Intellectual property and the valuation of biotechnology companies: GEN-dex versus Dow Jones.

Valuation of biotechnology companies is a perplexing issue. The common method of deriving company's worth by discounting its free cash flow is not of much help, since cash flow in most of the biotechnology sector is usually still negative (e.g. there is more cash going out than coming in). Still, biotechnology companies are traded, in various stock exchanges, with a considerable positive value. Clearly the value of a company that looses money, as is the case for most of the biotechnology sector, is based on its potential for future earnings. In biotechnology it is generally accepted that such potential is closely linked to the intellectual property owned by the company. Thus, we might expect that the value of a biotechnology company should mainly reflect the value of its intellectual assets.

Is this presumption supported by the real world data? Apparently it does, as will be shown in this article.

Valuation Concepts: Tangible and Intangible assets.

(the following method of analysis is described with much rigor in: *Gordon V. Smith & Russell L. Parr, "Intellectual Property: Licensing and Joint Venture Profit Strategies", John Wiley & Sons, 1993*).
Conceptually the value of a company is the sum of its assets value. However accounting procedures allow companies to reflect only the tangible part of there assets. Tangible assets include current assets, which are assumed to be equivalent to cash, and fixed assets which generate part of the firm's earnings. Unfortunately the accounting profession has not developed yet an accepted method to record intangible assets. These assets include: employees training, know-how, brand nams, trademarks, copyrights and patents. Although financial statements can reflect only a portion of a firm's value, markets evaluate companies according to the full scope of their assets. Thus, we can estimate the value of the intellectual assets of a firm by examining market data.

We begin with the significant insight, initially presented by Modigliani & Miller (*"The Cost of Capital, Corporation Finance, and the Theory of Investment," AER, June 1958*), that the value of a firm is the sum of its equity market value and its debt market value. Debt market value is usually assumed to be equal to the respective book value, and thus we

can calculate the firm's market value as the sum of its market capitalization and the book value of its current liabilities and long term debt. The difference between the firm's market value and its assets book value is a fair estimate to its intangible assets worth.

The weight of intellectual property in the determination of the firm's value can be measured by the ratio of intangible assets worth to the firm's market value. I have named this ratio: the Intellectual Property (IP) Intensity. The IP Intensity has some desirable properties making it a good mean of comparison between different companies. Since the tangible assets value is always positive, the IP Intensity must be, by definition, less than one. Intangible assets value can be negative, usually when the market is very pessimistic about the firm's prospects. However, we can discard this possibility as anomaly and thus the IP intensity will vary between zero to one. Firms with IP intensity close to zero derive their value mainly from their tangible assets, while values close to one characterize IP intensive companies, which derive most of their value from their intellectual assets.

Equipped with these analytic tools we can move forward to analyze the biotechnology sector. More specifically I am interested in the IP intensity of the biotechnology sector in comparison to general industry norm. I have used two samples of companies: (1) the GEN index (GEN-dex) of 46 U.S. biotechnology companies; (2) the Dow-Jones index of 30 large U.S. industrial companies. All the data presented below are for the first quarter of 1997.

GEN-dex Companies.

The relevant data for the GEN-dex companies are presented in Table 1. The companies are sorted by their assets book value, which is linked to their size. The tangible assets in the average GEN-dex company worth $285 millions, while the intangible assets worth - $850 millions - is almost threefold. The IP intensity average and median range between 72%-73%.

The relation between intangible assets and tangible assets is shown in Diagram 1. Apparently there is a positive correlation between the two. Firms with high tangible assets value, which will usually be larger also in terms of sales and number of employees, tend to have higher value of intangible assets. However this relation does not hold for the IP intensity, as demonstrated by Diagram 2. Since IP intensity is not correlated to the

size of the firm, it is more suitable as a measure to compare intellectual property role in firms with different sizes.

Table 1: GEN-dex companies

COMPANY	Assets Book Value ($MIL)	Assets Market Value ($MIL)	Intangible Assets Value ($MIL)	IP Intensity
Repligen	5.7	20.7	15.0	72.5%
Immunogen Inc.	6.9	25.4	18.5	72.9%
Matritech Inc.	8.7	100.2	91.5	91.3%
T Cell Sciences Inc.	17.2	40.4	23.2	57.5%
Unigene Labs Inc.	17.3	131.3	114.0	86.8%
Enzon Inc.	18.4	81.3	62.9	77.4%
Neorx Corp.	20.5	62.1	41.6	67.0%
Celgene Corp.	20.9	80.3	59.4	74.0%
Shaman Pharmaceuticals	23.0	112.9	89.9	79.6%
Imclone Systems Inc.	25.3	149.5	124.2	83.1%
Immunomedics Inc.	25.5	160.0	134.5	84.1%
Ribi Immunochem. Res. Inc.	28.3	85.4	57.1	66.9%
Cytogen Corp.	34.9	293.7	258.8	88.1%
Oncor Inc.	38.6	111.8	73.2	65.5%
Epitope	40.7	136.9	96.2	70.3%
Immune Response Corp.	46.2	180.3	134.1	74.4%
U.S. Bioscience Inc.	47.6	260.9	213.3	81.8%
Xoma Corp.	49.2	215.6	166.4	77.2%
Sequus Pharmaceuticals	50.6	239.8	189.2	78.9%
Alkermes Inc.	51.3	330.4	279.1	84.5%
Cambridge Neuroscience	52.5	167.2	114.7	68.6%
Advanced Tissue Sciences	56.6	501.9	445.3	88.7%
Enzo Biochem Inc.	63.7	341.9	278.2	81.4%
Molecular Biosystems Inc.	69.2	186.8	117.6	63.0%
Oncogene Science Inc.	69.2	138.9	69.7	50.2%
Cor Therapeutics Inc.	71.2	200.7	129.5	64.5%
Incyte Pharmaceuticals	79.2	730.2	651.0	89.2%
Gensia Sicor Inc.	89.1	194.5	105.4	54.2%
Liposome Co. Inc.	91.9	975.6	883.7	90.6%
Isis Pharmaceuticals	97.8	461.4	363.6	78.8%
Regeneron Pharmaceuticals Inc.	115.1	249.4	134.3	53.9%
Scios Inc.	130.9	278.1	147.2	52.9%
Nexstar Pharmaceuticals	144.5	351.2	206.7	58.9%
Agouron Pharmaceuticals	153.8	1044.6	890.8	85.3%
Medimmune Inc.	163.3	413.3	250.0	60.5%
Cephalon Inc.	175.9	350.3	174.4	49.8%
Immunex Corp.	224.0	1289.8	1065.8	82.6%
Human Genome Sciences	238.6	830.5	591.9	71.3%
Mycogen Corp.	262.7	793.3	530.6	66.9%
Centocor Inc.	342.1	2469.2	2127.1	86.1%
Biogen	684.2	2661.3	1977.1	74.3%
Genzyme	1258.3	2232.8	974.5	43.6%
Ivax Corp.	1369.8	1863.3	493.5	26.5%
Chiron Corp.	1657.7	4273.7	2616.0	61.2%
Genentech Inc.	2258.3	7521.5	5263.2	70.0%
Amgen Inc.	2608.2	18888.0	16279.8	86.2%
Average	**285**	**1,135**	**851**	**71.6%**
Median				**73.4%**
Observations				**46**

Diagram 1: Intangible Assets (GEN-dex)

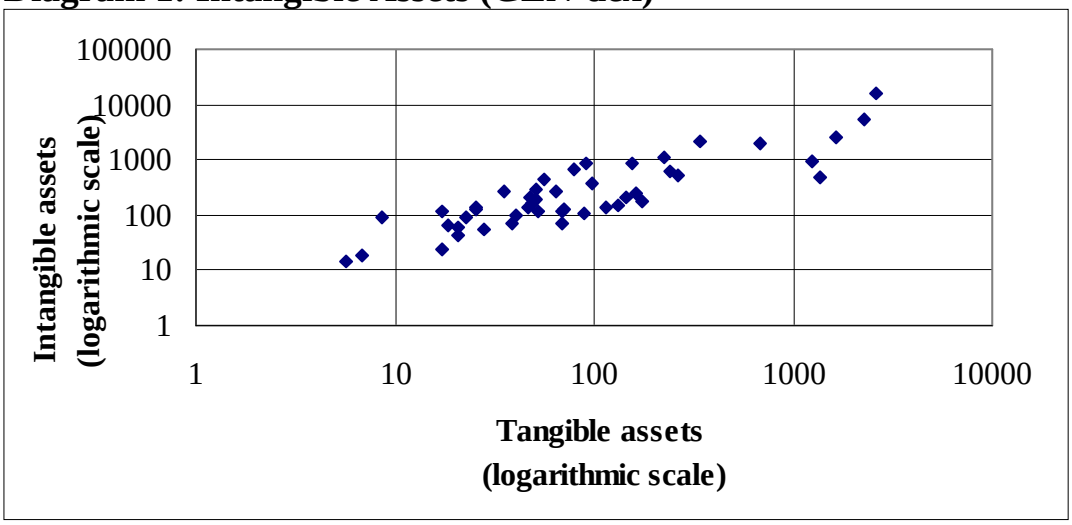
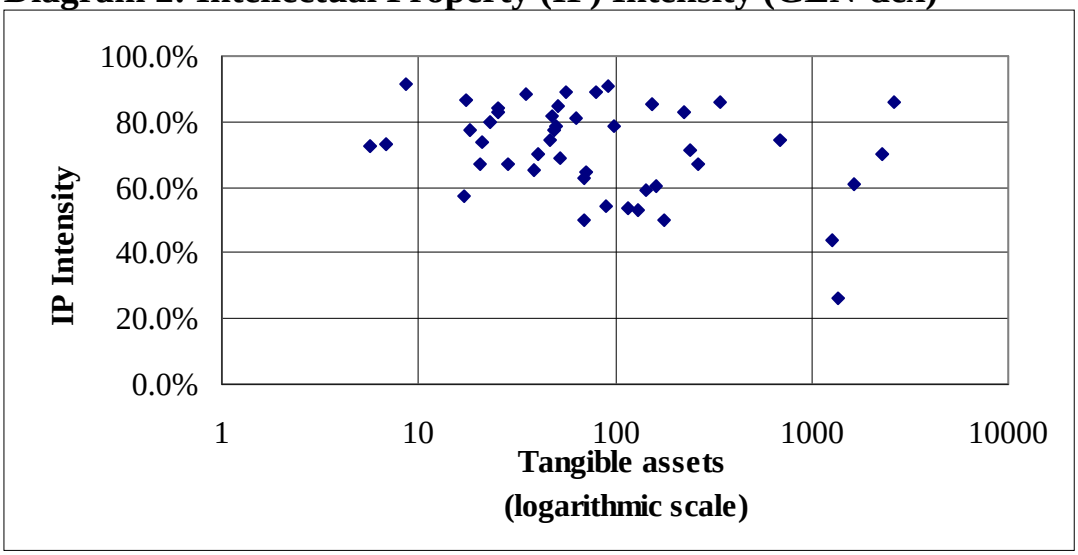


Diagram 2: Intellectual Property (IP) Intensity (GEN-dex)



Dow-Jones Companies.

Similarly, the Dow-Jones companies are presented in Table 2 sorted according to their size. The average Dow-Jones company tangible assets value is close to $31 billions, more than 100 times larger than the average GEN-dex company. However the intangible assets value of the average Dow-Jones company - $43 billions - is only 50 times larger than the equivalent value in the average GEN-dex company. The IP intensity average and median in the Dow-Jones companies are both around 53% which is considerably lower than the equivalent values in the GEN-dex companies.

Table 2: Dow Jones companies

COMPANY	Assets Book Value ($MIL)	Assets Market Value ($MIL)	Intangible Assets Value ($MIL)	IP Intensity
Bethlehem Steel Corp.	2,347	2,533	186	7.4%
Woolworth Corp.	2,652	4,627	1,975	42.7%
Union Carbide Corp.	4,758	8,640	3,882	44.9%
Goodyear Tire & Rubber Co.	7,732	14,068	6,336	45.0%
Aluminium Co. of America	8,416	17,028	8,612	50.6%
Allied Signal Inc.	9,002	28,569	19,567	68.5%
Eastman Kodak Co.	9,705	30,851	21,146	68.5%
Minnesota Mining & Mfg.	10,752	46,547	35,795	76.9%
United Technologies Corp.	13,102	28,998	15,896	54.8%
American Express Co.	14,713	42,709	27,996	65.6%
Coca Cola Co.	14,840	182,590	167,750	91.9%
Mcdonalds Corp.	15,103	41,038	25,935	63.2%
Westinghouse Electric Corp.	15,216	23,441	8,225	35.1%
Caterpillar Inc.	16,258	32,369	16,111	49.8%
Merck & Co.	18,459	130,722	112,263	85.9%
Texaco Inc.	21,062	40,306	19,244	47.7%
International Paper Co.	21,822	27,782	5,960	21.5%
Procter & Gamble Co.	22,111	105,055	82,944	79.0%
Boeing Co.	24,600	53,132	28,532	53.7%
J.P. Morgan & Co. Inc.	25,435	34,746	9,311	26.8%
Dupont E I Nemours & Co.	28,386	86,782	58,396	67.3%
Chevron Corp.	28,413	60,860	32,447	53.3%
Sears Roebuck & Co.	31,545	47,537	15,992	33.6%
Walt Disney Holdings Co.	35,997	74,768	38,771	51.9%
Philip Morris Companies	42,029	135,156	93,127	68.9%
AT&T Corp.	46,485	85,713	39,228	45.8%
IBM	61,341	132,845	71,504	53.8%
Exxon Corp.	69,738	176,034	106,296	60.4%
General Motors Corp.	124,929	149,329	24,400	16.3%
General Electric Co.	178,778	364,913	186,135	51.0%
Average	**30,858**	**73,656**	**42,799**	**52.7%**
Median				**52.6%**
Observations				**30**

Diagrams 3 and 4 show that intangible assets measures in the Dow-Jones companies have the same properties as their equivalent measures in the GEN-dex. Intangible assets value is positively correlated with the firm's size, while IP intensity is independent of such size.

Diagram 3: Intangible Assets (Dow Jones)

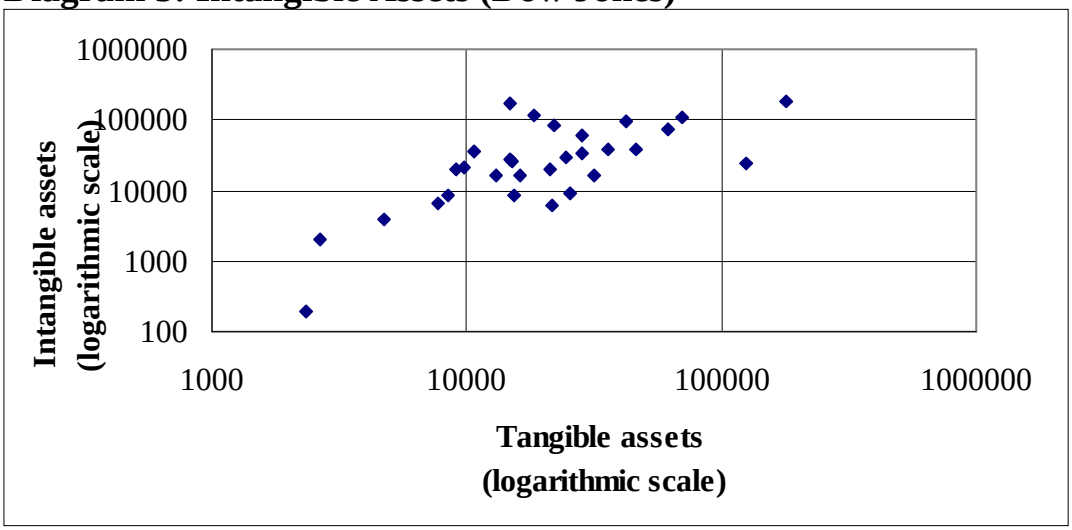
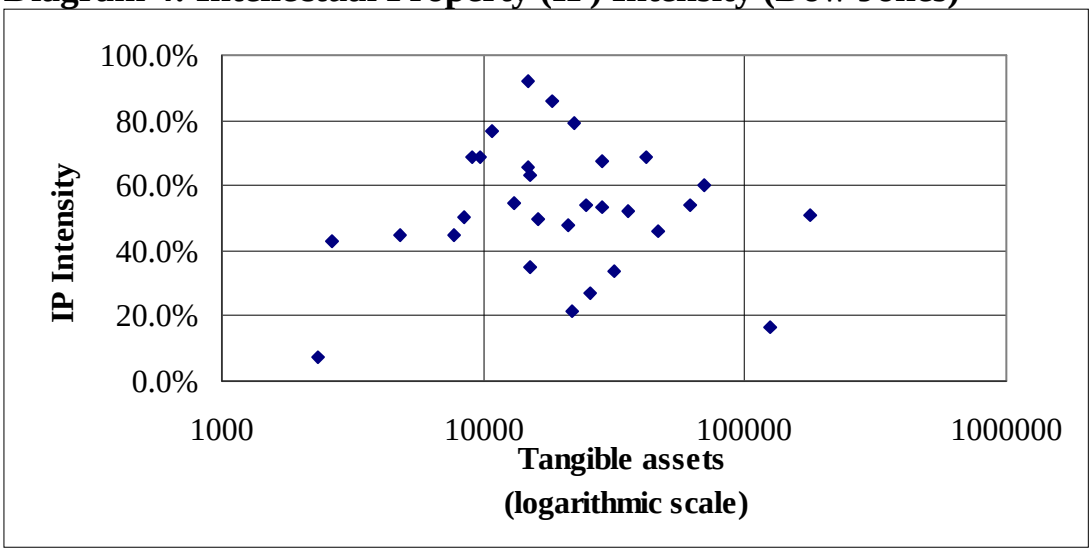


Diagram 4: Intellectual Property (IP) Intensity (Dow Jones)



GEN-dex versus Dow-Jones

The previous discussion has already suggested that GEN-dex companies are more IP intensive than the Dow-Jones companies. To elaborate this point, the IP intensity distributions were analyzed, and are presented in Table 3, while the histograms are presented in Diagrams 5 and 6. The results are illuminating. The GEN-dex IP intensity distribution is highly asymmetric and skewed to the right. About three quarters of the observations lie the IP intensity range of 60% to 90%. The Dow-Jones IP intensity distribution is more symmetric, almost bell shaped. About two thirds of the observations lie in the IP intensity range of 40% to 70%.

Table 3: Distribution of IP Intensity

GEN-dex

IP Intensity	*Frequency*	*Frequency %*	*Cumulative %*
10%	0	.00%	.00%
20%	0	.00%	.00%
30%	1	2.17%	2.17%
40%	0	.00%	2.17%
50%	2	4.35%	6.52%
60%	6	13.04%	19.57%
70%	10	21.74%	41.30%
80%	12	26.09%	67.39%
90%	13	28.26%	95.65%
100%	2	4.35%	100.00%

Dow Jones

IP Intensity	*Frequency*	*Frequency %*	*Cumulative %*
10%	1	3.33%	3.33%
20%	1	3.33%	6.67%
30%	2	6.67%	13.33%
40%	2	6.67%	20.00%
50%	6	20.00%	40.00%
60%	7	23.33%	63.33%
70%	7	23.33%	86.67%
80%	2	6.67%	93.33%
90%	1	3.33%	96.67%
100%	1	3.33%	100.00%

Diagram 5: Distribution of IP Intensity (GEN-dex)

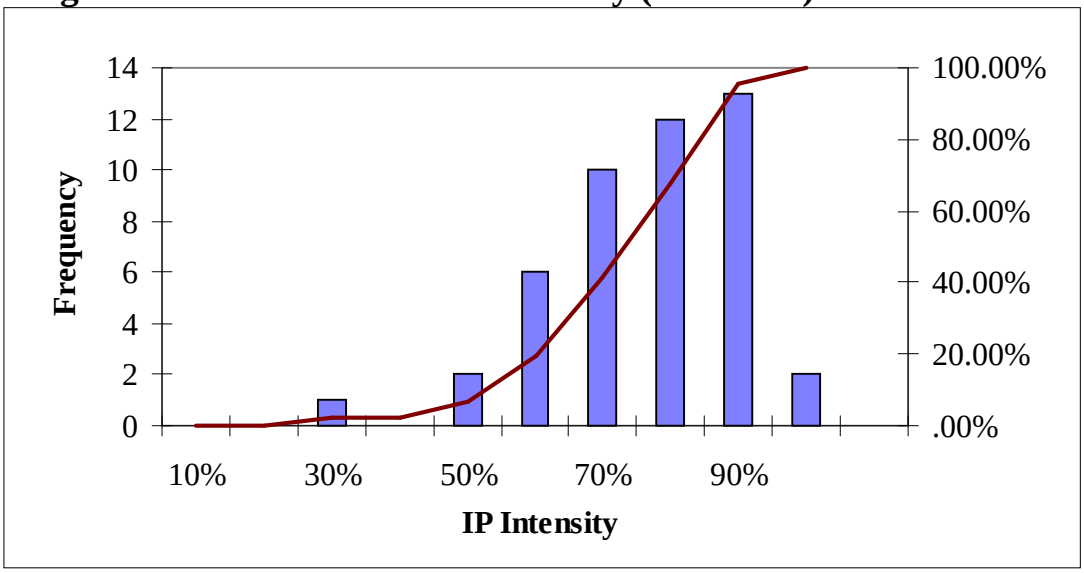
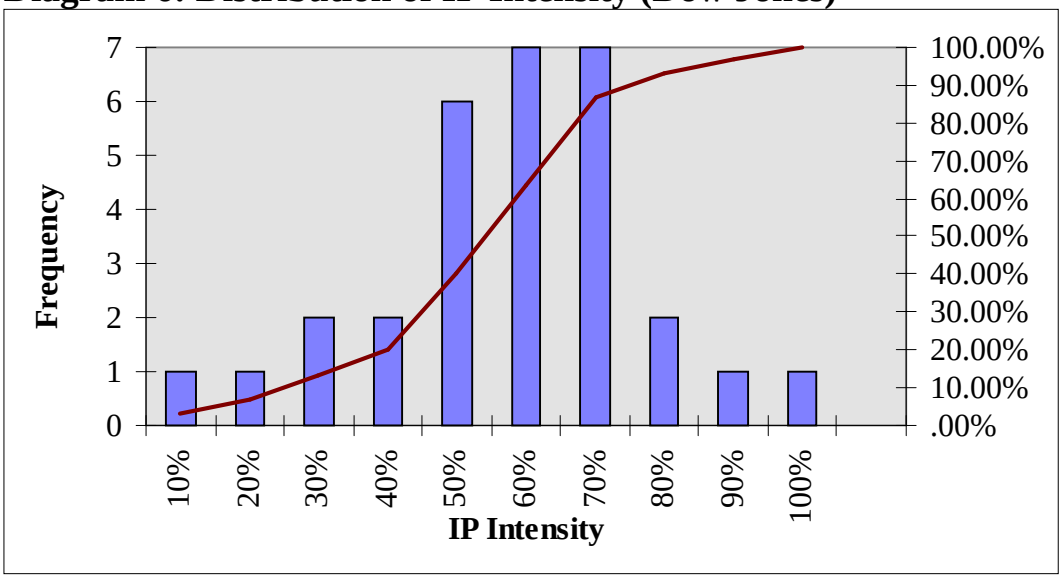


Diagram 6: Distribution of IP Intensity (Dow Jones)



Thus, by using market data, I have demonstrated that biotechnology sector is considerably more IP intensive than the industrial norm. As common sense suggests, intellectual property is the major determinant of value in the biotechnology sector.

Appendix: Intellectual Property Intensity (IPI) - a mathematical representation

As a starting point we can use the basic identities of the balance sheet:

(1) $ABV = CA + NFA = EBV + DBV$

ABV - Assets Book Value
CA - Current Assets
NFA - Net Fixed Assets
EBV - Equity Book Value
DBV - Debt Book Value

Next we will use the definition of the firm's value proposed by Modigliani & Miller:

(2) $AMV = EMV + DMV$

AMV- Assets Market Value, which according to M&M, is the firm's market value and is equal to its discounted sum of

future net operating income (income before interest payments minus tax).

EMV - Equity Market Value.
DMV - Debt Market Value.

Now we will assume that debts book value is equal to its market value (which is usually not observable).

(3) DMV = DBV

Thus (2) becomes:

(4) AMV = DBV + EMV

Equation (4) defines AMV by combining the balance sheets figures with its market data.

Now we can define the ratio:

(5) AMBV = AMV/ABV

AMBV- Assets Market to Book Value.

And we can define the Intellectual Property Intensity (IPI):

(6) IPI = (AMV - ABV)/AMV

Inserting (5) into (6) we can get the relation between these two measures:

(7) $IPI = 1 - AMBV^{-1}$

(8) AMBV = 1/(1 - IPI)

IPI cannot exceed 1 by definition, and thus AMBV is always defined and positive. In normal cases IPI will also be larger or equal to zero, and thus AMBV will be larger or equal to 1. As the preliminary findings show, IPI is not dependent on the size of the firm and the same conclusion holds for AMBV too.

For illustration purpose we present the AMBV and IPI for selected companies (data are for the first quarter of 1997):

Company	AMBV	IPI
Amgen	7.25	86.2%
Genentech	3.33	70.0%
Chiron	2.58	61.2%
Merck	7.09	85.9%
IBM	2.16	53.8%
General Electric	2.04	51.0%
General Motors	1.19	16.3%

AMBV ratio to can be use as an estimate of value and is superior to P/E or P/B ratios.

P/E is meaningless when the firm does not have profits, as is the case with many start-up companies, and moreover earnings can be manipulated by different accounting methods (a recent article in the Economist describes the case of Daimler-Benz, that due to its listing in NYSE in 1993, had to change its report of $372 millions profit under German accounting rules to $1.1 billion loss under American rule).

P/B is not robust and depends on the firms capital structure. To illustrate this let's look at a firm that is financed only by equity. Thus, its P/B ratio will be:

(9) $(P/B)_0 = AMV/ABV = AMBV$

Now suppose that the same firm is financed by debt and equity. If we accept the M&M theorem, the firm's AMV should remain the same. Thus its P/B ratio will be:

(10) $(P/B)_1 = (AMV - DMV)/(ABV - DBV)$

Which according to (3) can be rewritten as:

(11) $(P/B)_1 = (AMV - DBV)/(ABV - DBV)$

It can be easily shown that:

(12) $(P/B)_0 \leq (P/B)_1$ if $AMV \geq ABV$ (e.g. $AMBV \geq 1$)