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There is a large body of literature on the poor long-run stock performance of the typical initial public offering (IPO). Academic research has observed that IPOs are poor long-run investments. Considering this documented long-run underperformance of IPO firms, a debate still remains of whether the actual event of an equity issuance signals that a firm is overvalued at the time of IPO. Specifically, this empirical study looks to discern whether a firm's post-IPO performance is a result of an *industry* or *firm-specific overvaluation* at the time of IPO.

A firm may choose to time its IPO with the impetus that current investor sentiment has placed an unusually high valuation for the entire industry. Conversely, if underperformance is not found to be an industry effect, then the theory of a firm-specific effect (as in, whether or not a firm times and performs an IPO) may be the condition to underperformance. Investors understand that a firm's executives undoubtedly have better information than the investor public. Therefore, a company's decision to enter the public stock exchange market is made with the knowledge that this information asymmetry exists. Hence, investors must question whether an IPO firm has timed its initial public offering to coincide with an unusually high firm valuation by the public – a valuation that the firm's Management knows may not be substantiated in future earning years.

As later mentioned in the Literature Synopsis section, Loughran and Ritter (1995) and in part, Brav and Gompers (1997) identify that firms performing initial public offerings underperform in the long run. If empirical evidence from this research project supports that underperformance is indeed a firm-specific effect, the event of an initial public offering would signal that a firm is overvalued. In contrast, evidence may instead be indicative of investor over-exuberance over a particular industry; and thus, this IPO effect is merely a side-effect of an industry downturn following investors' overvaluation.

To discern whether a firm's post-IPO performance is due to an industry or firm overvaluation, a relevant benchmark must be chosen. It is recognized that the measurement of long-term abnormal stock performance is sensitive to the benchmark utilized. As detailed in the literature review in the following section, academics who have studied the long-run underperformance of IPOs have not agreed on the appropriate metrics and adjustments that ought to be used on a sample population. In response, my research will attempt to bring forward some new evidence in regards to the link between the robustness of IPO underperformance and the estimation of overvaluation by isolating the sample population to the biotechnology sector. A well-defined industry like biotechnology can eliminate the variable of market sentiment. Specifically, this study controls for unexpected industry-wide events which would equally affect the returns of the entire sample population. Brav and Gompers (1997) cite that "matching firms to industry portfolios avoids the noise of selecting individual firms and can control for unexpected events that affect the returns of entire industries." In their study, Brav and Gompers match firms to industry portfolios by utilizing the 49 industry portfolios created in Fama and French (1994) for one of their test of underperformance relative to different benchmarks. By using the SIC codes of 2830-2836 and 8730-8734, I have a well-defined benchmark to adjust for industry and can thus test for various corporate finance behavior hypotheses. The SIC codes chosen for this study match two of Fama and French's industry portfolios[1]: (1) Pharmaceutical Products and (2) Research Development, and Testing labs.

In this article, I examine the robustness of IPO underperformance by using several benchmarks and methodologies, which are similar to the Loughran and Ritter (1995) and Brav and Gompers (1997) papers. However, as an addendum to these two previous papers, I make the adjustment for industry, by utilizing biotechnology portfolios of issuers and non-issuers. The

[1] Defined by SIC codes also.

first test examines the long-term performance of individual firms that performed an IPO between the years of 1980 and 1997, and therefore employs a time period that extends to 2002. The second procedure investigates the long-run returns and wealth relatives of Initial Public Offering Portfolios in comparison to various benchmarks. The third test examines long-run performance of IPOs by Cohort Year. Lastly, the fourth method emphasizes the Fama-French three-factor time-series regressions on monthly returns for portfolios of issuing and non-issuing firms. In an ideal empirical research project, each of these four varied tests would confirm the results from the other three. However, as one will see in this article, the analysis from each of these tests yields some-what conflicting results, but in aggregate more fully depicts the population and provides answers to the question posed in this research.

Based on the empirical evidence from the biotechnology industry, I find that underperformance is not a firm specific effect. After adjustments for risk, size, and industry have been undertaken, IPOs do not underperform relative to the benchmark – the biotechnology industry. When size-matched Fama-French regressions are utilized, small Biotech issuers and non-issuers perform poorly relative to the explicit market pricing model. However, when adjustments for industry are undertaken, small issuers do not underperform. This is in addenum to the Brav and Gompers study, which found that underperformance is characteristic of small, low book-to-market non-VC backed companies, regardless of whether they are IPO firms or not. This result may be also indicative of a partial industry effect. Small firms within the biotechnology industry may time their initial public offerings to coincide with an industry overvaluation, as small non-issuers perform even more poorly than small issuers in the same industry.

This paper is organized as follows. Section I reviews previous research papers that are most relevant to this article. Section II describes the data. Section III presents evidence on the long-run performance of Biotechnology firms who had issued an initial public offering from January 1980 to December 1997 {utilizing stock return data from December 1979 to December 2002}. Section IV addresses some analyses and possible explanations of the results.

Section I. Literature Synopsis

In a frequently cited study, Tim Loughran and Jay Ritter (1995) discuss the poor long-run performance of IPOs from 1970 to 1990. They state that the geometric five-year average annual return of a firm which issued an initial public offering was 5% versus a size-matched non-issuing firm's 12% average annual return. In other words, to be left with the same wealth five years later, forty-four percent more money would need to be invested in issuers than in nonissuers. Brav and Gompers (1997) also investigate the long-run underperformance of IPOs, but distinguish venture backed IPOs from non-venture backed companies. They find evidence that venture backed IPOs do not underperform, and reason that the negative IPO Effect that Loughran and Ritter (1995) discuss was instead a characteristic of small, non-venture backed IPO firms. Specifically, the researchers describe that over five years, venture backed IPOs earn 44.6% on average, while nonventure-backed IPOs earn 22.5% in returns. In addition, Brav and Gompers posit that stock underperformance is an attribute of small, low book-to-market companies, regardless of whether they are IPO firms or not. The researchers relied on a combined metric of size and book-to-market as a benchmark to measure IPO performance, because they believe that a sized matched firm adjustment (as completed by Loughran and Ritter) ignores evidence that book-to-market cap

is related to returns. On the other hand, Loughran and Ritter state that only a modest portion of IPO firms' underperformance can be linked to book-to-market effects.

In relation to the appropriate benchmarks used to match the performance of IPO firms, Brav and Gompers replicated Loughran and Ritters' use of the four broad market indexes. However, the former also compared the performance of IPOs to industry portfolios, while Loughran and Ritter did not match by industry.

As a corollary to their main focus on IPO underperformance, both papers bring forth evidence of the positive relationship between high issuance volume years and severe underperformance in returns. However, Brav and Gompers point out that event time results may be misleading about the pervasiveness of underperformance, as returns of recent IPO firms may be correlated. They cite some initial evidence in support of the correlation between the returns of IPO firms and calendar time. Loughran and Ritter also suggest a market in which firms issue equity during transitory windows of opportunity when they are substantially overvalued. Jain and Kini (1994) echo the same sentiments and note that entrepreneurs time their IPOs to coincide with unusually good financial results, which may not be sustainable in the future.

Section II. Data

The biotechnology industry portfolio used in this study is defined by Standard Industrial Classification (SIC) codes: 2830 – 2836 and 8730 – 8734. These two industrial groups include Pharmaceutical Preparations, Diagnostic Substances, Biological Products, and Research, Development, And Testing Services. As aforementioned, these two groups of SIC codes also encompass two of Fama and French's industry portfolios: "Pharmaceutical Products" and "Research, Development, and Testing labs".

The biotechnology industry was selected as the area for study because it is a sector that frequently utilizes the public equity markets. Biotechnology companies derive value from the discovery and development of new drugs and compounds, which is expensive. It has been documented that a typical drug costs approximately $800 million over ten years to bring from development to the market. Hence, IPO activity may be a substitute for additional venture capital financing and the sector's utilization of equity issuances is partly due to the capital intensive nature of the sector. With these basic characteristics, the biotechnology industry provides a very relevant benchmark and a good initial pick for an industry study.

Within this defined industry population, a sample of 633 operating companies that had gone public in the United States from January 1980 to December 1997 was analyzed for this article. However, returns data was taken up to December 2002 to provide a full five years for those firms who performed IPOs in 1997. These stock data returns are listed on the University of Chicago Center for Research in Security Prices (CRSP) Nasdaq or American Stock Exchange (AMEX) and New York Stock Exchange (NYSE) daily tapes. Therefore, to be included in this sample, a firm carrying out an initial public offering must be followed by CRSP at some point after the offering date.

On December 31, 1979, there were forty-nine firms in the biotech portfolio. The number of companies within the population grew to 415 on December 31, 2002. However, with the knowledge that almost twice as many companies have become publicly listed during this time period, this supports the intuition that the number of companies that have listed and delisted within this population is high.

The long-run performance of new issues is measured over a five-year or sixty months interval. The choice of time study is consistent with the Brav and Gompers and Loughran and

Ritter studies. The five year time interval was chosen, because the longer the time interval, the greater the total underperformance, although the greater the variability of returns expected. In addition, Loughran (1993) states that IPOs underperform for approximately five years.

Section III. Evidence

A) Average Five-Year Returns for Individual New Issuers from 1980 to 1997.

The majority of this paper utilizes *portfolio* returns to investigate any underperformance of IPOs. However, this section provides some introductory evidence on the individual long-term performance of biotechnology IPOs from 1980 to 2002. As seen in Table I, 56.4% of these biotechnology issuers had negative returns over the first five years after their CRSP initial listing (or the last CRSP listed price). However, the mean five-year return is 41.1% and the median is -18.4%. This deviation between mean and median returns is due to the extremes on the positive returns end, where 20% of the population from 1980 to 2002 had greater than 110% in buy-and-hold returns over five years. In addition, the 40% of IPOs which performed below -70% within five years can be attributed to the difficulties in remaining as a publicly listed company. As seen in this two-axes graph (Figure I), the histogram is positively skewed, which indicates the presence of a small proportion of relatively large extreme values. In addition, the variance of buy-and-hold returns is large, at $356(\%)^2$.

It is easy to comprehend that investing in any one of these individual IPO firms which had a negative five-year buy-and-hold return would not be an optimal investment choice. However, one cannot properly interpret the remaining 44% of the biotechnology industry sample population which had positive returns over five years, without the comparison of an appropriate benchmark. For example, it would be unwise for an investor, who was basing her investment

decisions solely on the historical performance of a stock, to pick a firm that had a positive 10% buy-and-hold return over five years when the entire industry returned 30%.

The previously noted characteristics of the histogram and oglive (the cumulative relative frequency plot) signal that an examination of only individual IPO firm returns can be misleading to investors. The variability of returns within this 633 large IPO population highlights the need for the use of portfolios, rather than individual firms in a data-based academic study. Single company returns do not have a normal distribution (or bell-shaped histogram), as seen in Figure I. Hence, the construction of useful tests and statistics that describe this particular data set would be difficult and unreliable if this normal distribution requirement is not achieved. In addition, analysis on individual issuers alone would be misleading because returns of issuing firms are correlated with each other.

Thus, by studying portfolio returns on this population, I can examine the co variances of issuing firms' returns and properly analyze statistics of the population. IPO portfolios are used in the analysis of firm underperformance in the remainder of this paper. Also, in order to interpret and understand the relative magnitude of IPO long-run stock performance returns, a benchmark is used for comparison.

B) Five-Year Post-Initial Public Offering (IPO) Returns and Wealth Relatives versus Various Benchmarks

Brav and Gompers (1997) and Loughran and Ritter (1995) utilize several benchmarks to investigate the negative IPO effect. This study extends their analyses by using a well-defined benchmark, the biotechnology industry. The biotechnology industry population, as defined in the preceding section, is used in the equal and value-weighted portfolio studies. In the equal-weighted portfolio, one calculates the monthly return on a portfolio that buys equal amounts of

all IPO firms. In respect to the value weighted portfolio, one invests an amount that is proportional to the market value of each IPO firm's equity in the previous month. Value-weighted portfolios of IPO firms' returns and the relative benchmarks are utilized because they demonstrate how IPO underperformance can affect an investor's wealth. The Biotech benchmark portfolio excludes any IPO firms' returns that had gone public within the previous five years. Similar to the two previously cited studies, the performance of initial public offering firms is also compared to the S&P500, Nasdaq Composite, and NYSE/AMEX (includes dividends). However, IPO firms are not eliminated from these three broad market indices.

Table II presents the average long-run (as defined by five years) buy-and-hold performance for IPO and benchmark portfolios based on holding either an equal or value-weighted portfolio. These average five-year buy-and-hold returns are calculated assuming monthly portfolio rebalancing. CRSP monthly tapes are used for the earlier of 60 months or the delisting dates. Five-year buy-and-hold returns are compounded monthly and are based on holding an IPO portfolio which contains all biotechnology IPOs that had gone public in the previous 60 months for five years. The wealth relative measure is computed by dividing the average terminal value from investing $1 in each issuing firm with the average terminal value from investing $1 in the relevant benchmark. Wealth relatives less than one signify that the IPO portfolio has underperformed relative to its benchmark.

As seen in Table II, the difference between the mean and median five-year average buy-and-hold returns of the equal and value-weighted IPO portfolios indicates that IPO returns within this industry are highly skewed and have a large standard deviation. The positive skewness and variance of the equal and value weighted portfolios are in line with the similar descriptive statistics as the individual IPO returns in the previous section. The mean five-year buy-and-hold

return of 158% for the equal-weighted IPO portfolio is considerably greater than the comparable percentage return for the value-weighted portfolio of 24%. Relying on this evidence alone would signal that IPO firms that have had higher returns are those with lower market values, which are not weighted as heavily in a value weighted portfolio (this assumption is adjusted in the later Fama French analysis). The equal weighted and value-weighted industry portfolios have similar long-term return performance. The equal-weighted IPO portfolio slightly underperforms relative to this industry benchmark, while the significantly lower return of the value-weighted portfolio underperforms strongly with a wealth relative of .46.

The most suitable benchmark used to compare IPO portfolio returns is the aforementioned biotechnology industry portfolio, which excludes all issuing firms within the previous 60 months. Comparing the IPO portfolios to the broad market indexes like the S&P500, Nasdaq, and NYSE/AMEX is misleading. The five-year wealth relatives for the equal-weighted portfolio for each of these broad market indexes are greater than one, and range from 1.16 to 1.36. Wealth relatives greater than one signal that issuing firms on average, outperformed these three broad market indexes over five years. This would mislead investors to believe that a biotechnology IPO portfolio is a wise investment, while in reality IPOs are underperforming relative to the industry benchmark (based on this empirical test's results). However, the IPO value weighted portfolio's wealth relatives using the broad market indices as benchmarks still yields results below 1, which signals underperformance. This is consistent with the value-weighted IPOs to industry benchmark wealth relative analysis.

As with all empirical tests, some caveats must be weighed. Comparing the buy-and-hold returns of issuers' and non-issuers' portfolios implicitly assumes that the two portfolios to have the same betas and risk-loading. IPO portfolios, the biotechnology industry, and most definitely

the broad market indices all have different risks which have not been adjusted for within this empirical test which utilizes wealth relatives.

C) The Long-Run Performance of IPOs by Cohort Year.

As an extension of the previous section analyzing the average buy-and-hold returns of IPO portfolios, this performance test (Table III) examines returns on the basis of different cohort years. For firms which had performed an IPO between the years of 1980 and 1997, buy-and-hold returns and wealth relatives are reported on a cohort year-by-year basis. The benchmark used for comparison is solely the biotechnology industry portfolio, which excludes all firms that had performed an IPO in the previous five years. IPO equal and value-weighted portfolios are used once again for this set of tests.

Loughran and Ritter (1995) and Brav and Gompers (1997) write that the years of greatest IPO activity are associated with the most underperformance. As seen in Table III and Figure II, there does not seem to be the same correlation in the biotechnology industry population. Visually, there does not seem to be any relationship between the volume of issuances in a particular year and the performance of an IPO portfolio relative to its industry.

In each of the cohort years, from 1980 to 1997, the five-year buy-and-hold return for the equal-weighted IPO portfolio is considerably greater than the comparable percentage return for the value-weighted portfolio. Hence, the yearly cohort results suggest that when returns are value-weighted, the underperformance effect is heightened. As noted in the previous analyses, this signals that IPO firms with higher returns are those with lower market values, which are not weighted as heavily in a value weighted portfolio. Additionally, when the yearly cohort returns are value weighted, the portfolio wealth relative through time becomes more uniform. The

spikes in the equal-weighted portfolio wealth relative in cohort years 1981, 1986, and 1993 are minimized in the value-weighted portfolio. The value-weighted IPO portfolio only outperforms the industry benchmark in 1986, while the equal-weighted IPO portfolio has wealth relatives greater than one in 1981, 1986, 1990, 1993, 1994, and 1995.

Despite the previously noted six years of IPO over-performance relative to the industry benchmark, an investor who invests in the IPO portfolio for five years based on the firms at year *t*, will on average earn a return that is less than a return that would have been earned by investing in the biotechnology industry portfolio (excluding IPOs). Analysis of cohort year IPO performance supports the previous finding of a long-run IPO underperformance relative to the industry benchmark.

The cohort year test which was analyzed in the preceding two paragraphs are held to the same caveats as the buy-and-hold returns and wealth relatives versus several benchmarks test in the previous section. The portfolios formed in this round of tests are again not adjusted for betas and risk-loading. Hence, one must be cautious in comparing IPO portfolio returns to non-issuers and then drawing final conclusions. Adjustments for such risks are undertaken in the time series regressions tests of this research paper.

D) Three-Factor Time-Series Regressions – Full Sample and Size Matched

In Tables IV and V, I report the results of time-series regressions of monthly portfolio returns on Fama French three factors. Eugene Fama and Kenneth French (1993) used these three factors to explain excess returns on stock portfolios. In their study, they show that these three stock market variables (MKTRF, SMB, HML) describe a statistically significant portion of stock returns variation. One disadvantage of this test is that to the degree that the portfolio is

correlated with omitted factors, the intercepts can embody factors other than what is explicitly controlled for.

The sample is all Biotechnology IPOs from January 1980 to December 2002. Portfolios of IPOs include all firms which performed an initial public offering within the previous five years. In other words, the IPO portfolio is a five-year rolling portfolio. The regressions which follow are based on the following Fama-French Three-Factor Equation:

$$R_{p,t} - R_{f,t} = a + b[R_{m,t} - R_{f,t}] + sSMB_t + hHML_t + e_t$$

In the regression equations, $R_{p,t}$ is the return on the respective portfolio, whether it is the running IPO portfolio or the non-issuers benchmark portfolio. These benchmark factors represent (1) the overall market return (R_m), (2) the performance of small stocks relative to big stocks (SMB, Small Minus Big), and (3) the performance of value stocks relative to growth stocks (HML, High Minus Low)[2]. Specifically, $R_{m,t}$ is the return on the value –weighted index of NYSE, Amex, and Nasdaq stocks in month t; $R_{f,t}$ is the beginning-of-month one-month Treasury Bill rate in month t; SMB_t is the return on small firms minus the return on large firms in month t; and HML_t is the return on high book-to-market (value) stocks minus low book-to-market (growth) stocks in month t.

This paper focuses on the regressions based on the dependent variable of the industry adjusted excess portfolio return, or the difference between the running IPO portfolio and the respective non-issuing firms portfolio within the Biotechnology population. One expects the difference of the two regressions: 1) [Issuers - One month T-bill] minus 2) [Non-issuers benchmark - the One month T-bill] to be equal to the coefficient of the industry adjusted excess portfolio returns: [Issuers – Non-issuers benchmark].

[2] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

The first set of the Fama-French three factor regressions is completed on the full IPO portfolio sample. The second set of three factor regressions uses an IPO portfolio sorted on the size of the firm.

Fama-French (1993) Three-Factor Regression on Full Sample Initial Public Offering (IPO) Portfolios

Table IV presents the Fama-French three-factor time series results for the Full-Sample. Loughran and Ritter (1995) explain that if the poor performance of issuing firms is simply a manifestation of compounding effects - such as differences in size, book-to-market ratios, and betas - then the intercepts in the regressions should be equal to zero. Lines (3) and (6) represent the excess return between the issuers and non-issuers portfolio. Utilizing an equally-weighted portfolio, issuing firms seem to outperform non-issuing firms by 14.5 basis points per month, or 1.74% over one year. However, this point estimate is not statistically significant with a t-statistic of 0.56. The value weighted portfolio yields a slightly negative, but weak intercept coefficient of -.00023. The implied t-statistic is -.07, which indicates that this coefficient result is statistically insignificant. If the coefficient had been statistically significant, the IPO portfolio would seem to underperform the non-issuers portfolio only by .276% over one year and a severe IPO underperformance effect is not found.

If the intercept coefficients of the equally-weighted portfolio are compared to the value-weighted portfolio, the value weighted intercept coefficients are less than the equally-weighted intercept coefficients for both issuers and non-issuers. This result suggests that the largest market capped firms may not have performed as well as smaller market cap firms did, which is the conclusion that was reached in the five year buy-and-hold returns in Tests B and C. However, this inference is not completely sound, as indicated by the regression analysis on large

and small firms which follows. As later noted in this article, large issuers and non-issuers outperform small issuers and non-issuers relative to the three-factor asset pricing model. The relatively smaller intercept coefficients for the value-weighted portfolio versus the equal-weighted portfolio are representative of the fact that the majority of the population is made up of small firms (as described by the SMB coefficient analyzed in the following paragraphs). Hence, in this study, the value-weighted portfolio places greater weight on a smaller portion of the population, but the number of small firms with poor returns still depresses returns due to the sheer number of small issuers.

The *b* coefficient in the regressions represents MKTRF: the excess return on the market. As seen by the higher *b* coefficient for issuers versus non-issuers (within both the equally-weighted and value-weighted regressions), issuers have betas which are larger than non-issuers. Hence, if we assume that beta risk is taken into account in the price of a security, issuers should have higher returns than non-issuers.

Both issuers and non-issuers in the equal and value weighted portfolios have negative HML coefficients *h*. This indicates that their returns covary with the returns of growth (low book-to-market) firms. As the *h* coefficients for the IPO equal and value portfolios are more negative than the non-issuers' benchmark portfolio, this indicates that the returns on IPO tend to covary more with the returns of growth companies.

The large positive loading coefficients on SMB indicate that issuers covary with small firms, and to a higher degree than their non-issuing counterparts. Interestingly, there is a statistically significant negative coefficient on the value weighted non-issuers. This may be explained, as the value weighted portfolio places more weight on large market capped stocks, so thus these non-issuer returns covary with large firms.

Fama-French (1993) Three-Factor Regression on Size Sorted Initial Public Offering (IPO) Portfolios

Table V presents the Fama-French three factor regression results after dividing the sample by size. Large firms are those whose market capitalization at time *t* is greater than the median firm in the biotechnology sample population. Conversely, Small firms are those whose market capitalization is smaller than the median firm within the sample population at that time period.

Lines (3), (6), (9), and (12) represent the excess return between the issuers and non-issuers portfolio. Utilizing equally-weighted portfolios, large issuing firms considerably outperformed large non-issuers by 78.7 basis points per month, with a significant t-statistic of 2.74. Smaller issuers do not perform as badly as non-issuing firms in the equally-weighted portfolio, as there is a positive excess return intercept of .00173. However, this result is not significant with a .52 t-statistic. When returns are value-weighted, large issuers have an almost indistinguishable to zero intercept coefficient of -.00006, which economically is equal to zero. The result is not statistically significant with a t-statistic of -.01. Similar to the equally-weighted portfolio, small issuers' value-weighted returns are not as poor as small non-issuers. The associated coefficient for the excess return's intercept is 11.1 bps, but it is not statistically significant.

Brav and Gompers (1997) write that if IPOs underperform on a risk-adjusted basis, portfolios of IPOs should consistently underperform relative to an explicit asset pricing model, such as the Fama French three-factor model. Hence, the intercept from time series regressions is used as an indicator of risk-adjusted performance. For both equal and value weighted portfolios, large issuers and non-issuers have positive and statistically significant intercepts, which indicate

over performance relative to this asset pricing model. On the other hand, both small issuers and non-issuers have negative intercepts, which indicate underperformance to the Fama French asset pricing model. Yet, when IPO firms of both size quintiles are compared to their non-issuer benchmark (in both the equal and value weighted portfolios and large and small market capped firms' returns), they do not underperform relative to this industry adjusted benchmark.

The coefficients on HML are negative for all portfolios in the time series regressions – both large and small equal and value weighted portfolios. In the equal weighted portfolio, the larger the firm, the more it co varies with low book-to-market firms. As Brav and Gompers cite, large firms (in market value) will have low book-to-market ratios and hence covary with growth companies. Also of note, issuing firms load more negatively than non-issuing firms, indicating that issuing firms have characteristics of growth companies. This pattern is not as clear utilizing the value-weighted portfolio, as the coefficients on HML for large issuers, small issuers, and small non-issuers are not statistically significant.

The *b* coefficients in the regressions for equally-weighted Large Issuers and Small Issuers and value-weighted Small Issuers are greater than the betas for non-issuers. This finding is consistent with the issuer versus non-issuer betas in the full-sample. Issuers with their higher betas are expected to have higher returns than non-issuers, if beta risk is priced – which is also demonstrated by the associated positive intercept coefficients (in lines 3, 6, 9 and 12 of Table V). Contrary to expectations, the beta of large issuers within the value-weighted portfolio is significantly smaller than the beta for large non-issuers. In parallel, the return for large issuers is slightly less than large non-issuers in the value-weighted portfolio. The difference in betas between the equal and value-weighted portfolio signifies that the largest market capped IPO firms in the biotechnology industry sample have low co variability of return with the market

return, while those large firms closer to the industry median market cap have betas above or close to 1.

The coefficients on SMB are as expected, given the information on the HML coefficients. In the equal weighted portfolio, both large and small issuers covary with small firms, and to a degree that is greater than their respective non-issuers. Small issuers in the value-weighted portfolio also covary more with small firms than its respective small non-issuers. Large issuers in the value-weighted portfolio have a slightly negative SMB coefficient, but not statistically significant. In respect to large non-issuers in the value-weighted portfolio, these large issuers seem to be smaller in respect.

Section IV. Evaluation:

The coefficients from the three-factor regressions in the two analyses above can be used to describe the biotechnology population. Issuers have more positive and higher betas (or excess returns to the market) than non-issuers in the biotechnology population. While both issuers and non-issuers are growth (low book-to-market) firms, companies that perform an IPO are relatively more growth oriented firms in comparison to the benchmark. As per intuition, issuing firms are smaller in market capitalization than non-issuers.

In both the full sample and size differentiated regressions that were run using the Fama French three factor model, IPO underperformance relative to the industry benchmark is not substantiated. In the full-sample time series regressions, the equal weighted portfolio's intercepts do not indicate IPO underperformance relative to the three-factor pricing model and in comparison to the industry benchmark. It is only in the value-weighted portfolio that IPOs slightly underperform by 2.3 basis points per month relative to the industry benchmark – but this

point estimate is not statistically significant. The second time-series regressions divide the issuer and non-issuer population into large and small divisions, based on market capitalization. The equal and value-weighted small issuers' regressions have similar intercept coefficients, where these small issuers and non-issuers both show underperformance relative to the explicit pricing model, but a positive industry adjusted excess return.

Examining small issuers in the value-weighted portfolio finds a statistically significant underperformance of 212.6 basis points per month, relative to the Fama French explicit pricing model. However, the robustness of this IPO underperformance effect is minimized in comparison to small non-issuers within the industry portfolio, which underperformed relative to the asset pricing model by 223.6 basis points. The industry adjusted excess return of issuers minus non-issuers actually has an over-performance of 11.1 basis points per month (with a t-statistic of 0.37). This conclusion supports the theory that stock underperformance by small firms is not a firm-specific effect. Instead, small biotech firms may time their initial public offerings to coincide with an industry overvaluation, as small non-issuers are seen to perform even more poorly than small issuers.

These remarks refine Brav's and Gompers' (1997) conclusions. As noted earlier in this article, Brav and Gompers observe that stock underperformance is attributed to small, low book-to-market companies, regardless of whether they are IPO firms or not. In this study, I find that with an industry adjustment, small IPO firms actually do not underperform. In addition, as seen in the coefficients of HML in the Fama French regressions, the biotechnology industry co varies strongly with low book-to-market firms, and hence my small firm portfolio is similar to Brav's and Gompers' small, low book-to-market portfolio with an industry adjustment.

The underperformance of issuing companies relative to the industry benchmark in the buy-and-hold analysis in Table II cannot be directly compared to the Fama French regression analysis. The comparison of buy-and-hold returns of issuers relative to non-issuers, as calculated through the Wealth Relative ratio is a forced and unnatural evaluation. Comparing the buy-and-hold returns of issuers' and non-issuers' portfolios implicitly assumes that the two portfolios to have the same betas and risk-loading, although they undoubtedly have different risks. The Fama-French three factors take care of the risk-loading differences between issuers and non-issuers, and thus allows for an investigation of returns underperformance. In addition, academic research has shown that as variance of returns increases, the buy-and-hold return decreases. As noted earlier, the variance in returns of the issuing firms' portfolio is high and hence, results are biased toward to a lower buy-and-hold return relative to a less variable non-issuing portfolio.

As noted in the above analyses, underperformance of returns relative to the overall market is only found in the returns of small biotechnology issuers and non-issuers. However, when industry has been adjusted for, any IPO underperformance effect is negated. Regressions of IPO and non-issuing firms' returns on the Fama French three factors do not support the theory of firm specific misevaluation, since IPOs do not underperform relative to the industry adjusted benchmark. Similar to the Brav and Gompers (1997) study, this article shows that the underperformance documented by Loughran and Ritter (1995) is not characteristic of all IPO firms. Large issuers are seen to outperform large non-issuers in the same industry, while small issuers perform as poorly as small non-issuers relative to the market pricing model. This result again reaffirms the need to examine the specific characteristics of firms that underperform in the long-run.

Brav and Gompers (1995) detail several reasons why small, low book-to-market firms appear to underperform. These reasons may also be relevant in this industry adjusted study. Brav and Gompers write that investor sentiment may have an impact on the performance of small, low book-to-market firms as these firms are more liable to be subject to fads and investor sentiment. With the relatively small size of these firms, they are also more likely to be held by individuals. Additionally, the aforementioned problem of information asymmetry is particularly predominant between small firms and their investors because institutional research analysts are less likely to cover these firms. Likewise, individual investors are unable to spend as much time tracking the returns of their investment decisions. Lastly, Brav and Gompers theorize that individuals who are most likely to invest in small IPO companies are those who view such an investment like a lottery ticket. If an investor's utility is derived from a bet as such, his investment decisions will not appear perfectly rational.

However, there may be additional real factors which can explain the underperformance of small firms within this industry in respect to the overall market. This study should be replicated using another industry portfolio, such as technology, in order to verify the results of this study. Since most firms in the biotechnology portfolio are growth (small book-to-market) firms, another industry with a greater variety of book-to-market ratios can be used to discern if a firm's book-to-market ratio is also an indicator of underperformance.

In response to the question initially posed in the beginning of this article, *"Does an equity issuance serve as a signal for overvaluation?"*: Long-run return underperformance is indeed not a firm specific effect (as signaled by an IPO), based on evidence from the Biotechnology industry from 1980 to 2002. In addendum to the Brav and Gompers (1997) study, small firms do not underperform when an industry adjustment is completed. In addition, a partial industry

effect at the time of IPO is also supported, as small firms within the biotechnology industry may time their initial public offerings to coincide with an industry overvaluation.

Table I. Average Five-Year Returns for Firms Performing Initial Public Offerings from 1980 to 1997.

The IPO sample comes from the biotechnology industry population from 1980 through 2002. IPOs are identified by an initial CRSP listing during this time period. The average five-year returns for individual firms that performed an IPO between 1980 and 1997 are calculated below. It is a monthly compounded percentage return over the earlier of 60 months or the last CRSP listed return. In total, 633 IPO firms were used in the calculation. Five-year buy-and-hold returns are first listed, followed by the number of firms within that category, and finally the cumulative number of firms which fall at that percentage return and below.

Buy-and-Hold Returns (%)	*Number of IPOs*	*Cumulative %*	*Buy-and-Hold Returns (%)*	*Number of IPOs*	*Cumulative %*	*Buy-and-Hold Returns (%)*	*Number of IPOs*	*Cumulative %*
-100	0	.0%	80	7	74.6%	260	1	91.6%
-90	59	9.3%	90	10	76.1%	270	1	91.8%
-80	51	17.4%	100	12	78.0%	280	4	92.4%
-70	44	24.3%	110	8	79.3%	290	2	92.7%
-60	51	32.4%	120	12	81.2%	300	2	93.0%
-50	29	37.0%	130	8	82.5%	310	1	93.2%
-40	25	40.9%	140	8	83.7%	320	1	93.4%
-30	27	45.2%	150	5	84.5%	330	2	93.7%
-20	27	49.4%	160	7	85.6%	340	1	93.8%
-10	25	53.4%	170	7	86.7%	350	0	93.8%
0	19	56.4%	180	3	87.2%	360	2	94.2%
10	19	59.4%	190	3	87.7%	370	1	94.3%
20	20	62.6%	200	6	88.6%	380	1	94.5%
30	18	65.4%	210	4	89.3%	390	0	94.5%
40	22	68.9%	220	2	89.6%	400	0	94.5%
50	12	70.8%	230	1	89.7%	More	35	100.0%
60	10	72.4%	240	5	90.5%			
70	7	73.5%	250	6	91.5%			

Table II. Five-Year Post-Initial Public Offering (IPO) Returns and Wealth Relatives Versus Various Benchmarks

The biotechnology sample includes returns from 1980 through 2002. The benchmarks used also utilize returns from the same time period. The average five-year buy-and-hold portfolio return of IPO portfolios is compared to seven benchmarks. Both an equal weighted and value weighted portfolio are created, each containing returns up to sixty months from an IPO's initial CRSP listing. The average five-year buy-and-hold *portfolio* returns are a monthly compounded percentage return over 60 months (for all IPOs that went public from 1980 to 1997). This is akin to buying a portfolio of all of the IPOs that had gone public in year t and holding the portfolio for five years. The wealth relatives for the five-year period after IPO is the ratio of one plus the IPO portfolio return over one plus the return on the chosen benchmark. The Biotech Industry Portfolio Benchmark contains all firms within the described industry population, but removes all returns from IPO firms within five years of the CRSP initial listing date. EW signifies equally weighted and VW signifies value-weighted portfolios. The Average Buy-and-Hold Returns presented in Table II are percentage returns. For example, the average five-year buy-and-hold return for the equal-weighted IPO Portfolio is 157.7%.

	Avg 5-Year Buy-and-Hold Return	
	IPO Portfolio: equal-weighted	IPO Portfolio: value-weighted
	157.7	**24.4**
medians	84.8	3.3

Benchmark	Average 5-year Buy-and-Hold Return	5-Year Wealth Relative	5-Year Wealth Relative
Biotech Industry Portfolio - equal-weighted	171.7	0.95	0.46
Biotech Industry Portfolio - value-weighted	174.5	0.94	0.45
S&P500	122.6	1.16	0.56
Nasdaq composite - EW	90.4	1.35	0.65
Nasdaq composite - VW	117.9	1.18	0.57
NYSE/AMEX - VW	89.4	1.36	0.66
NYSE/AMEX - EW	108.1	1.24	0.60

Table III. The Long-Run Performance of IPOs by Cohort Year.

The sample consists of 842 initial public offerings (633 from 1980 to 1997) by firms subsequently listing on the New York Stock Exchange (NYSE), the American Stock Exchange (Amex), the NASDAQ. Each cohort year portfolio includes all returns up to five years of biotechnology firms which went public in that given year. The Benchmark is representative of a portfolio of the biotechnology population returns, excluding IPO returns within five years of the initial CRSP listing date. Once again, the benchmark buy-and-hold return is the five year buy-and-hold return of the benchmark portfolio purchased in that cohort year. The wealth relative in each cohort year is $[(1+R_p) / (1+ R_{bench})]$. R_p is the five year buy-and-hold percentage return of a portfolio which contains the returns up to 5-years of all firms which performed an IPO in that given year. R_{bench} is the five year buy-and-hold return of the biotechnology portfolio that excludes all IPO returns within five years of the initial CRSP listing date. For example, 1980's five-year wealth relative of .93 is calculated as 1.7476/1.8857.

		Equally Weighted Portfolio - 5 Year Buy-and-Hold Return			Value Weighted Portfolio - 5 Year Buy-and-Hold Return		
		Mean Buy-and-Hold Returns (%)			Mean Buy-and-Hold Returns (%)		
Cohort Year	Number of IPOs	IPOs	Benchmark	Wealth Relative	IPOs	Benchmark	Wealth Relative
1980	6	88.66	186.70	0.66	74.76	88.57	0.93
1981	9	405.90	194.68	1.72	18.02	122.59	0.53
1982	14	28.64	245.21	0.37	3.84	198.17	0.35
1983	29	(48.48)	137.23	0.22	(61.60)	158.08	0.15
1984	10	19.94	142.39	0.49	(37.18)	165.72	0.24
1985	13	77.89	165.12	0.67	24.16	258.43	0.35
1986	74	734.52	77.99	4.69	271.29	185.09	1.30
1987	25	59.41	239.51	0.47	6.64	230.64	0.32
1988	13	(48.14)	259.24	0.14	(61.37)	153.38	0.15
1989	67	14.85	212.38	0.37	(62.48)	105.17	0.18
1990	23	151.67	117.59	1.16	(3.30)	58.91	0.61
1991	58	190.45	265.17	0.80	2.78	116.50	0.47
1992	46	60.11	72.29	0.93	12.45	64.23	0.68
1993	46	360.55	66.58	2.76	60.06	185.95	0.56
1994	39	222.08	49.89	2.15	196.96	367.22	0.64
1995	40	268.17	220.38	1.15	(7.28)	295.51	0.23
1996	73	172.21	207.62	0.88	0.10	244.65	0.29
1997	48	80.96	231.31	0.55	1.04	142.75	0.42
1998*	32	49.44	98.89	0.75	(0.42)	26.04	0.79
1999*	38	17.69	106.46	0.57	3.63	(15.59)	1.23
2000*	92	(49.95)	25.81	0.40	4.74	(10.61)	1.17
2001*	30	(26.21)	(18.66)	0.91	(0.58)	(35.37)	1.54
2002*	17	11.53	(38.03)	1.80	12.21	(24.80)	1.49
1980-2002**	633	$ 78.21	$ 66.66		$ 37.09	$ 37.97	

** The return window for these cohorts is truncated at December 31, 2002.*
*** If one were to invest $1 and hold the IPO portfolio for the 22 year period from Jan-1980 to Dec-2002, this is the dollar amount of the portfolio at Dec 2002. The IPO portfolio includes IPO firms' returns up to 5 years after the initial CRSP listing date.*

Table IV. Fama-French (1993) Three-Factor Regression on Full Sample Initial Public Offering (IPO) Portfolios

The sample is all IPOs from 1980 to 2002. The universe is CRSP-listed New York Stock Exchange (NYSE), American Stock Exchange (Amex), and Nasdaq firms which are within the biotechnology industry portfolio, as defined by SIC codes 2830-2836 and 8730 and 8734. Portfolios of IPOs include all issues that were performed within the previous five years. $R_{m,t}$ is the return on the value–weighted index of NYSE, Amex, and Nasdaq stocks in month *t*; $R_{f,t}$ is the beginning-of-month one-month Treasury Bill rate in month *t*; SMB_t is the return on small firms minus the return on large firms in month *t*; and HML_t is the return on high book-to-market (value) stocks minus low book-to-market (growth) stocks in month t.

$$R_{p,t} - R_{f,t} = a + b[R_{m,t} - R_{f,t}] + sSMB_t + hHML_t + e_t$$

	Coefficient Estimates				
	a, Intercept	b, MKTRF	s, SMB	h, HML	R^2, adj
Panel A. Equally-Weighted Portfolio Returns					
(1) Issuers	0.01059	0.99610	1.61309	-0.41467	0.53531
	(3.07)	(11.31)	(14.68)	(-3.20)	
(2) Non-issuers, Benchmark	0.00914	0.88842	1.19632	-0.30430	0.71620
	(3.38)	(12.87)	(13.89)	(-3.00)	
(3) Excess Return	0.00145	0.10767	0.41678	-0.11037	0.14826
(1) - (2)	(0.56)	(1.62)	(5.02)	(-1.13)	
Panel B. Value-Weighted Portfolio Returns					
(4) Issuers	0.00632	0.97177	0.63499	-0.28745	0.53531
	(1.84)	(11.08)	(5.80)	(-2.23)	
(5) Non-issuers, Benchmark	0.00655	0.76200	-0.40392	-0.20772	0.53957
	(2.94)	(13.40)	(-5.69)	(-2.48)	
(6) Excess Return	-0.00023	0.20978	1.03891	-0.07973	0.39188
(4) - (5)	(-0.07)	(2.71)	(10.76)	(-0.70)	

Table V. Time-series Regressions of Equally Weighted and Value-Weighted Monthly Percentage Returns on the Fama French three-factors for Portfolios of Large and Small Firms.

The universe is CRSP-listed New York Stock Exchange (NYSE), American Stock Exchange (Amex), and Nasdaq firms which are within the biotechnology industry portfolio, as defined by SIC codes 2830-2836 and 8730 and 8734. Large firms are those whose market capitalization at the end of the month t is greater than the sample's median market cap at the end of the same time period. Likewise, small firms are those with market capitalizations smaller htan the sample's median market cap. $R_{m,t}$ is the return on the value–weighted index of NYSE, Amex, and Nasdaq stocks in month *t*; $R_{f,t}$ is the beginning-of-month one-month Treasury Bill rate in month *t*; SMB_t is the return on small firms minus the return on large firms in month *t*; and HML_t is the return on high book-to-market (value) stocks minus low book-to-market (growth) stocks in month t. The dependent variable in regressions (3), (6), (9), and (12) is the difference in returns between issuing and non-issuing portfolios. t-Statistics are in parentheses beneath each coefficient.

$$R_{p,t} - R_{f,t} = a + b[R_{m,t} - R_{f,t}] + sSMB_t + hHML_t + e_t$$

	Coefficient Estimates				
	a, Intercept	b, MKTRF	s, SMB	h, HML	R^2, adj
Panel A. Equally-Weighted Portfolio Returns					
(1) Large Issuers	0.02674	1.04603	1.56299	-0.57942	0.66492
	(6.49)	(10.08)	(11.91)	(-3.70)	
(2) Large Non-issuers	0.01887	0.92813	1.07544	-0.44743	0.68165
	(6.08)	(11.87)	(10.87)	(-3.79)	
(3) Excess Return	0.00787	0.11790	0.48755	-0.13199	0.17263
(1) - (2)	(2.74)	(1.63)	(5.33)	(-1.21)	
(4) Small Issuers	-0.00300	0.96546	1.59565	-0.23405	0.62588
	(-0.78)	(9.79)	(12.96)	(-1.61)	
(5) Small Non-issuers	-0.00473	0.81335	1.47027	-0.13792	0.55479
	(-1.22)	(8.21)	(11.88)	(-0.95)	
(6) Excess Return	0.00173	0.15211	0.12538	-0.09613	0.03231
(4) - (5)	(0.52)	(1.81)	(1.19)	(-0.78)	
Panel B. Value-Weighted Portfolio Returns					
(7) Large Issuers	0.00674	0.14613	-0.08076	-0.12519	0.00400
	(1.41)	(1.20)	(-0.53)	(-0.70)	
(8) Large Non-issuers	0.00680	0.76114	-0.41487	-0.20755	0.53835
	(3.02)	(13.23)	(-5.80)	(-2.46)	
(9) Excess Return	-0.00006	-0.61501	0.33411	0.08236	0.10368
(8) - (9)	(-0.01)	(-4.55)	(1.99)	(0.42)	
(10) Small Issuers	-0.02126	1.03784	1.56566	-0.14015	0.61938
	(-5.45)	(10.42)	(12.61)	(-0.96)	
(11) Small Non-issuers	-0.02236	0.84328	1.42073	-0.15509	0.56888
	(-5.92)	(8.75)	(11.81)	(-1.09)	
(12) Excess Return	0.00111	0.19456	0.14493	0.01494	0.02697
(11) - (12)	(0.37)	(2.31)	(1.37)	(0.17)	

Figure I. Individual IPO Firms' Buy-and-Hold Returns

This bar and line graph charts Table I data. All specifics and assumption denoted for Table I apply here. The left y-axis denotes the number of firms which fall within each percentage return value. The right y-axis provides the cumulative percentage of firms that have returns that fall below the particular percentage return. The x-axis presents the return on holding the particular individual IPO stock for five years or the last CRSP listing date.

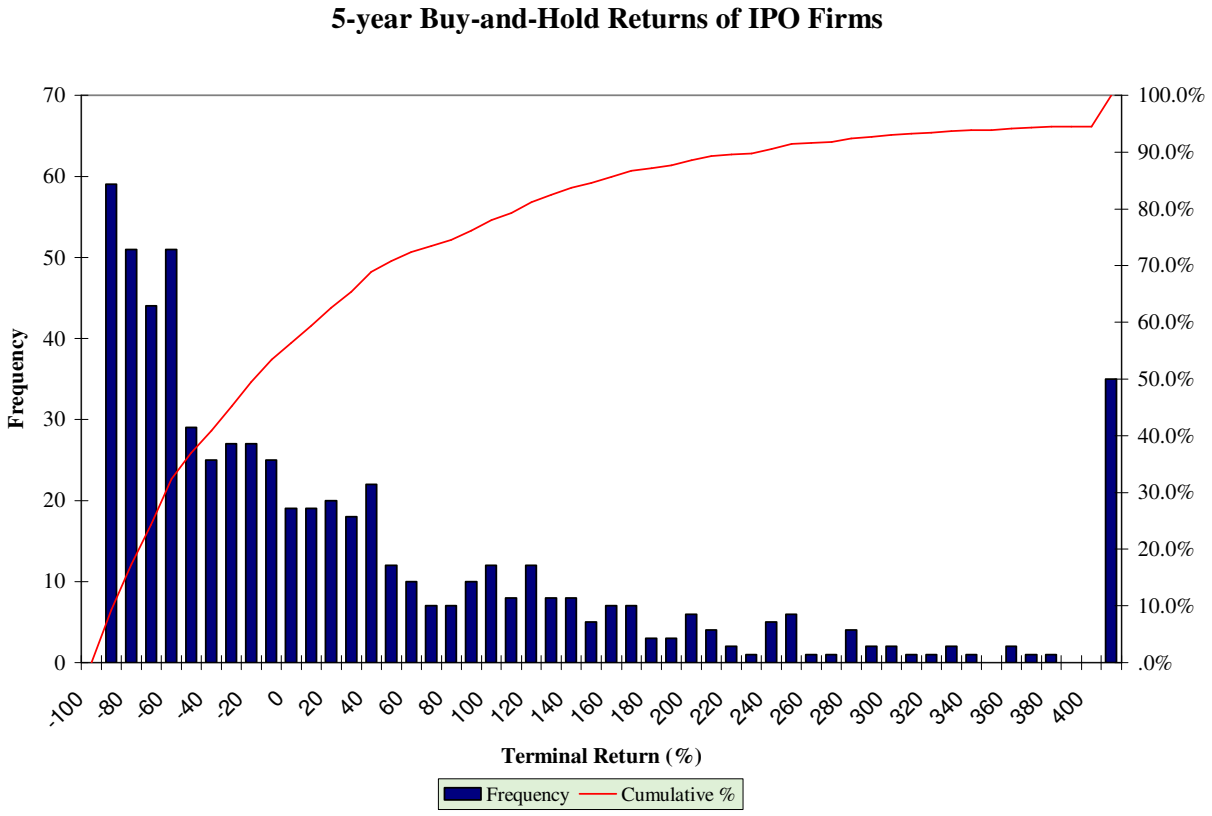
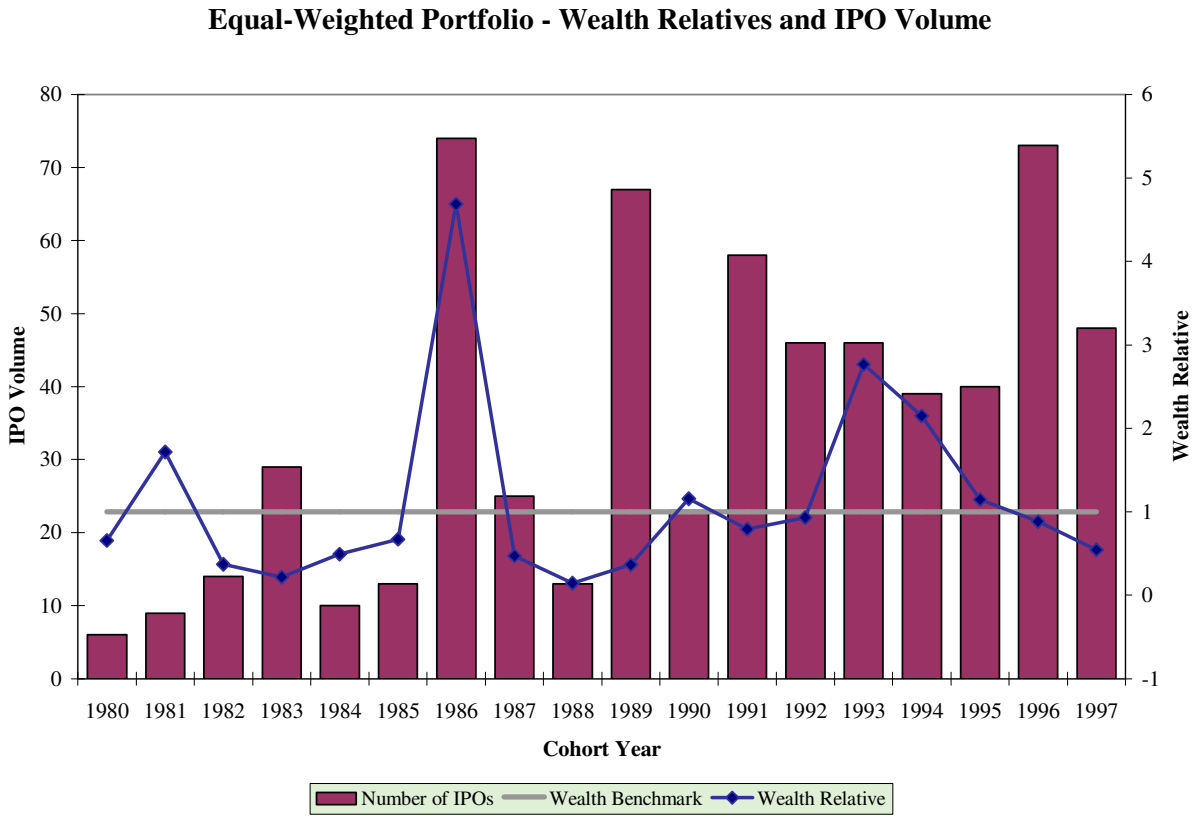


Figure II. IPO Long-Run Performance and Volume by Cohort Year.

This bar and line graph charts Table III's data. All specifics and assumption denoted for Table III apply here. The left y-axis denotes the volume of firms that performed an IPO during that cohort year. The right y-axis provides the wealth relative ratio between the cohort IPO portfolio and biotechnology industry portfolio. The x-axis supplies the cohort year of firms that performed an IPO between 1980 and 1997.



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