The Value of a Biotechnology Start-up:

Creative Destruction and Real Options Approach

Cecilia Maya Ochoa. PhD[1].
cmaya@eafit.edu.co

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Resumen

La valoración de la inversión en compañías nacientes de alto crecimiento no es tarea fácil, pues los ingresos esperados se generan en un futuro lejano y bajo gran incertidumbre. De acuerdo con métodos tradicionales de valoración como el Valor Presente Neto, el mercado parece sobrevalorar algunas de estas compañías. Ello se debe a que estos métodos tradicionales no tienen en cuenta tres elementos esenciales que determinan el valor en estos casos: el capital intelectual como el motor de la innovación, el poder de mercado por la expectativa de ingresos monopolísticos si se da la innovación y una opción real de crecimiento que puede ser ejercida en caso de éxito.

Este artículo aplica a una empresa de biotecnología el enfoque de opciones reales y destrucción creativa (Maya, 2004), el cual incluye estos tres determinantes del valor y logra explicar el alto precio que los inversionistas pagan por una acción de este tipo de empresas. Se demuestra que éste no es un caso de sobrevaloración sino de reconocimiento del alto potencial de crecimiento de empresas que se encuentran en sectores altamente innovativos.

Abstract

The value of investments in high growth start-up firms is difficult to assess because payments are far in the future and their arrival is uncertain. Some of these firms may seem overvalued according to traditional methods, such as the Net Present Value, which fails to account for three drivers of value for highly innovative industries: intellectual capital as the engine of innovation, market power as the expectation of monopolistic power when innovating, and a growth option which may be exercised in the case of success.

[1] Docente e investigadora del departamento de Finanzas, Escuela de Administración, Universidad EAFIT.

This paper presents a case study on a biotechnology start-up and applies the Creative Destruction – Real Options approach (CD-ROA) (Maya, 2004) which takes into account all three drivers of value and is able to explain the high prices investors pay for shares of a company in this industry. It proves that such prices are not cases of overpricing but of recognition of the large growth potential of firms which are part of highly innovative industries.

Palabras claves: Valoración, opciones reales, biotecnología, destrucción creativa, procesos estocásticos de salto.

Keywords: Valuation, Real Options, Biotechnology, Creative Destruction, Jump-only Stochastic Process.

"Deals have started trading on best-case scenarios".
Fitzsimmons (Prudential Securities) after Gilead Sciences Initial Public Offering in 1992[2].

More than ten years after the comment above and motivated by a rally on Biotechnology market prices, Morgan Stanley advised its clients to invest in "high-quality, later-stage biotech names with top and/or bottom line growth" (WSJ, 2003). In general, the valuation of these companies appears to be overpriced in terms of traditional methods such as discounted cash flows. They require large investments in R&D, depend on the success of clinical trials and on Food and Drug Administration (FDA) decisions, and only a few of them show profits. Additionally, when these companies become public, their products are in early stages of development. Consequently, there is much uncertainty regarding their value.

Although the Biotechnology industry is more than twenty five years old –not an infant industry anymore-, the prices of companies in this industry still present high volatility[3]. This is evidence that investors´ attitudes towards biotech firms have fluctuated over the years, and not necessarily depending on general market behavior.

The distribution of returns on the Initial Public Offerings (IPO)[4] of two hundred biotechnology firms covering the period 1980-2003 exhibits a median of 6.61%, a mean return of 15.85% and is highly skewed to the right. Figure 1 shows the histogram of these returns. This is a representative sample of the industry in terms of the period it covers and the number of firms included[5], meaning it comprises periods of time when the stock market was booming and in recession, and when the stock market for this particular industry was alternatively bearish and bullish. Furthermore, it is not just a case of success at the stage of their IPO since returns on the Nasdaq Biotechnology Index (NBI) from January, 1995 to August, 2006, were almost twice the returns of the S&P500 for the same period[6].

How could some apparently high valuations in the Biotech industry be explained? Generally, the valuation of investments in start-up firms

[2] Investment Dealer's Digest (1992).

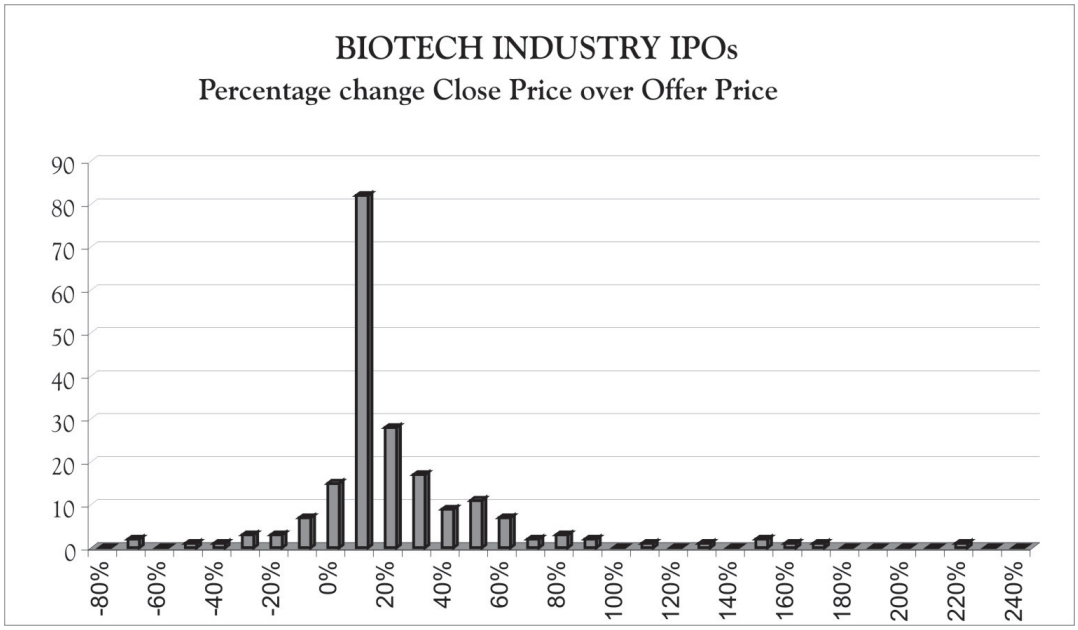
[3] Average annual volatility of returns on the Nasdaq Biotechnology Index (NBI) from January, 1995 to August, 2006 is 37.5%.

[4] These returns are computed as the percentage change in the closing price over the offer price of the IPO. The sources of information on the offering price are Lexis-Nexis News and http://www.BioSpace.com (June 4th, 2003) For the closing price the source is http://finance.yahoo.com (June 18, 2003).

[5] The biotechnology industry was born at the end of the seventies and this sample includes more than 41% of the public firms in the industry by June 30, 2003.

[6] Annualized average daily returns on the NBI for this period were approximately 24% versus 13% on the S&P500.

Figure 1



in high growth businesses is difficult to assess because payments are far in the future and their arrival is uncertain. Some of these firms may seem overvalued according to traditional methods such as the Net Present Value, which fails to account for three drivers of value for highly innovative industries: intellectual capital as the engine of innovation, market power as the expectation of monopolistic power when innovating, and a growth option which may be exercised in the case of success.

The Creative Destruction – Real Options approach (CD-ROA) (Maya, 2004) takes into account all three drivers of value and is able to explain the high prices investors pay for shares of one of these firms. It proves that these prices are not a case of overpricing but rather of recognition of the large growth potential of firms which are part of highly innovative industries. Clearly, the biotechnology industry is one of such industries. This paper performs a Case Study applying the CD-ROA to a real biotechnology firm, Gilead Sciences Inc. For this purpose, I will begin by discussing the characteristics of the industry, the technology, and the product, which allow me to use this approach on this particular case.

1. Biotechnology and antisense technology for drug discovery

The Biotechnology Industry Organization -henceforth BIO- defines biotechnology as "the use of the cellular and molecular processes to solve problems or make products. Included in this definition of the industry are the firms that use cells and biological molecules for applications in medicine, agriculture, and environmental management" (BIO, 2000).

This industry has become the focus of attention of politicians as well as investors because there are many expectations about its potential to improve the quality of life, increase agricultural productivity, and generate a safer environment. Also, from an economic point of view, it gets great attention due to its fast growth –the industry has more than quadrupled in revenues

and increased almost seven times in market capitalization since 1994[7].

The larger group of biotech firms is focused on therapies for human diseases. Particularly, the deciphering of the human genetic code has pushed fast development of genetic drugs. There are two main categories of therapies based on this kind of drug: gene therapy which involves inserting new genes into cells to produce therapeutic proteins in the body and nucleic acid-based therapy or code blocking which switches off genes so that they stop making harmful proteins.

There are three principal strategies in the development of products for nucleic acid-based therapeutics: Antisense, Triplex, and Ribozyme technologies. Appendix A, Exhibit A1 gives a description of each one, its major therapeutic targets, and the name of the companies competing in each technological race. Of these three technologies, this paper focuses on the oldest one, the antisense technology, and the competition that takes place among the antisense firms to develop new drugs against HIV/AIDS[8].

In 1980 AntiVirals Inc., now AVI BioPharma Inc., became the first antisense firm, but it was not until 1986, after Dr. Zamecnik published a paper showing that the antisense strand could interfere in the life cycle of the AIDS virus, when research on this technology really took off. Principally four companies started to compete on the development of antisense drugs against viruses, having HIV/AIDS as their natural target. Gilead Sciences Inc. in 1987, Isis Pharmaceuticals Inc. in 1989, and Hybridon Inc. in 1990, joined AVI BioPharma Inc. in a technological race to discover the first antisense compound to fight HIV/AIDS.

HIV/AIDS captured the attention of the antisense companies because at the end of the eighties it had become a major worldwide epidemic[9]. AIDS is caused by the human immunodeficiency virus (HIV). By killing or damaging cells of the body's immune system, HIV progressively destroys the body's ability to fight infections and certain cancers. Since the epidemic began, more than sixty million people have been infected by the virus. HIV/AIDS is now by far the leading cause of death in sub-Saharan Africa, and the fourth biggest global killer. In 2001, the epidemic claimed about three million lives[10].

With the aim of fighting HIV/AIDS, a group of scientists founded Gilead Sciences, Inc. in 1987. This company, located in Foster City, California, has focused its research on the development of antisense compounds against viruses, specifically HIV. Exhibit 2 shows the market price of its stock from the time of its inception up to its IPO. The last value of $214.5 million is calculated based on the offer price for the IPO. The actual price achieved by the company was $289.6 million, after a successful public offer which made an investment banker exclaim that "Deals have started trading on best-case scenarios". In what follows I apply the Creative Destruction-Real Options Approach (CD-ROA) (Maya, 2004) to explain why investors paid 35% more than the offer price for Gilead Sciences when it went public in January 22, 1992.

[7] http://www.bio.org/er/statistics.asp (August 31st, 2006).
[8] The antisense drug is a "synthetic strand of genetic material which replicates the second strand of the DNA double helix, called the antisense strand. It sticks to the mRNA like Velcro, and blocks the production of proteins. It is this process, much more precise and foolproof than the tentative way in which most current drugs cling to bad proteins, that hints at so much promise for these synthetic strands, which are known as antisense oligonucleotides, or oligos for short". "Antisense: A Drug Revolution in the Making", Business Week, March 5th, 1990.

[9] The first case of AIDS was reported in the U.S. in 1981.
[10] Report on the Global HIV/AIDS Epidemic 2002 http://www.unaids.org/epidemic_update/report_july02/english/contents.html (June 16, 2003)

2. The valuation of Gilead Sciences Inc. based on the CD-ROA

Valuing Gilead Sciences on the basis of its passive NPV is inadequate. Such valuation does not account for the fact that this company is subject to a creative destruction process and for the real options it available to it, specifically a growth option which can be exercised if it succeeds in innovating. An approach like the CD-ROA can estimate the value of this firm in a more accurately way as is discussed in what follows.

Gilead Sciences (henceforth Gilead) is subject to a creative destruction process described by Schumpeter (1942) since it is in a patent race against Isis Pharmaceuticals Inc. (Isis), AVI BioPharma Inc. (AVI BioPharma), and Hybridon Inc. (Hybridon) to develop the first antisense drug against HIV/AIDS, in a way that the first innovating firm becomes a monopolist in the market. Immediately after that, another patent race starts where the next innovating firm takes the previous monopolist's market power away. Permanently, some value is created but, at the same time, some is destroyed.

This patent race is "memoryless" as coined by Tirole (1988), meaning that all the firms in the market start from the same point. Past R&D experience or expenses do not affect the result, only the current R&D expense is a determinant of the probability of success in innovation. The CD-ROA assumes a single expected innovation, a drug against HIV/AIDS in this case, produced by means of a single R&D technology, the antisense technology, by a profit maximizing firm. The cost function is assumed to be the same for all the firms involved in the patent race.

Another assumption of the CD-ROA is that innovation is always "drastic" in the sense that the product developed by the expected monopolist guarantees absolute market power to the innovating firm. The discovery of an antisense drug for HIV/AIDS would be considered a drastic innovation since this technology is much more precise than most current drugs in the way they cling to bad proteins. As a result, it would not produce the unwanted side effects characteristic of current drugs.

In addition to the expectation of an exclusive market power that emerges in a creative destruction process, the CD-ROA accounts for another factor, a growth option, which also adds value to the firm. This option may be exercised in the case of innovation if the change in the firm's value is larger than the additional investments required for these purpose. The underlying asset to this option - S - is the current value of Gilead's research project without flexibility. This value follows a jump-only stochastic process since market risk is ruled out by the expectation of an exclusive market power, thus the only uncertainty this firm faces is the technological risk of innovating first or being defeated in the race.

Due to this technological risk, the underlying asset is subject to two independent sources of jumps. One occurs when the expected monopolist introduces a "drastic innovation" causing a proportional change in the asset's value equal to $\zeta = (J - 1)S$, meaning that when S jumps, its value changes to SJ. The other jump occurs when the challenger firm wins the race by innovating first or produces a "drastic innovation" which puts an end to the previous firm's monopolistic power. In this last case, the underlying asset's value will jump to a scrap value, SY, since once the firm is forced out of the market, the only alternative is selling its assets for their scrap value. Hence, the proportional change in the asset's value is $\gamma = S\ (Y\text{-}1)$. Immediately after that, it may participate in a new technological race which starts immediately after the challenger firm innovates.

Based on the above, S follows a jump-only stochastic process:

$$dS = (J - 1)S\, dq + (Y - 1)S\, d\pi \quad (1)$$

therefore,

$$d \ln S = (\ln J)\, dq + (\ln Y)\, d\pi \quad (2)$$

where

J : jump size in the case of innovation by the expected monopolist; $\ln J \sim \phi(\mu, \sigma)$;

Y : constant percentage of scrap value when the challenger innovates;

dq: a Poisson process, which is equal to one with probability λm and zero with probability $(1 - \lambda m)$. λm is the intensity of the Poisson process (expected number of drastic innovations); λmdt is the probability of innovation by the expected monopolist per unit time.

$d\pi$: another Poisson process which is equal to one with probability λc and zero with probability $(1 - \lambda c)$. λcdt is the probability, per unit time, of the challenger firm innovating.

Both, λm and λc, depend on the corresponding firm's level of investment in R&D -as a proportion of the total amount of investment required to producing and marketing the product- in the following way:

$$\lambda_i = \lambda(R\&D_i) = (R\&D_i)^{b_i} \quad b_i < 1 \text{ and constant}$$

meaning that the expected number of "drastic innovations" each firm can introduce in the market is a concave function of R&D, therefore, the probability of innovation increases by less as larger R&D investments are put in place. Firm i expends $R\&D_i\, dt$ between time t and t + dt. b_i is a parameter that measures the efficiency of such investment.

If the value of S after innovating is greater than the value of the investment required to produce and market the product, the firm will exercise its growth option, G. By doing so, it exploits the exclusive market power guaranteed by its monopolistic position. The amount of investment necessary to exercise the option is the exercise price, X. The value of G at t = 0 is equal to the present value of its expected payoff:

$$G_0 = e^{-rt} E_0 [\text{Max}(S_t (\lambda_m, \lambda_c) - X, 0] \quad (3)$$

In a creative destruction process, the jump risk is non-systematic since it depends only on the technological uncertainty that surrounds the project and it affects the firms subject to this process exclusively. Being that the case, this risk may be diversified away (and therefore should not be priced by the market) by means of conforming a well-diversified portfolio which includes this project along with other assets (Ross, 1976). On the other hand, there is no market risk either since the firm has absolute market power, as explained above. In consequence, the appropriate discount rate for the option's expected payoffs is the risk-free rate, r.

If there is no innovation, the innovation is not drastic, or another firm wins the technological race, this firm may abandon the project and move on to a new project, a new patent race. The value of the firm, V, will be the sum of the project's value without flexibility represented by S(t=0) plus the value of the growth option G(t=0):

$$V(t=0) = S(t=0) + G(t=0) \quad (4)$$

Assessing CD-ROA Parameter Values for the Case of Gilead Sciences:

For S, the underlying asset price, I take the offer price for Gilead's IPO since it is set by an investment banker based on the valuation performed on the firm, which I assume was done, at that time, using traditional valuation

methods which do not account for flexibility. The offer price was $15, thus the value of the company at that price, including the new shares issued in the IPO, was $214.500.000[11]. However, the offer price usually includes a discount to attract investors which is typically 10%[12], thus the value of Gilead would have been $235.95 million.

X, the exercise price for the growth option, is the amount of additional investment in plant, equipment, and working capital necessary to produce the new drug. There is no information about an estimation of this amount for the industry. I found some evidence, however, from the same firm under study and from Agouron Pharmaceuticals, another biotechnology firm which was studied by Kellogg, Charnes, Demirer (2002).

In the case of Gilead Sciences, the production of Viread, its successful drug against HIV/AIDS, required an additional investment of 27% of the increase in revenues from 2001-2002 (See Appendix A, Exhibit A3.2: Gilead Sciences Balance Sheet and Exhibit A4.2: Consolidated Statement of Operations data). A similar percentage, 22%, was required by Agouron Pharmaceuticals when it started producing Viracept, the previously successful drug for HIV/AIDS. In the period 1997-1998, Agouron's total revenue increased by $335 million requiring $74 million in additional investment. (See Appendix A, Exhibits A5.1 and A5.2 for Agouron Balance Sheet and Consolidated Statement of Operations data). Based on the this evidence, an estimate for X of 25% of the expected additional revenues will be used in this case. Kellogg, Charnes, Demirer (2002) cites data from Myers and Howe (1997) on expected revenues from new drugs as shown in the next table:

Table 1
Expected Revenues from New Drugs

	Peak Annual Revenue	Probability
BREAKTHROUGH	1,323,920	10%
ABOVE AVGE	661,960	10%
AVGE	66,200	60%
BELOW AVGE	7,440	10%
DOG	6,620	10%
E [REVENUE]	239,714	

Myers and Howe (1997)

A drastic innovation corresponds to a breakthrough drug. Exhibit A6 shows the expected revenue generated by the sales of a breakthrough, and the additional investment required to produce it calculated as 25% of this revenue. The exercise price of the growth option is the present value of this investment: $189.52 million.

In the CD-ROA, mainly two factors determine success in this technological race: the amount of R&D each firm is willing to invest and the efficiency of such an investment. Average industry values for these parameters are provided by Kellogg, Charnes, Demirer (2002)[13] where it is shown that, for the discovery phase, the average investment is $2.2 million, therefore, the average ratio of R&D / X equals .0116. Also, a value of b = ½ was suggested by Darby, Liu, Zucker, (1999), therefore the probability of discovery is $\lambda=(R\&D/X)^{½}$ = .1077 per year, meaning that the average time to discover a drug is around ten years[14].

[11] Appendix A, Exhibit A2 shows the number of shares issued by Gilead Sciences and the firm's value from its inception up to its IPO.
[12] Ivo Welch, a Finance Professor who has studied IPOs extensively, notes that the typical underpricing -the return from the offer price to the price when the market starts trading - is about 10%. http://www.iporesources.org/lebaron.html (Sept. 4th, 2003).

[13] They make assumptions based on previous work by Myers and Howe (1997), Office of Technology Assessment (1993), DiMasi et al. (1991), and Grabowski and Vernon (1994).
[14] Evidence showing that this is the average time required to discover a new drug is cited by Cochrane (2001), Schwartz (2002), and Kellogg, Charnes, Demirer (2002).

In order to compute the amount of R&D as a proportion of X for the firms participating in this race, I use the actual firm's expenses on R&D in 1992[15]. Table 2 shows the R&D / X ratio for each firm[16]. See Appendix A, Exhibits A7, A8.1, and A9 for the Consolidated Statement of Operations Data of Isis Pharmaceuticals Inc., Hybridon Inc., and AVI BioPharma Inc., respectively.

Table 2
R&D Expenses

FIRM	R&D (R&D expenses / X)
Gilead Sciences Inc.	0.0720
Isis Pharmaceuticals Inc.	0.1261
Hybridon Inc.	0.0467
AVI BioPharma Inc.	0.0039
Total Challengers	0.1767

Clearly, the greater the amount of investment the expected monopolist is willing to make, relative to its challengers, the higher its probability of becoming the next monopolist. In this case, Gilead is investing more than Hybridon and AVI BioPharma combined, but less than Isis, giving this last firm an advantage in this race.

The other determinant of which firm will win a technological race is the efficiency of its investment in research. Measuring efficiency is a difficult task in general, but even more for start-up firms which usually are on early stages of development of their products. They do not show profits, revenues are very low, and sometimes they do not even have any patents, as it is the case under analysis. However, two different ways to assess efficiency will be proposed next, keeping in mind that the subject calls for additional research.

The first methodology accounts for the number of patent applications filed up to the time of the IPO. It would be preferable to consider the patents approved since there is no guarantee that an application would become a patent. However, none of these firms had any patents approved at the time of this analysis. Before January 1992, Gilead and Isis had filed for ten applications each, Hybridon just for one, and AVI BioPharma had zero applications[17]. In the standard case, a $b = ½$ represents the average efficiency.[18] On the other hand, there are reasons to argue that the real competitors in this race were Gilead and Isis only. AVI BioPharma investments in R&D were very low until 1997[19] and Hybridon was recently founded in 1990. By January, 1992, only Gilead and Isis had expectations of filing an Investigational New Drug (IND) application[20]. According to this argument, and based on the number of patent applications filed by each company, both are equally efficient and $b = ½$ for both.

Another approach to measure the efficiency of R&D is computing the ratio of revenue to R&D expenses as it is shown in the next table[21]:

[15] The information the potential investor requires is the expected expenses on R&D next period by both the expected monopolist and its challenger. I use the actual value as a proxy for this value.
[16] There is no public information for Gilead Sciences in 1992. R&D expenses on that year were calculated based on 1993 data and adjusted to grow at the same average growth that this account showed in the following three years: 33.11%.

[17] U.S. Patent and Trademark Office (PTO). http://www.uspto.gov. (June 27, 2003).
[18] The standard case is when these firms invest the average amount of $2.2 million in R&D in the discovery phase.
[19] See Exhibit 9.
[20] Isis filed the first IND application for an antisense drug – ISIS2105- in January 30, 1992. (PR Newswire, January 30, 1992). Gilead filed for GS504 in March, 1992 (Business Wire, March 19, 1992) and for GS393 in September, same year (Business Wire, September 23rd, 1992).
[21] This ratio is the Average revenue / Average R&D for the period 1993-1996 when public information is available for Gilead, Isis, and Hybridon. For AVI BioPharma, the ratio is computed as the average for the period 1995-1996 since public information is available only after 1995.

Table 3
Revenue to R&D Expenses Ratio

FIRM	Gilead	Isis	Hybridon	AVI Bio Pharma
Revenue/R&D	0.40	0.54	0.07	0.03

Efficiency in terms of this ratio gives another argument to support that although apparently there were four firms competing in this race, the real competition was between Gilead and Isis since the ratio for Hybridon and AVI BioPharma is close to zero. Based on the ratio shown above for Gilead and Isis, it is clear that Isis' research was more efficient. If a Revenue / R&D ratio of ½ is taken as the average[22], Gilead will be 20% less efficient and Isis 8% more efficient than the average case, therefore b (Gilead) = 0.55 with λm = 0.086 and b (Isis) = 0.482 with λc = 0.116.

As for the other determinants of value, the drift rate for S is r, the risk-free rate. The interest rate on the 10-year Federal bond was 7.03% in January, 1992. This approach also requires data on the distribution of the size of the jump, J, where ln J $\sim$ ϕ (μ, σ). As a proxy for μ and σ I take the mean and standard deviation of the NBI in a period of ten years starting in November 1st, 1993, when μ = 12.77% and σ = 35.74%.

Finally, for the scrap value, I assume 80%, meaning that when another company preempts the monopolist, this last one may still get some value by selling its assets and recovering at least 80% of their value at that time[23].

[22] This ratio was 0.51 for Isis Pharmaceuticals in the period 1990-1992 (Exhibit 7) and 0.49 for Agouron Pharmaceuticals in the same period (Exhibit 5B). There is no information for Gilead in this period.

[23] In this case, the assets are mainly equipment with the newest technology, therefore, an assumption of an 80% scrap value would be appropriate.

3. Simulation and results

In order to value Gilead, I use the Monte Carlo method. According to (2), the stochastic process ln S follows is:

$$d\ln S = (\ln J)dq + (\ln Y)d\pi \quad (5)$$

This process can be approximated by:

$$d\ln S = \ln\frac{S_t}{S_{t-1}} = (\ln J)dq + (\ln Y)d\pi \quad (6)$$

Using Monte Carlo, n paths of asset prices are simulated as follows:

$$S_t = S_{t-1} * e^{[(\mu-\frac{\sigma^2}{2})+\sigma Z]*Dummym} * e^{[\ln Y]*Dummyc} \quad (7)$$

where Z is a normal random variable. Dummym is one when there is a jump J and zero otherwise. The probability of a jump J in a period of time dt is λm dt. Then, Dummym will be one when the value of a simulated uniformly distributed random number is less than or equal to λm dt and zero otherwise. μ and σ are the mean and standard deviation of this jump J, a process that is assumed to follow a lognormal distribution. On the other hand, the probability of a jump Y is λc dt. Dummyc is one when there is a jump Y and zero, otherwise, and it may be simulated in a similar way to Dummym. Y is assumed constant.

The n paths of S are simulated up to a time period T which covers the average time for a "drastic innovation" to take place in the industry. Whenever a Dummym equals one is found on each path, the asset price jumps. At that time, t, the firm decides to exercise the option depending on the size of the jump and the corresponding value reached by S(t). If this value is greater than the value of the exercise price (X) as defined above, the firm exercises

the option, and the option payoff is discounted at the risk-free interest rate. If the challenger innovates first or none of them innovate, the payoff from the option on that path is zero. The expected value of the growth option, G, will be the average of the present value of all these payoffs. The final value of the firm will be the sum of the project's value without flexibility – S (t=0) – plus the value of the growth option G (t=0).

Two different cases are analyzed in order to value Gilead. Exhibit 10 shows the parameter values used to simulate each case. If the race is defined between Gilead and Isis only, they are equally efficient in terms of the number of patent applications, but Isis is investing more in research. In this case, the value of Gilead should have been around $286.26 millions. The other case measures R&D efficiency on the basis of the ratio of Revenue / R&D. Isis is more efficient and it also invests more than Gilead, resulting in a much lower value for Gilead of $289.58 millions.

Gilead's investors actually paid $20.25 for its shares in its IPO, which is 35% higher than the offer price and translates into a market value of $289.6 millions, close to the previous two estimations[24]. Both methodologies used to measure efficiency give approximately the same estimation; however, this subject requires further research.

Based on the findings presented above, I conclude that the CD-ROA is able to explain the apparently high price paid by investors at this IPO which made an investment banker exclaim that "deals have started trading on best-case scenarios". This approach shows that the success of Gilead's IPO is not due to overpricing but recognition of the value added by two facts not being considered by the traditional valuation method, the passive NPV approach. Those facts are, on one hand, that this firm is under a creative destruction process, which gives it an expectation of becoming the next monopolist, and, on the other hand, it has a growth option which gives it flexibility to make additional investments only in the case of success.

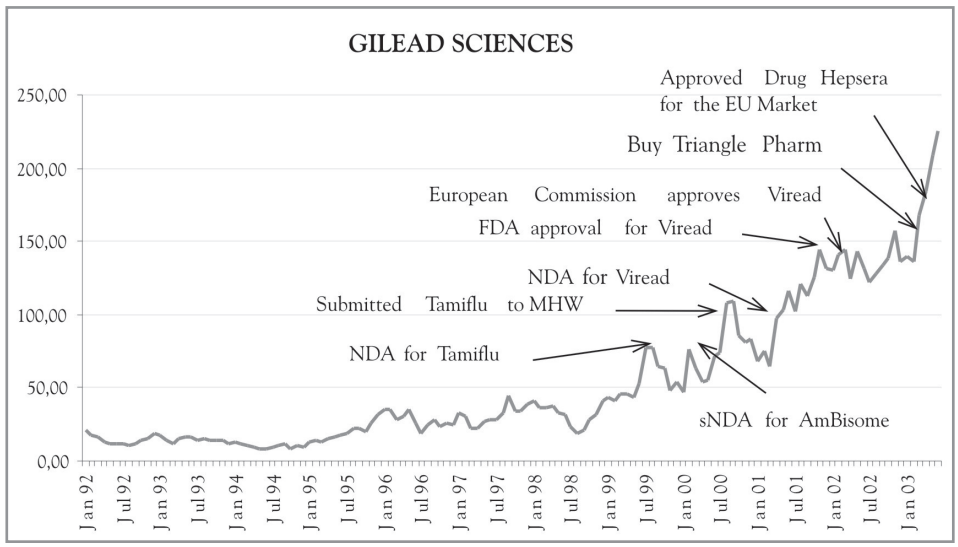
This approach also accounts properly for the probability of preemption by any competitor, in addition to other determinants of the value such as the characteristics of the industry which gives the distribution of the jump size, and the scrap value in case of preemption. Hence, all cases, not only best-case scenarios, are considered to estimate the value of this firm.

Furthermore, history will prove Gilead's investors were right. In April, 2001, this firm applied for an FDA approval for its antisense drug Viread, after successful clinical trials proving that it is effective against HIV/AIDS. The approval came in December that year. Later, in 2002, the EU approved its sale in Europe as well. Annual revenues from this drug are estimated around $500 millions for 2003. Gilead's stock price has soared since its IPO from $20.25 to $225.56[25] in 2003, as can be seen in the following Figure.

[24] These estimations have a 95% confidence level. The estimation errors are reported in Appendix A Exhibit 10.

[25] This price was adjusted for splits. One share of Gilead in 1992 is equivalent to four shares in 2003.

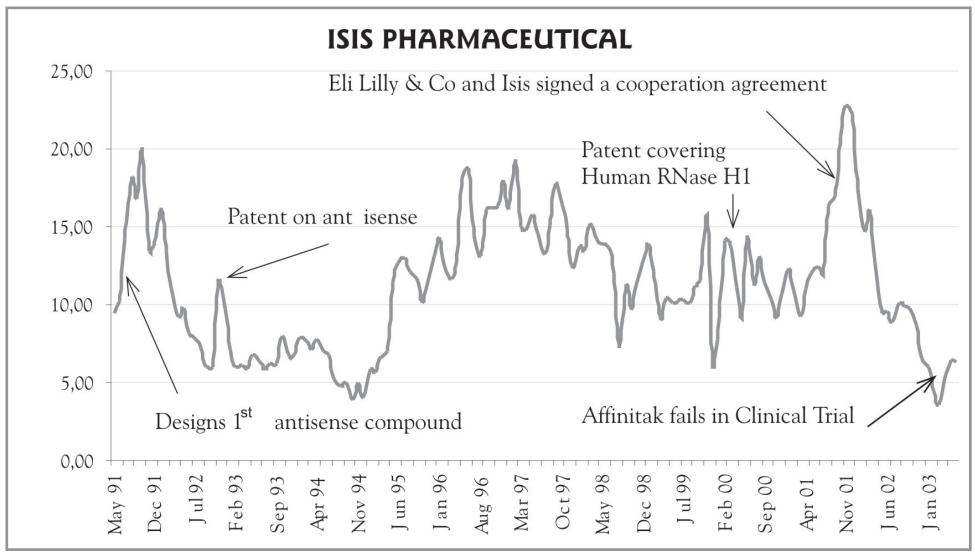
Figure 2
Gilead Sciences Share Price



NDA: New Drug Application sNDA: Supplemental New Drug Application
MHW: Japanese Ministry for Health and Welfare

As for the defeated companies, they had the choice to participate in a new technological race to discover another "drastic innovation" or leave the market. In the case of Gilead's challenger, Isis, considered the "Microsoft of biotechnology" in the nineties, it has concentrated all its efforts in a drug to fight cancer called Affinitak; however, news announcing that clinical trials have failed made the stock price fall in 2003. Some other relevant news and its effect on the Isis' stock price are shown in Figure 3:

Figure 3
Isis Pharmaceuticals Stock Price



The other two firms which started in the same race, AVI BioPharma and Hybridon, only managed to become public by 1997 and 1998, respectively. Although AVI BioPharma, founded as AntiVirals Inc, was the oldest of all antisense firms, after more than twenty years, its research has produced poor results with only four patents by 2003, compared to 554 of Isis and 106 of Gilead. In 1997, its founder, Dr. Summerton, was forced to resign as CEO and a new management came in, licensed new technologies, and now it has completed Phase II for Resten-NG, an antisense drug against Restenosis[26] as well as for Avicine, a therapeutic cancer vaccine[27].

The fourth firm, Hybridon, is using another three technologies additional to antisense: Synthetic DNA, Cyclicon, and Immunomodulatory Oligonucleotide compounds. Their recent results are based on this last technology and are mainly focused on cancer. In conclusion, as it is predicted by the CD-ROA, all three of Gilead's challengers have decided to move on to new technological races, either by using new technologies different from antisense or by aiming to discover different kinds of drugs, - mainly drugs to fight cancer.

Conclusions

In general, the value of biotech companies appears to be overpriced only in terms of traditional valuation methods such as the passive NPV approach which fails to account for drivers of value in highly innovative industries such as a growth option these companies may exercise in case of success innovating and the expectation of monopolistic market power if the innovation is drastic in the way described by the Creative Destruction - Real Options Approach.

In this paper I apply the CD-ROA to the valuation of Gilead Sciences Inc., considering two different cases depending on the way efficiency of its research is measured. Results show that the value of Gilead should have been between $286-289 millions. Gilead's investors paid 35% more than the offer price, a market value of $289.6 millions, close to the previous two estimations[28]. Both methodologies used to measure efficiency give approximately the same estimation; however, this subject requires further research.

Based on the findings presented above, I conclude that the CD-ROA is able to explain the apparently high price paid by investors at this IPO which made an investment banker exclaim that "deals have started trading on best-case scenarios". This approach shows that the success of Gilead's IPO is not due to overpricing but to recognition of the value added by two facts not being considered by the traditional valuation method, the passive NPV approach. Those facts are, on one hand, that this firm is under a creative destruction process, which gives it an expectation of becoming the next monopolist, and, on the other hand, it has a growth option which gives it flexibility to make additional investments only in case of success.

This approach also accounts properly for the probability of preemption by any competitor, in addition to other determinants of the value such as the characteristics of the industry which gives the distribution of the jump size, and the scrap value in case of preemption. Hence, all cases, not only best-case scenarios, are considered to estimate the value of this firm.

[26] Restenosis occurs when the arteries opened up by angioplasty become blocked again. Like cancer, restenosis involves abnormal cell division (The Register Guard, 2001).

[27] AVI BioPharma, 10k Report, 2002.

[28] These estimations have a 95% confidence level. The estimation errors are reported in Appendix A Exhibit 10.

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EXHIBIT 1
Strategies for the development of drugs for nucleic acid-based therapeutics

Technology	Description	Therapeutical Target	Firms
Antisense	Antisense compounds are oligonucleotides. That is, they are short strings (oligomers) of the nucleotides that constitute either DNA or RNA. Their therapeutic potential arises from the fact that these antisense oligonucleotides contain nucleotide sequences that are complementary to specific mRNA sequences, and can block the translation of the mRNA to protein.	Viral infections Inflammatory diseases Cancer therapy	Isis Pharmaceuticals Lynx Therapeutics Gilead Sciences Anti Virals, Inc Hybridon, Inc Enzo Biochem Hoffman-LaRoche Amgen Genta Incorporated
Triplex	The potential for Triplex Technology was first realized at about the same time that Watson and Crick discovered the double helix of DNA, back in the 1950s. Like antisense, triplex technology ultimately prevents the expression of an gene to its protein. But whereas antisense blocks the translation of protein from RNA, triplex technology inserts a third strand of DNA into the target gene to prevent the initial formation of the mRNA , the process known as transcription.	Cancer Viral infections Inflammatory diseases - rheumatoid arthritis	Triplex Pharmaceuticals MicroProbe Corporation
Ribozyme	Ribozymes are unique compounds that are molecules of RNA having enzymatic properties. These catalytic molecules will bind to specific sequences on mRNA and cleave it so that it is no longer functional.	Cancer Chronic viral infections Inflammatory processes autoimmune diseases Rheumatoid arthritis Organ transplant rejection	Ribozyme Pharmaceuticals Immusol, Inc Johnson & Johnson

"Antisense: A Drug Revolution in the Making", Business Week, March 5th, 1990.

EXHIBIT 2
GILEAD SCIENCES Inc.

Date	Amount raised	Value of Gilead at that time	Investors	Shares sold (millions)	Share value
Jun-87	$ 6.100	-	Founders		
Ago-87	$200.000	$ 810.000	Menlo Ventures	0.7	0.300
Ago-88	$600.000	$3.030.000	Menlo Ventures	0.7	0.900
Dic-87	$1.200.000	$10.260.000	Menlo Ventures	0.4	2.700
Oct-88	$10.000.000	$24.250.000	JH Whitney	2.7	3.750
Ago-90	$ 8.010.000	$66.600.000	Glaxo Holdings	0.9	9.000
Sep-91	$20.150.000	$ 97.700.000	JH Whitney	1.9	10.500
Ene-92	$75.000.000	$214.500.000	Public offering	5.0	15.000

Source: Recombinant Capital Inc.
Biotech IPOs Ignite Buying Frenzy
Two Bay Area firms see their stocks soar The San Francisco Chronicle
January 23, 1992

EXHIBIT 3.1

GILEAD SCIENCES INC 1
(Before business combination with NeXstar Pharmaceuticals)
BALANCE SHEET
(Dollars in thousands)

BALANCE SHEET	1993	1994	1995	1996	1997	1998
ASSETS						
Current assets:						
Cash and cash equivalents			27.420	131.984	31.990	32.475
Short-term	139.353	114.968	128.239	163.979	290.308	247.464
marketable securities						
Accounts receivable						
Inventories						
Other current assets			1.558	4.290	17.960	8.371
Prepaid expenses and other						
Total current assets			157.217	300.253	340.258	288.310
Property and equipment, net			8.369	9.172	10.313	10.182
Other noncurrent assets			1.073	1.248	1.498	4.368
Total	146.809	126.602	166.659	310.673	352.069	302.860
LIABILITIES AND						
STOCKHOLDERS' EQUITY						
Current liabilities:						
Accounts payable			2.412	2.501	3.303	3.422
Accrued liabilities			6.152	9.440	18.694	24.283
Deferred revenue			208	527	9.541	3.275
Current portion of capital						
Long-term obligations due within one year			2.906	3.631	1.853	770
Total current liabilities			11.678	16.099	33.391	31.750
Long term liabilities:						
Long-term deferred revenue						
Long-term obligations due after one year	1.156	2.479	3.482	2.914	1.331	563
Accrued rent						
Convertible senior debt						
Convertible subordinated debt						
Total long term liabilities			3.482	2.914	1.331	563
Stockholders' equity:						
Preferred stock, par value per share					1	1
Common stock, par value per share			24	29	30	31
Additional paid-in capital			265.460	426.577	479.737	489.183
Accumulated other comprehensive income(loss)			167	89	344	43
Accumulated deficit	-28.353	-54.065	-112.754	-134.486	-162.479	-218.554
Deferred compensation			-1.398	-549	-286	-157
Total stockholders' equity	139.402	115.280	151.499	291.660	317.347	270.547
Total			166.659	310.673	352.069	302.860

EXHIBIT 3.1

Notes

*In 1995 fiscal year changes from March 31st to December 31st. In Years 1993-1996 fiscal year ended in March 31st.

On July 29, 1999, The company entered into a business combination with NeXstar

Pharmaceuticals, Inc. ("NeXstar"). The business combination has been accounted for as a pooling of interests and our historical consolidated financial statements for all years prior to the business combination have been restated in the accompanying consolidated financial statements to include the financial position, results of operations and cash flows of NeXstar.

Pooling of interests method is used in limited situations in which shares of stock in the two companies are exchanged.

EXHIBIT 3.2

GILEAD SCIENCES INC 2
(After business combination with NeXtar Pharmaceuticals)
BALANCE SHEET
(Dollars in thousands)

BALANCE SHEET	1995	1996	1997	1998	1999	2000	2001	2002
ASSETS								
Current assets:								
Cash and cash equivalents				101.136	47.011	197.292	123.490	616.931
Short-term								
Marketable securities				247.607	247.383	315.586	459.361	325.443
Accounts receivable							74.228	125.036
Inventories				16.550	20.959	20.562	39.280	51.628
Other current assets				43.090	45.599	48.814		50.000
Prepaid expenses and other				8.506	11.029	11.544	11.400	14.722
Total current assets				416.889	371.981	593.798	707.759	1.183.760
Property and equipment, net				**51.019**	**51.398**	**55.174**	**62.828**	**67.727**
Other noncurrent assets				19.856	13.429	29.127	24.199	36.696
Total	275.376	450.540	516.989	487.764	436.808	678.099	794.786	1.288.183
LIABILITIES AND STOCKHOLDERS' EQUITY								
Current liabilities:								
Accounts payable				7.662	9.481	11.605	19.174	24.406
Accrued liabilities				41.555	30.372	39.244	55.455	72.600
Deferred revenue				3.275	4.833	4.355	3.996	7.692
Current portion of capital								
Long-term obligations due w/in one yr				4.842	3.191	3.034	1.492	194
Total current liabilities				57.334	47.877	58.238	80.117	104.892
Long term liabilities:								
Long-term deferred revenue						10.730	7.252	16.677
Long-term obligations due after one year	13.330	18.120	9.658	8.883	5.253	2.238	389	273
Accrued rent				7.848	6.853	5.769	4.591	
Convertible senior debt								345.000
Convertible subordinated debt				80.000	79.533	250.000	250.000	250.000
Total long term liabilities				96.731	91.639	268.737	262.232	611.950
Stockholders' equity:								
Preferred stock, par value per share				1				
Common stock, par value per share				42	44	189	193	198
Additional paid-in capital				716.964	749.081	857.847	898.533	950.308
Accumulated other comprehensive income(loss)				-337	-2.527	-901	7.448	2.475
Accumulated deficit				-382.746	-449.232	-506.008	-453.737	-381.640
Deferred compensation - (3)				-225	-74	-3		
Total stockholders' equity	228.931	374.649	357.726	333.699	297.292	351.124	452.437	571.341
Total				**487.764**	**436.808**	**678.099**	**794.786**	**1.288.183**

EXHIBIT 3.2

Notes

*In 1995 fiscal year changes from March 31st to December 31st. In Years 1993-1996 fiscal year ended in March 31st.

On July 29, 1999, The company entered into a business combination with NeXstar Pharmaceuticals, Inc. ("NeXstar"). The business combination has been accounted for as a pooling of interests and our historical consolidated financial statements for all years prior to the business combination have been restated in the accompanying consolidated financial statements to include the financial position, results of operations and cash flows of NeXstar.

Pooling of interests method is used in limited situations in which shares of stock in the two companies are exchanged.

EXHIBIT 4.1

GILEAD SCIENCES INC 1
(Before business combination with NeXstar Pharmaceuticals)
CONSOLIDATED STATEMENT OF OPERATIONS DATA
(in thousands, except per share data)

	1993	1994	1995	1996	1997	1998
Revenues:						
Product sales, net	0	0	0	8477	11735	6074
Contract revenues and royalties	4177	4085	4922	24943	28302	26496
Total revenues	4177	4085	4922	33420	40037	32570
Costs and expenses:						
Cost of product sales	0	0	0	910	1167	594
Research and development	17987	26046	30360	41881	59162	75298
Selling, general and administrative	4377	7639	9669	26692	25472	31003
Total operating costs and expenses	22364	33685	40029	69483	85801	106895
Income (Loss) from operations	(18187)	(29600)	(35107)	(36063)	(457640	(74325)
Interest income, net	4105	3888	3833	15042	18260	18442
Net income (loss)	(14082)	(25712)	(31274)	(21732)	(27993)	(56075)
Basic and diluted Income (loss) per share	(0,88)	(1,37)	(1,65)	(0,78)	(0,95)	(1,85)
Common shares used in the calculation of basic and	16065	18779	18971	27786	29326	30363

EXHIBIT 4.2

GILEAD SCIENCES INC 2

(After business combination with NeXtar Pharmaceuticals)

CONSOLIDATED STATEMENT OF OPERATIONS DATA

(In thousands, except per share data)

	1997	1998	1999	2000	2001	2002
Revenues:						
Product sales, net	100887	114176	139890	149709	190970	423879
Contract revenues and royalties	31371	36943	29089	45846	42799	42911
Total revenues	**132258**	**151119**	**168979**	**195555**	**233769**	**466790**
Costs and expenses:						
Cost of product sales	21646	23357	29546	33512	43764	69724
Research and development	**112177**	**127773**	**112888**	**132339**	**185553**	**134758**
Selling, general and administrative	70626	78234	78347	82022	125141	181301
Total operating costs and expenses	**220480**	**230631**	**239838**	**247873**	**354458**	**385783**
Income (Loss) from operations	(88222)	(79512)	(70859)	(52318)	(120689)	81007
Interest income, net	20706	21765	16435	17634	25591	22291
Net income (loss)	**(72893)**	**(44758)**	**(66486)**	**(56776)**	**52271**	**72097**
Basic and diluted Income (loss) per share	(1,85)	(1,09)	(1,55)	(0,31)	0,28	0,37
Common shares used in the calculation of basic and	39432	41015	42826	182099	190245	195543

EXHIBIT 5.1

AGOURON PHARMACEUTICALS, INC.

BALANCE SHEET (000s)	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
ASSETS													
Current assets:													
Cash and cash equivalents				7984	8135	11460	5966	7783	2104	4358	16451	52484	19098
Short-term					9089	1,001	33795	29617	27757	15886	74424	38833	68025
Accounts receivable				471	366	161	228	342	328	344	2966	31975	51341
Inventories												58800	103706
Other current assets				74	146	229	184	242	891	871	1800	2209	5247
Total current assets				8529	17736	12851	40173	35284	31080	21459	95641	184201	247981
Property and equipment, net				**2749**	**3128**	**2821**	**5452**	**6437**	**6098**	**5638**	**6936**	**22613**	**47212**
Total	**92**	**6529**	**8123**	**11278**	**20864**	**15672**	**45625**	**41721**	**37178**	**27097**	**102577**	**266914**	**363337**
LIABILITIES AND													
STOCKHOLDERS' EQUITY													
Current liabilities:													
Accounts payable				604	469	574	868	1287	1514	5426	6659	28833	44393
Accrued liabilities				140	326	364	303	380	519	683	4327	8889	35356
Deferred revenue				973	1444	2403	3005	2826	6818	5745	13788	27567	23563
Current portion of capital						532	882	858	1190	768	486	2526	15802
Leases				965	584								
Total current liabilities				**2682**	**2823**	**3873**	**5058**	**5351**	**10041**	**12622**	**25260**	**68415**	**120253**
Long term liabilities:													
Capital leases, less													
Current portion				400	1141	1179	2126	1351	992	580	501	5940	5892
Accrued rent											1233	1277	1623
Total long term liabilities											1734	7217	6915
Stockholders' equity:													
Preferred stock				6551	6551	32780	68809						
Common stock													
Accumulated deficit				9128	15352	22160	31292	(41121)	(50583)	(63522)	(83045)	(125851)	(112697)
Total stockholders' equity	*23*	*6282*	*6337*	*8196*	*16900*	*10620*	*37517*	*33757*	*24852*	*12591*	*75583*	*191282*	*236169*
Total				**11278**	**20864**	**15672**	**45625**	**41721**	**37178**	**27097**	**102577**	**266914**	**363377**

EXHIBIT 5.2

AGOURON PHARMACEUTICALS
CONSOLIDATED STATEMENT OF OPERATIONS DATA
(in thousands, except per share data)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Revenues:													
Product sales, net												56969	409298
Contract revenues and royalties			892	1829	2075	3781	5307	8266	16301	26722	40955	65094	38855
Interest			373	740	1274	1014	1540	1704	1350	1239			
License fees											15000	10000	18352
Total revenues	322,3	536	1265	2569	3349	4795	6847	9970	17651	27961	55955	132063	466505
Costs and expenses:													
Cost of product sales												24599	172644
Research and development			3518	6190	8035	9353	13142	17404	23957	36317	71010	108137	150657
Selling, general and administrative			657	912	1384	1880	2519	2127	2961	4358	8082	32941	58012
Interest			126	186	154	183	318	268	195	225			
Total operating costs and expenses			4301	7288	9573	11416	15979	19799	27113	40900	79092	223177	449736
Loss from operations													
Interest income, net													
Net loss	(162)	(773,1)	(3036)	(4719)	(6224)	(6621)	(9132)	(9829)	(9462)	(12939)	(19523)	(42806)	13154
Basic and diluted loss per share	0,1	0,42	1,24	1,77	1,77	1,42	1,47	1,4	1,31	1,77	1,98	3,18	(0,43)
Common shares used in the calculation of basic and	1666	1851	2456	2660	3739	4674	6199	6997	7241	7296	9844	13473	

(1) In October 1995, the Company changed its fiscal year end from March 31 to December 31, effective with the nine months ended December 31, 1995.

(2) No dividends have been declared or paid on the common stock.

EXHIBIT 6

Investments Required to Produce a Breakthrough Drug *(Investment in Plant, Equipment, and Working Capital)*													
YEAR	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
BREAKTHROUGH REVENUE*	275	275	275	275	775	775	775	1324	1324	1324	1324	1324	1324
INVESTMENTS (millions)	68,75	0	0	0	125	0	0	137,3	0	0	0	0	0
PV (INVESTMENTS) (millions)	**$189,52**												

* Myers and Howe (1997)

EXHIBIT 7

ISIS PHARMACEUTICALS
CONSOLIDATED STATEMENT OF OPERATIONS DATA
(In thousands, except per share data)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Revenues:													
Research and development revenues under coliaborative agreements	1826	6261	8727	10654	10088	12966	22572	32470	34130	29357	16912	40398	67820
Research and development revenues from afiliates										4402	7967	10561	11942
Gain on sale of investment					3174								
Interest income	132	1782	2089	1486	2251	3001	4012	4067					
Licensing and royalty revenues									5041	166	12376	2316	417
Total revenues	1958	8043	10816	12140	15513	15967	26584	36537	39171	33925	37255	53275	80179
Costs and expenses:													
Cost of product sales													
Research and development	4755	12381	23669	25604	26468	33175	45653	55940	62200	66413	57014	83741	1E+05
Selling, general and administrative	1689	4399	6657	4809	5981	5402	6246	8078	9511	10571	8644	11061	8547
Interest expense				789	1245	1102	1206	3585					
Total operating costs and expenses	6444	16780	30326	31202	33694	39679	53105	67603	76949	76984	67880	99375	1E+05
Income (Loss) from operations													
Interest income, net													
Net income (loss)	- 4486	- 8737	-19510	-19062	-18181	-23712	-26521	-31066	-42983	-59645	-53485	-46100	-50813
Basic and diluted Income (loss) per share	0,70	0,84	1,51	1,22	0,93	1,10	1,04	1,17	1,6	2,08	1,48	1,7	1,35
Common shares used in the calculation of basic	6451	10355	12892	15685	19542	21514	25585	26456	26873	28703	37023	44109	54480

EXHIBIT 8.1

HYBRIDON 1
(Before the sale of HSP*)
CONSOLIDATED STATEMENT OF OPERATIONS DATA
(In thousands, except per share data)

	1992	1993	1994	1995	1996	1997	1998	1999
Revenues:								
Research and Development		917	1032	1186	1419	945	1100	600
Product revenue					1080	1877	3254	6186
Contract revenues and royalties					62	48		
Interest income	12	267	135	219	1447	1079	148	215
Total revenues	12	1184	1167	1405	4008	3949	4502	7001
Costs and expenses:								
Cost of product sales								
Research and development	8762	16168	20024	29685	39390	46828	20977	13090
Selling, general and administrative	5163	4372	6678	6094	11347	11027	6573	3664
Interest	782	380	69	173	124	4536	2932	750
Reestrucuturing						11020		
Total operating costs and expenses	14707	20920	26771	35952	50861	73411	30482	17504
Income (Loss) from operations	-14695	-19736	-25604	-34547	-46853	-69462	-25980	-10503
Gain on exchange of 9% convertible subordinated notes payable							8877,00	
Interest income, net								
Net income (loss)	-14695	-19736	-25604	-34547	-46853	- 69462	-17103	-10503
Basic and diluted Income (loss) per share				2,13	(1,93)	(13,76)	(1,67)	(0,93)
Common shares used in the calculation				16195	24261	5050	11859	15811

*In September 21, 2000, Hybridon sold its Hybridon Specialty Products or "HSP" business and assets

EXHIBIT 8.2

HYBRIDON 2
(After the sale of HSP)
CONSOLIDATED STATEMENT OF OPERATIONS DATA
(In thousands, except per share data)

	1996	1997	1998	1999	2000	2001	2002
Revenues:							
Research and Development	1419	945	1100	600	179	988	29550
Service revenue			375	365	82		
Contract revenues and royalties	62			123	229	577	660
Interest income	1447	1079	148	92	83	134	46
Total revenues	**2928**	**2024**	**1623**	**1180**	**573**	**1699**	**30256**
Costs and expenses:							
Cost of product sales							
Research and development	**33150**	**35326**	**14183**	**5783**	**3620**	**4868**	**7877**
Selling, general and administrative	11347	11027	6573	3664	3184	5051	7054
Interest	34	4278	2820	683	2154	1319	150
Reestrucuturing		10345					
Total operating costs and expenses	**44531**	**60976**	**23576**	**10130**	**8958**	**13000**	**13784**
Income (Loss) from discontinued operations	-5250	-10509	-4028	-1553	5462	2663	
Gain on exchange of 9% convertible subordinated notes payable			8877				
Interest income, net							
Net income (loss)	**-46853**	**-69461**	**-17104**	**-10503**	**-2923**	**-5333**	**16972**

EXHIBIT 9

AVI BIOPHARMA Inc.

CONSOLIDATED STATEMENT OF OPERATIONS DATA

(In thousands, except per share data)

	1991*	1992*	1993*	1994*	1995	1996	1997	1998	1999	2000	2001	2002
Revenues:												
Product sales, net												
Contract revenues and royalties												
Total revenues					**83**	**28**	**14**	**120**	**17**	**1.297**	**706**	**837**
Costs and expenses:												
Cost of product sales												
Research and development	**725**	**725**	**725**	**725**	**2.098**	**1.730**	**2.737**	**6.307**	**6.672**	**9.268**	**12.751**	**22.414**
Selling, general and administrative					610	614	1.282	1.621	1.745	2.270	3.358	3.764
Total operating costs and expenses	**725**	**725**	**725**	**725**	**2.708**	**2.344**	**4.019**	**7.928**	**8.417**	**11.538**	**16.109**	**26.178**
Acquired in-process research and development								19.473	72			
Income (Loss) from operations												
Interest income, net										1.001	1.001	460
Net income (loss)					**-2.557**	**-2.087**	**-3.616**	**26.734**	**-8.278**	**-9.240**	**-26.925**	**-29.359**
Basic and diluted Income (loss) per share					(0,37)	(0,25)	(0,36)	(2,27)	(0,62)	(0,49)	(1,20)	(1,14)
Common shares used in the calculation of basic and												

Total expenses on R&D until 1997:
9.463.297
Source: 10-K report 1998
Total expenses on R&D until 1995: 2,898,775
*Average R&D for years 1991-1994 based on total R&D accumulated until 1995

EXHIBIT 10

CD-ROA SIMULATION

Parameter Values

CASE 1	
FIRM VALUE	**286,26**
(million dollars)	
error	3,3371
Parameter	*Value*
path *(n trials)*	10000
n steps	40
S0	235,95
X	187,52
r	7,03%
T	10
scrap %	0,8
b (E. monopolist)	0,5
b (challenger)	0,5
RD (E. monopolist)	0,0720
RD (challenger)	0,1261
miu (J)	0,25
sigma (J)	0,37

CASE 2	
FIRM VALUE	**289,58**
(million dollars)	
error	3,6034
Parameter	*Value*
path *(n trials)*	10000
n steps	40
S0	235,95
X	187,52
r	7,03%
T	10
scrap %	0,8
b (E. monopolist)	0,55
b (challenger)	0,482
RD (E. monopolist)	0,0720
RD (challenger)	0,1261
miu (J)	0,25
sigma (J)	0,37