which also yielded a positive return. Out-performance over the benchmark was not statistically significant after adjustment for risk and volatility.

In a comparison of the constructed portfolio of companies formed from the bottom 20 per cent least attractive PER against the benchmark, the returns of the constructed portfolio did better than the benchmark in Year 1 (Table 3). However, these differences in the performances were not statistically significant by *t*-testing after adjustments for risk. In Year 2, both the constructed and benchmark portfolios performed better than they did in Year 1. In addition, the constructed portfolio performed significantly better than the benchmark portfolio in Year 2 when the returns were adjusted for the Sharpe ratio ($P = 0.0006$). Over the three year horizon, returns did not show significant out-performance over the benchmark ($P = 0.9470$). Following adjustment for volatility, returns were not significantly positive ($P = 0.9238$).

When the bottom 10 per cent least attractive PER were selected for analysis, the returns of the constructed portfolio did better than the benchmark in Year 1 (Table 4). These differences in the performances were statistically significant by t-testing after adjustments for the

Table 3: Comparison of portfolio of companies formed from bottom 20 per cent least attractive PER against benchmark

	1 year	2 years	3 years
PF returns			
PFI	−0.01158	−0.00131	−0.00069
Variance	0.000656	0.002868	0.002148
Skew	−0.219	1.1382	1.117049
Kurt	0.37735	28.0746	33.8828
Max	0.04311	0.3514	0.3514
Min	−0.07626	−0.30042	−0.30042
Benchmark	−0.1232	−0.0162	−0.00101
t-test	0.8912	0.8620	0.9469
Sign test/no. positives	24/52	47/104	71/156
Return adjusted for volatility			
Average	−0.01402	−0.000156	−0.00084
Variance	0.00096	0.004205	0.003144
Skew	−0.219	1.1382	1.1171
Kurt	0.3077	28.0135	32.8859
Max	0.05219	0.42545	0.42545
Min	−0.09234	−0.36375	−0.36375
t-test	0.8900	0.7211	0.9238
Sign test/no. positives	25/52	47/104	69/156
Return adjusted for Sharpe ratio (beta = 1.1106)			
Average	−0.00617	−0.0007	−0.00104
Variance	0.00102	0.003262	0.002141
Skew	0.181945	1.3816	1.4224
Kurt	0.1582	26.7355	32.28716
Max	0.075818	0.376514	0.376514
Min	−0.08098	−0.3702	−0.3702
t-test	0.1112	0.0006	0.0000
Sign test/no. positives	19/52	27/104	25/156

Table 4: Comparison of portfolio of companies formed from bottom 10 per cent least attractive PER against benchmark

	1 year	2 years	3 years
PF absolute returns			
PF1	−0.01239	−0.00195	−0.00177
Variance	0.00099	0.002689	0.001996
Skew	−0.32693	1.2590	1.2450
Kurt	0.02733	22.35704	21.26
Max	0.048464	0.3277	0.3277
Min	−0.09222	−0.2641	−0.2641
Benchmark	−0.1232	−0.0162	−0.00101
t-test	0.8314	0.9309	0.8742
Sign test/no. positives	23/52	45/104	69/156
Return adjusted for volatility			
Average	−0.021159	−0.002295	−0.002004
Variance	0.002865	0.003438	0.002569
Skew	−0.32693	1.2590	1.24099
Kurt	0.02723	22.3570	26.0729
Max	0.08207	0.3705	0.3705
Min	−0.15617	−0.2986	−0.2986
t-test	0.9794	0.7495	0.9238
Sign test/no. positives	24/52	46/104	69/156
Return adjusted for Sharpe ratio (beta = 1.0196)			
Average	0.1309	0.144469	0.144361
Variance	0.0001278	0.000104	0.000103
Skew	−0.03691	5.9142	6.9382
Kurt	0.39533	52.58	74.99
Max	0.2108	0.2302	0.2302
Min	0.03066	0.1099	0.1099
t-test	0.0000	0.0000	0.0000
Sign test/no. positives	6/52	97/104	97/156

Sharpe ratio ($P = 0.000$). In Year 2, both the constructed and benchmark portfolios performed better than they did in Year 1. In addition, the constructed portfolio performed better than the benchmark portfolio in Year 2. These differences in the performances were statistically significant by *t*-testing after adjustments for the Sharpe ratio ($P = 0.000$). Over three years, returns were not significantly superior, even after adjustment for volatility. Returns adjusted for volatility significantly outperformed ($P = 0.000$).

There were no obvious differences in types of companies between the four portfolios. The top portfolio (PF 2) consisted of 34 companies, covering a wide range of businesses from immunoregulatory compounds, specialty animal nutrition and contract research organisations. There were also no discernible differences in early or late stage pharmaceuticals.

CONCLUSION

Portfolios of companies selected on the basis of most attractive PERs do not outperform a benchmark on a one, two or three year time-frame. This observation holds true even after adjustment for volatility and risk. The reasons for this could be that the time horizon over which the study is conducted is too short, ie 3 years while most biotechnology companies have a development cycle of seven to ten years. Also, the earnings used were actually reported earnings as opposed to predicted earnings which stock analysts use for stock recommendations. In instances where reported earnings have varied widely from estimated earnings, this would have significantly affected PERs.

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