

## **CSE 691**

### **Computational Finance**

## **Fundamental Price Modeling**

A person not familiar with the basic facts of economics and finance could assume that the price of a company's stock reflects, by a large amount, the actual value of the company. However, this notion cannot hold true in a free market where supply and demand are, eventually, the factors that affect market prices. But is the financial data of a company irrelevant to its stock price and useless for an investor? Presumably it is not, as there are people who use Fundamental Analysis to determine investment opportunities, and Fundamental Analysis is a method that utilizes the economic fundamentals of a company.

For this project we will try to use a company's financial data to attempt to calculate the market capitalization. Any significant discrepancies between the stock price and the fundamental price are of interest are further explored.

### **1. Financial statements**

The quarterly or annual financial statements that each company publishes and will be used by us are the following.

- Balance Sheet

Shows the overall financial status of a company at a given point of time.

- Income Statement

Shows the revenues, expenses, profit over a one year period.

- Cash Flow Statement

Similar to the income statement; but does not include depreciation, amortization etc.

A short description of each one follows.

## 1.1 Income statement

The income statement provides the most basic financial info on a company i.e. revenues, expenses and profit during a quarter or a whole year. In effect, it reflects the performance of the company during that period of time. It can generally be described by the following formula:

$$\text{Revenue} - \text{All Expenses} = \text{Income}$$

Income Statement				
Get Income Statement for:				GO
View: <a href="#">Annual Data</a>   <a href="#">Quarterly Data</a>				
All numbers in thousands				
PERIOD ENDING	31-Jul-03	30-Apr-03	31-Jan-03	31-Oct-02
Total Revenue	-	-	-	-
Cost of Revenue	-	(191)	191	1,105
Gross Profit	-	191	(191)	(1,105)
Operating Expenses				
Research Development	93	-	-	176
Selling General and Administrative	165	542	189	(347)
Non Recurring	-	-	-	(150)
Others	6	6	155	203
Total Operating Expenses	-	-	-	(118)
Operating Income or Loss	(264)	(357)	(536)	(987)
Income from Continuing Operations				
Total Other Income/Expenses Net	-	-	-	-
Earnings Before Interest And Taxes	(264)	(357)	(536)	(987)
Interest Expense	114	61	171	222
Income Before Tax	(378)	(418)	(706)	(1,209)
Income Tax Expense	-	-	-	-
Minority Interest	-	-	-	(0)
Net Income From Continuing Ops	(378)	(418)	(706)	(1,209)
Non-recurring Events				
Discontinued Operations	-	-	-	-
Extraordinary Items	-	-	-	-
Effect Of Accounting Changes	-	-	-	-
Other Items	-	-	-	-
Net Income	(378)	(418)	(706)	(1,209)
Preferred Stock And Other Adjustments	-	-	-	-
Net Income Applicable To Common Shares	(\$378)	(\$418)	(\$706)	(\$1,209)
<a href="#">Add to Portfolio</a> <a href="#">Set Alert</a> <a href="#">Email to a Friend</a>				

Sample from yahoo finance:

### **Key points:**

- **Revenue**

The amount of money the company received during the period in question. This is considered by many the most important piece of information about a company.

- **Expenses**

- **Cost of Revenue**

Shows the production costs that brought the revenue. It includes cost of raw material, worker salary etc.

- **Operating Expenses**

Costs of R & D and administration, including marketing, are under operating expenses.

- **Interest Expenses & Tax**

All interest (e.g. from loans) and tax paid by the company.

- **Non-recurring Events**

Usually one-time expenses that don't fall in the other categories.

- **Net Income**

The actual profit of the company after all expenses are deducted from revenue.

## 1.2 Balance Sheet

It is called a "balance sheet" because it has to show that the basic company figures balance out. That is:

$$\text{Liabilities} + \text{Stockholder Equity} = \text{Assets}$$

The Balance Sheet is a snapshot of a company's financial status at a given point in time. One balance sheet cannot give information about growth rate etc, but can show if a company is healthy, or owes too much.

Sample from yahoo finance:

View: <a href="#">Annual Data</a>   <a href="#">Quarterly Data</a>		All numbers in thousands		
PERIOD ENDING	31-Oct-02	31-Oct-01	31-Oct-00	
Assets				
Current Assets				
Cash And Cash Equivalents	31	0	347	
Short Term Investments	-	-	-	
Net Receivables	159	350	-	
Inventory	-	-	-	
Other Current Assets	3	-	-	
<b>Total Current Assets</b>	<b>193</b>	<b>350</b>	<b>347</b>	
Long Term Investments	-	-	50	
Property Plant and Equipment	88	73	-	
Goodwill	-	-	-	
Intangible Assets	-	-	200	
Accumulated Amortization	-	-	-	
Other Assets	-	5	11	
Deferred Long Term Asset Charges	-	-	-	
<b>Total Assets</b>	<b>281</b>	<b>428</b>	<b>607</b>	
Liabilities				
Current Liabilities				
Accounts Payable	2,157	907	218	
Short/Current Long Term Debt	-	-	-	
Other Current Liabilities	-	-	-	
<b>Total Current Liabilities</b>	<b>2,157</b>	<b>907</b>	<b>218</b>	
Long Term Debt	-	-	-	
Other Liabilities	-	-	-	
Deferred Long Term Liability Charges	-	-	-	
Minority Interest	5	5	-	
Negative Goodwill	-	-	-	
Other Assets	-	5	11	
Deferred Long Term Asset Charges	-	-	-	
<b>Total Liabilities</b>	<b>2,162</b>	<b>912</b>	<b>218</b>	
Stockholders' Equity				
Misc Stocks Options Warrants				
Redeemable Preferred Stock	-	3,958	-	
Preferred Stock	-	-	-	
Common Stock	6	43	1	
Retained Earnings	(5,596)	(2,509)	(130)	
Treasury Stock	-	-	-	
Capital Surplus	3,709	(1,976)	518	
Other Stockholder Equity	-	-	-	
<b>Total Stockholder Equity</b>	<b>(1,880)</b>	<b>(4,442)</b>	<b>389</b>	
<b>Net Tangible Assets</b>	<b>(\$1,880)</b>	<b>(\$4,442)</b>	<b>\$189</b>	

### *Key points:*

- **Assets (Depreciated Values)**

- **Current Assets**

Company assets that can be quickly converted to cash. Apart from actual cash, unsold inventory is an example of current assets.

- **Non-current Assets**

Other assets, like equipment, property etc, that cannot be easily converted to cash.

- **Liabilities**

- **Current Liabilities**

Short term liabilities. For example bills that have to be paid before the next statement.

### - Non-current liabilities

It is favorable for a company to have Non-Current liabilities than Current ones, as this would not always mean bad health status for a company.

- **Stockholder Equity (Internal Value)**

After subtracting the liabilities from the assets, stockholder equity reflects the current value of the company that stockholders own.

- **Net Tangible Assets (Book Value)**

By subtracting intangible assets and goodwill from the equity, we get the book value of the company, which shows how much we would sell all tangible assets for (buildings, inventory, materials etc).

## 1.3 Cash Flow Statement

The cash flow statement is similar to the income statement; however it does not include non-cash charges and focuses on cash earnings before depreciation or amortization.

Sample from yahoo finance:

View: Annual Data   <a href="#">Quarterly Data</a>		All numbers in thousands		
PERIOD ENDING	31-Oct-02	31-Oct-01	31-Oct-00	
Net Income	(3,086)	(2,380)	(130)	
Operating Activities, Cash Flows Provided By or Used In				
Depreciation	24	69	-	
Adjustments To Net Income	1,526	581	-	
Changes In Accounts Receivables	112	(350)	-	
Changes In Liabilities	38	687	18	
Changes In Inventories	-	-	-	
Changes In Other Operating Activities	2	-	-	
Total Cash Flow From Operating Activities	(1,385)	(1,392)	(112)	
Investing Activities, Cash Flows Provided By or Used In				
Capital Expenditures	(39)	(79)	-	
Investments	-	571	(50)	
Other Cashflows from Investing Activities	-	(3)	(11)	
Total Cash Flows From Investing Activities	(39)	490	(61)	
Financing Activities, Cash Flows Provided By or Used In				
Dividends Paid	-	-	-	
Sale Purchase of Stock	-	500	519	
Net Borrowings	1,455	-	-	
Other Cash Flows from Financing Activities	-	-	-	
Total Cash Flows From Financing Activities	1,455	500	519	
Effect Of Exchange Rate Changes	-	-	-	
Change In Cash and Cash Equivalents	\$31	(\$403)	\$347	

### ***Key points:***

- **Cash Flows from Operating Activities**

All the money that the company made or lost through its normal operating activities.

- **Cash Flows from Investing Activities**

Investing activities can include any third party bonds/shares/funds bought or sold, as well as property & infrastructure investments.

- **Cash Flows from Financing Activities**

Financing activities include borrowing or loaning money and money spent or received through company stocks / bonds.

## 1.4 Measures

The data collected from the above sources can be used to calculate some more useful measures, like:

- **Debt / Asset ratio**

A high ratio means a highly leveraged company.

- **Current ratio = current assets / total current liabilities**

A value of less than 1 shows liquidity problems.

- **Working Capital = current assets - current liabilities**

The Working Capital is a measure of a company's liquidity.

- **Turnover Ratio = Goods sold / inventory**

An indication of how quickly a company can sell its inventory. A higher number among similar industry companies is favorable.

- **Margins**

Margins are generally earnings as % of sales. A useful measure is the Net Margins which is net income divided by net sales, and a low value is a sign of a struggling company.

- **EPS (Earnings per share) = Profit / number of shares**

It is a rather straightforward calculation. However, the more useful prospective EPS growth rate is calculated through the consensus forecast earnings for the following year.

- **P/E ratio (Price to earnings)**

More useful than EPS to compare companies, it is the price per share divided by EPS and makes sense only for a company that has (positive) earnings. For a company with loss there is the **PSR (price to sales ratio)**.

- **PEG ratio (Prospective earnings growth)**

PEG is calculated by dividing a company's expected annual percentage earnings growth taking by its stock's P/E ratio.

- **P/B ratio (Price to book) = market cap / book value.**

Shows how much more than the book value of the company the market is willing to pay.

- **ROE (Return on Equity)**

ROE is an indication of a company's efficiency. It is calculated by taking a company's after-tax income and dividing by its book value.

- **Divident Yield & Divident payout ratio**

These measures show how much pay in dividends an investor can expect from his stock and the percentage of company earnings given as dividends respectively.

## **2. Available data**

The Financial Lab database was used to gather the following data:

- **Narrowed down to 1368 stocks for which full data set was available.**
- **Balance Sheets for 2001, 2002, 2003**
- **Income Statements for 2001-2003**
- **Cash Flow for 2001-2003**
- **Interest rates for 2001-2003**
- **Actual stock prices and Market Caps for the period (for comparison)**

Also, the industry sector info for the 1368 companies was downloaded from [finance.yahoo.com](http://finance.yahoo.com).

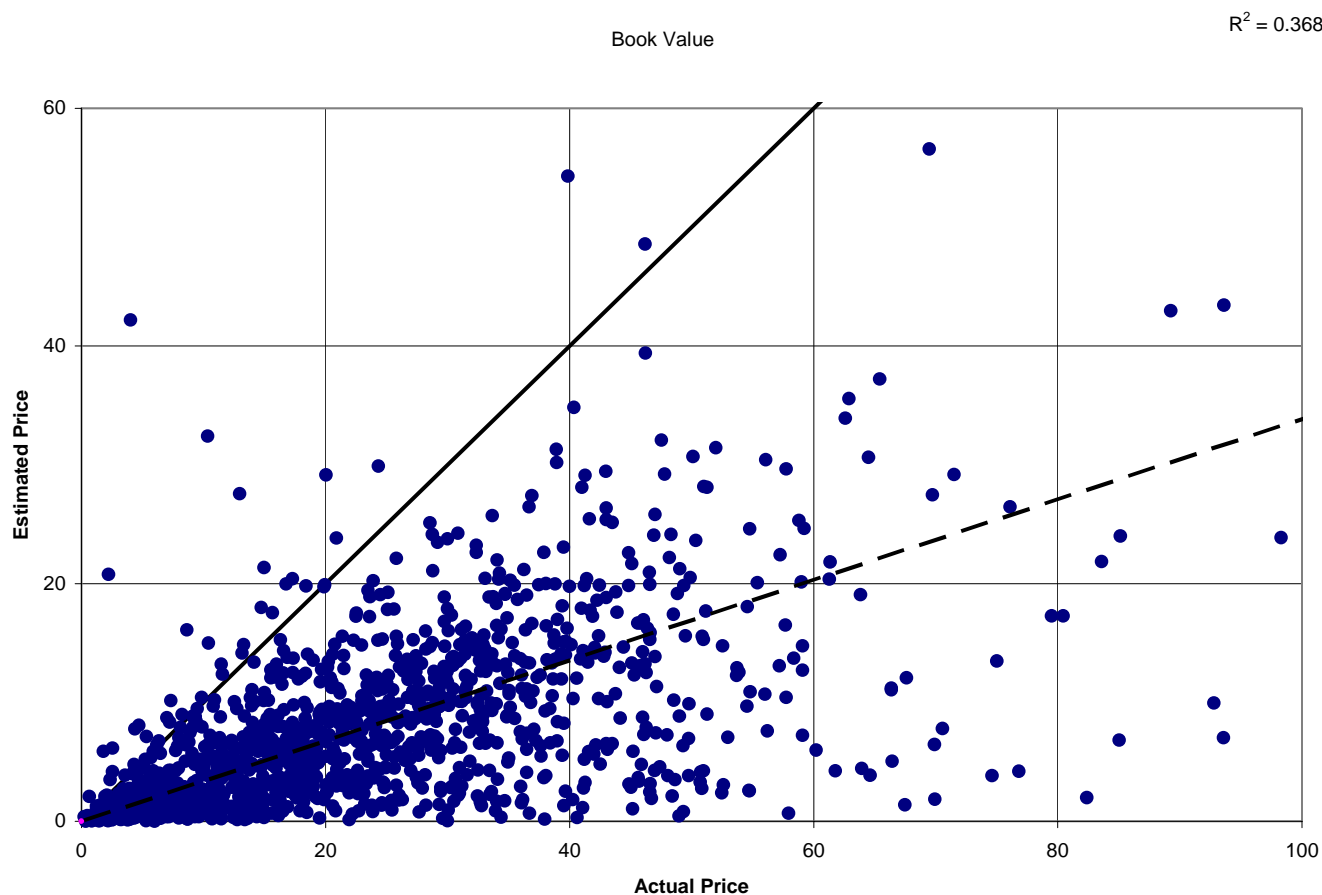
### 3. Calculating Book/Internal value

#### 3.1 Book Value

The book value is a very pessimistic estimation of a company's stock price, since it only accounts for a company's tangible assets.

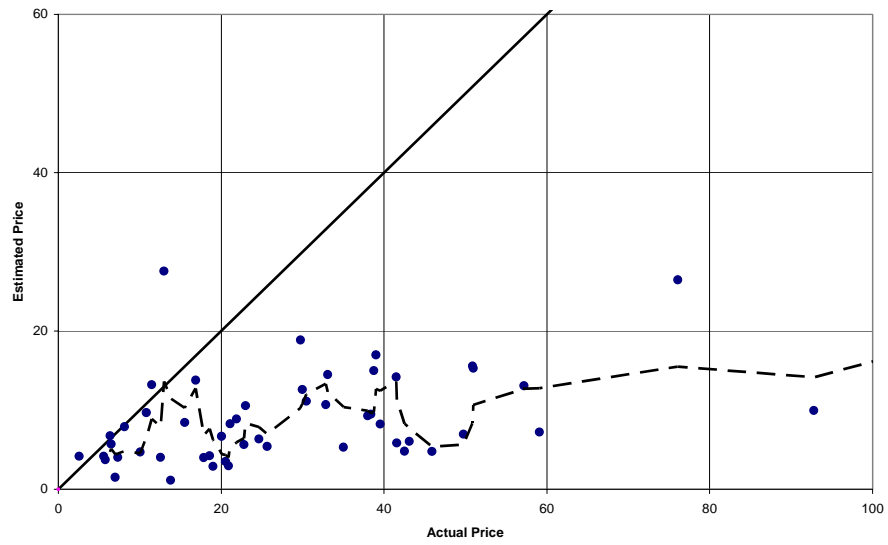
However, it is the value that is the easiest to calculate and understand.

We will first try plotting the actual stock value versus the book value for our complete set of companies:

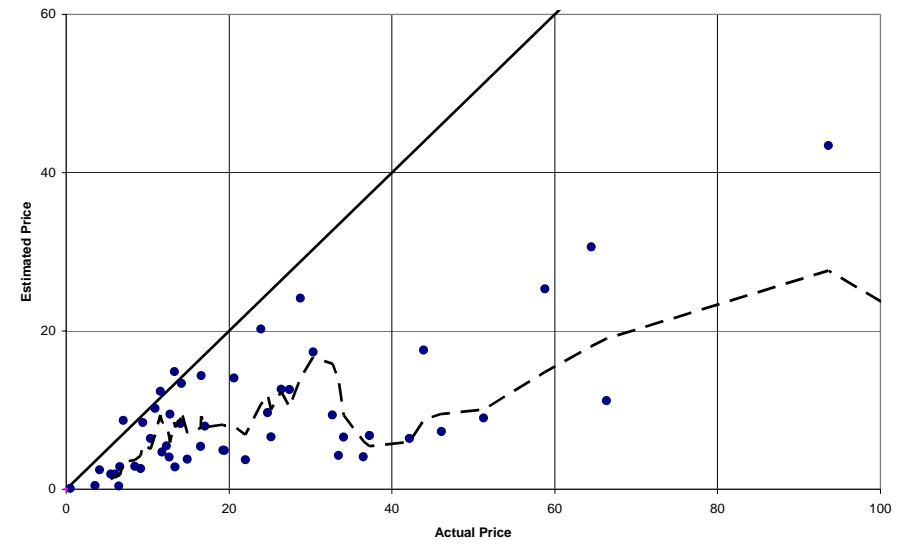


As we can see, the dashed line which is a trend line of the book values is far from the solid line which would mean a 100% accurate prediction of the actual price. Also, the  $R^2$  value is very low, which suggests that many of the companies deviate significantly from the average. We will try breaking down the graph to separate industries for more accurate conclusions.

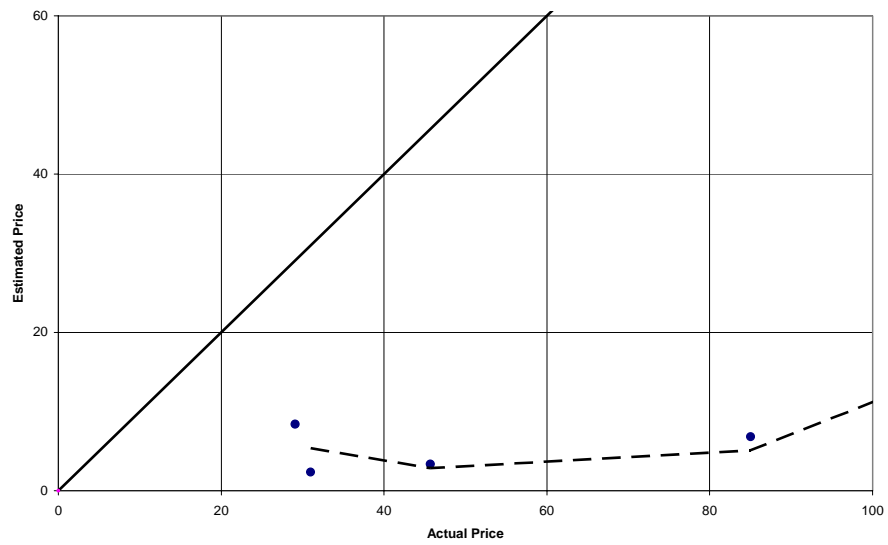
Book Value - Basic Materials



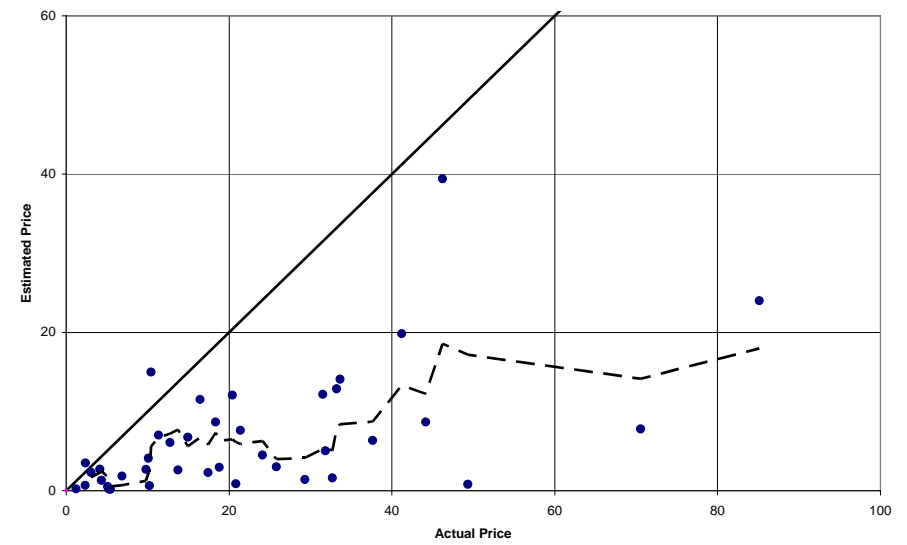
Book Value - Capital Goods



Book Value - Conglomerates

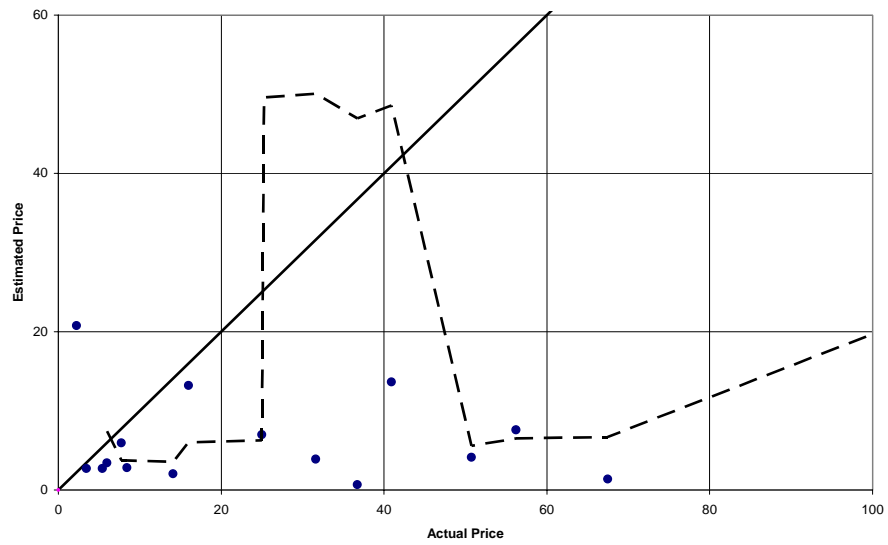


Book Value - Consumer Cyclical

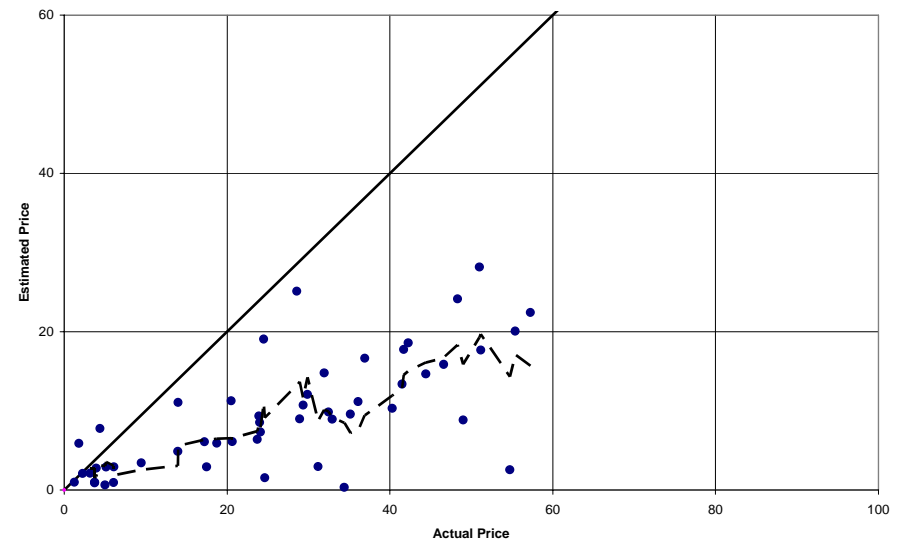




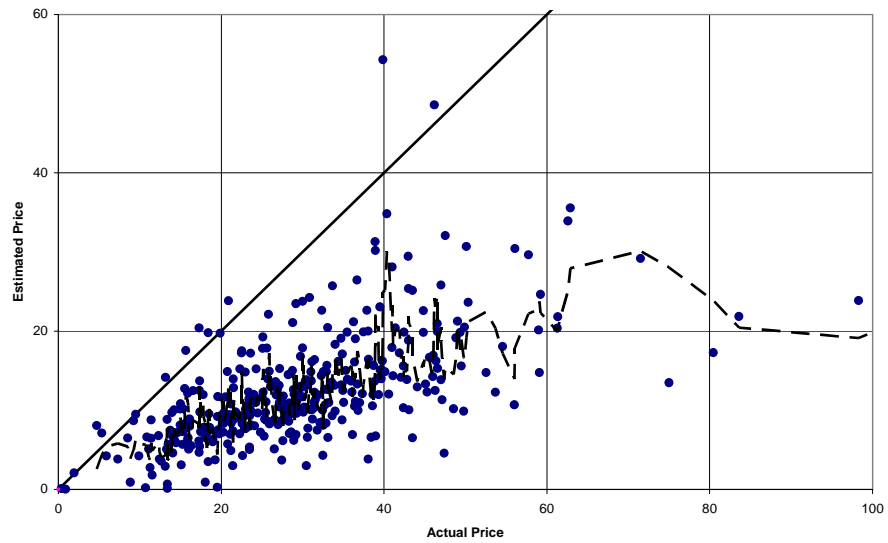
Book Value - Consumer Non-Cyclical



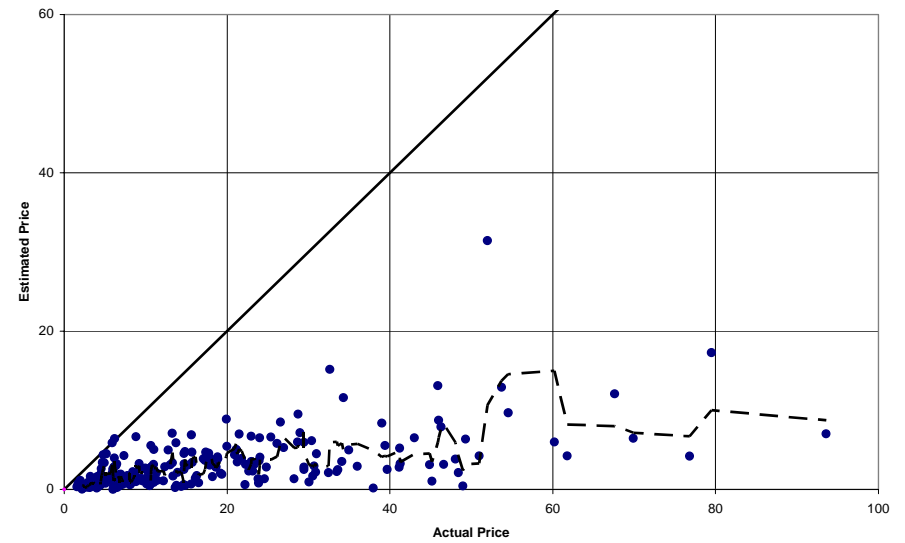
Book Value - Energy



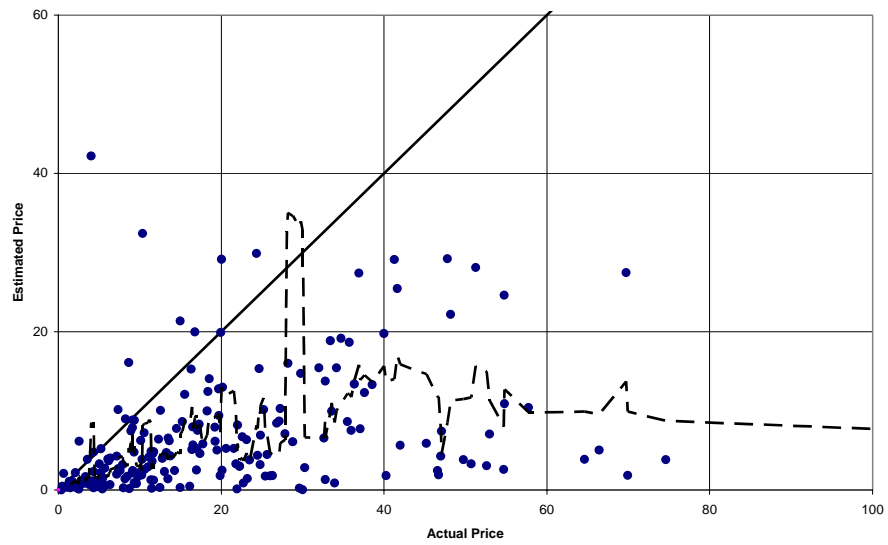
Book Value - Financial



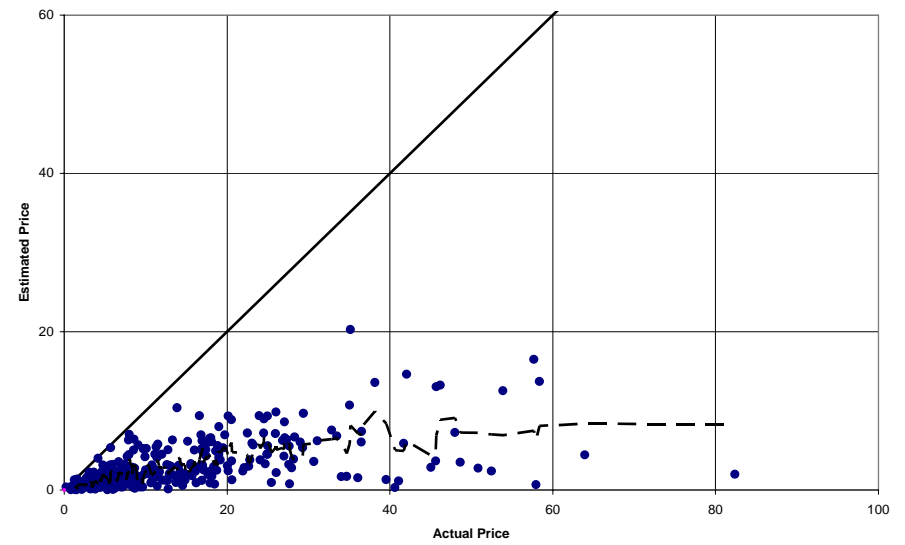
Book Value - Healthcare



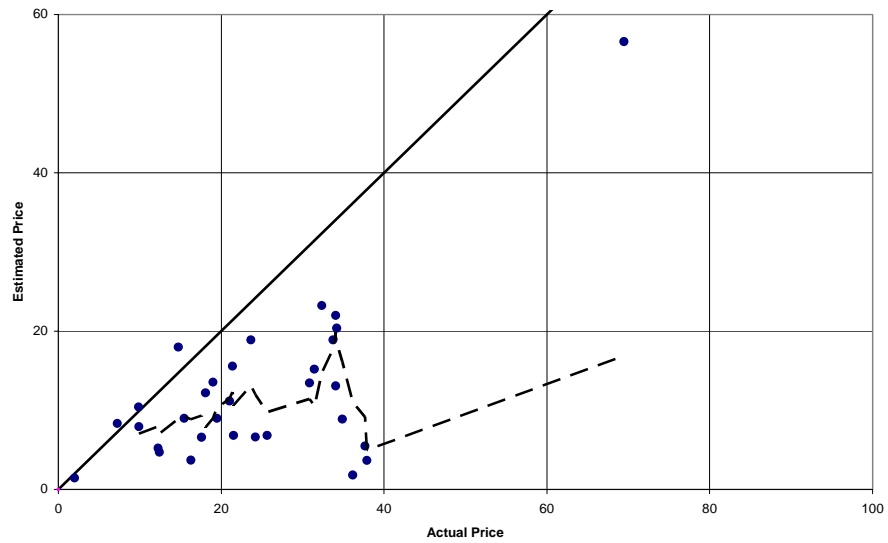
Book Value - Services



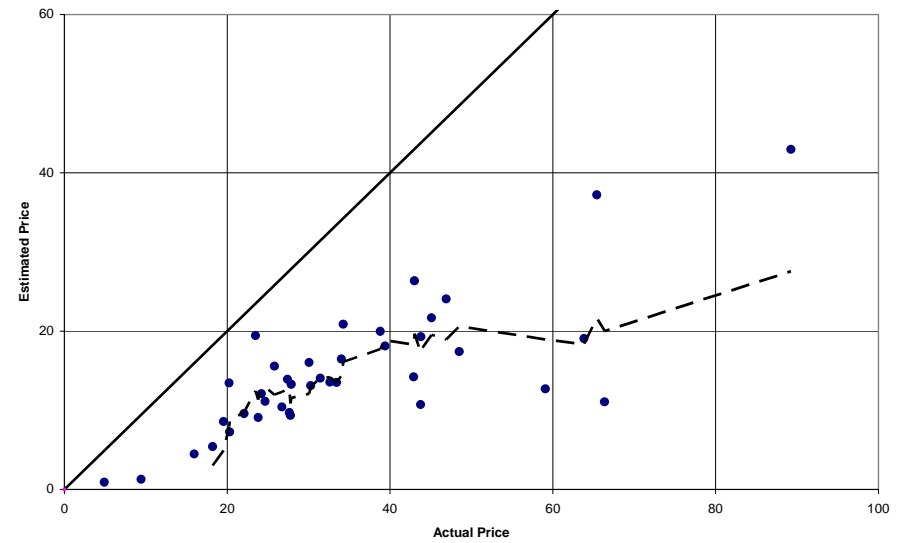
Book Value - Technology



Book Value - Transportation



Book Value - Utilities



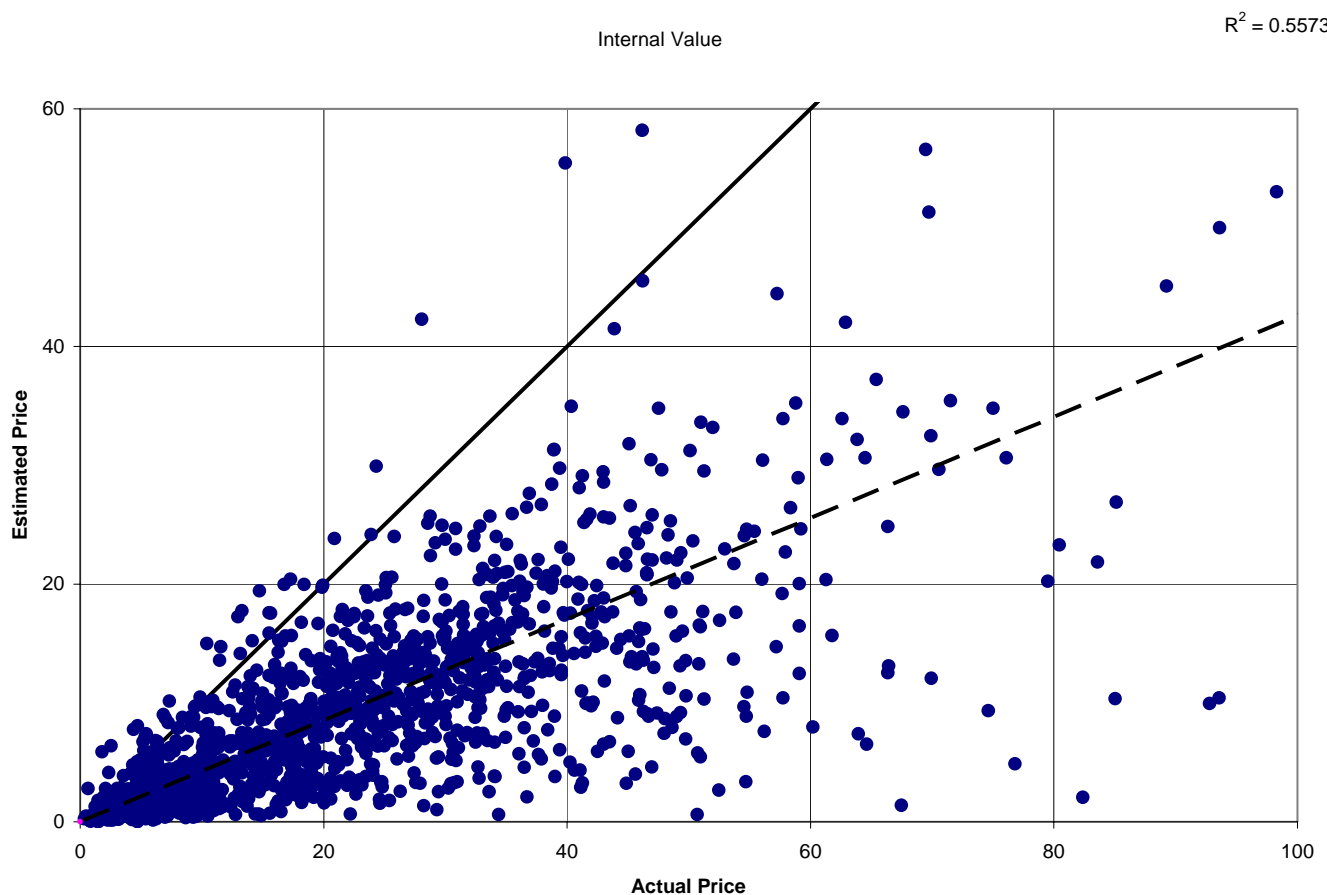
We could not use linear regression, to show the average trend, so a moving average of 3-6 points was used instead.

From the above we see some trends:

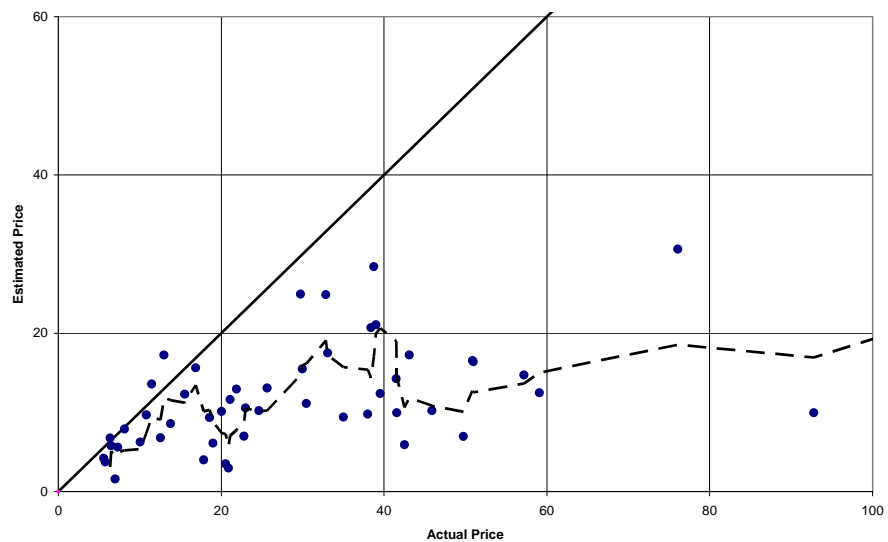
- Technology companies are more undervalued by the book value. A reason for that is the intellectual property, as well as other non tangible assets these companies hold.
- Financial companies are the best predicted by book value. The reason is that they mostly deal with cash and investments, plus their buildings, and all of that is well documented in their annual statements.
- There are some peculiar “spikes” in the moving average trend lines, that can only be explained with extra knowledge. For example the spike in Consumer Non-Cyclic graph is due to some smoke industries seeing their stocks fall after bad news about a multibillion dollar court decision.
- The healthcare sector has a surprisingly low book value. The next section will show us if the intangible assets will make up for the difference.

### 3.2 Internal Value

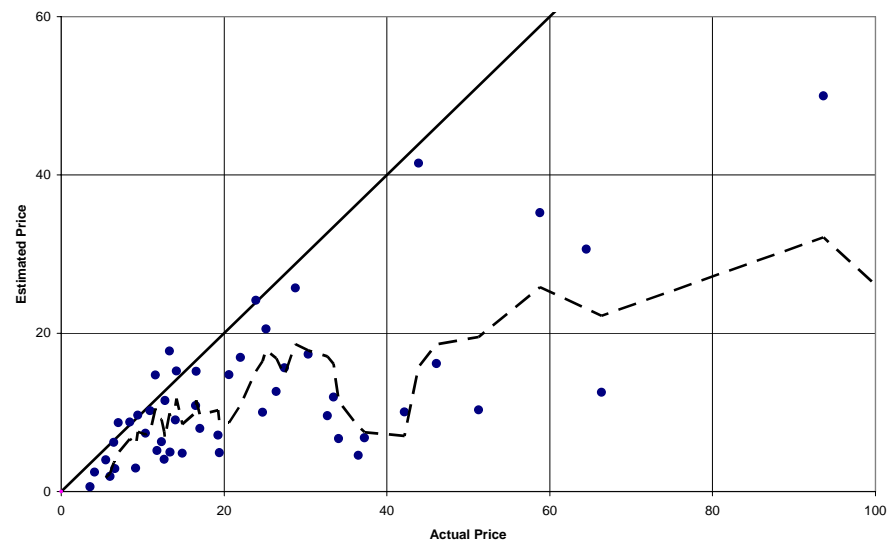
If we add the goodwill and the intangible value to the book value, we get a better estimation of the stock price. The  $R^2$  value has increased significantly too. We will break up again by sector.



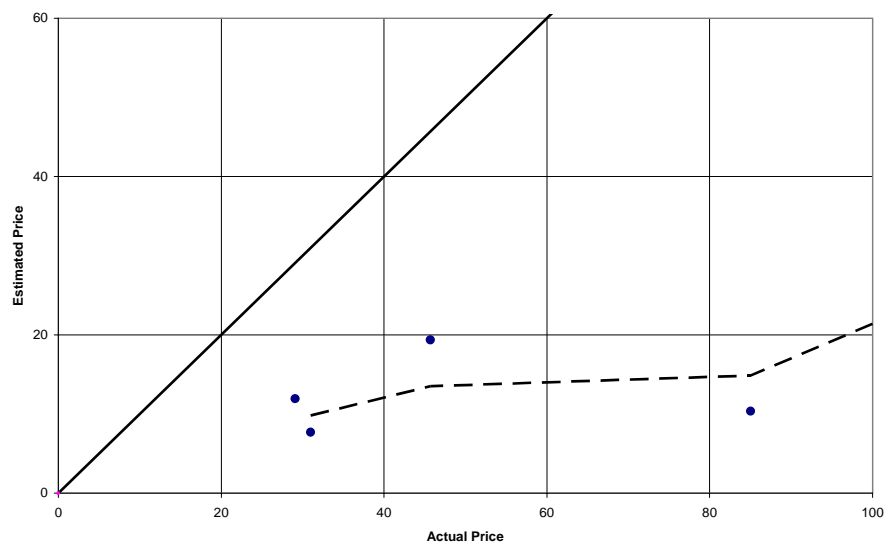
Internal Value - Basic Materials



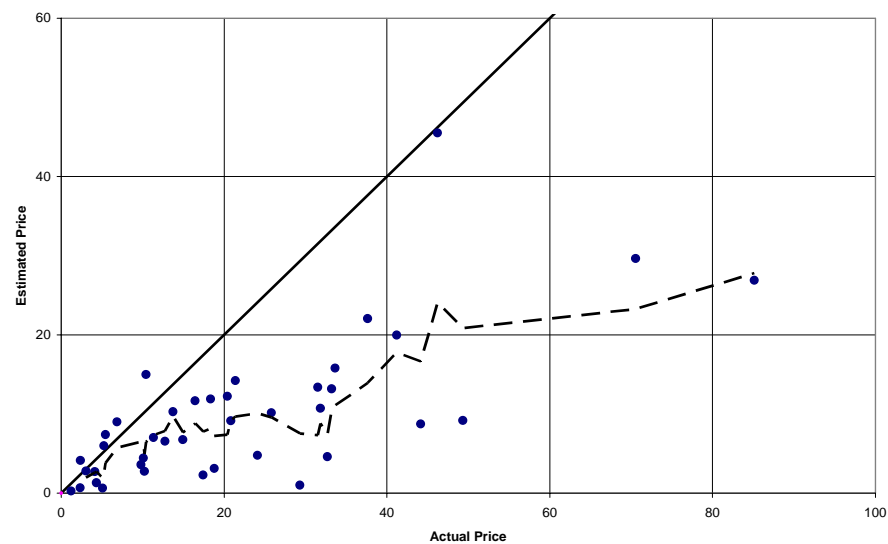
Internal Value - Capital Goods



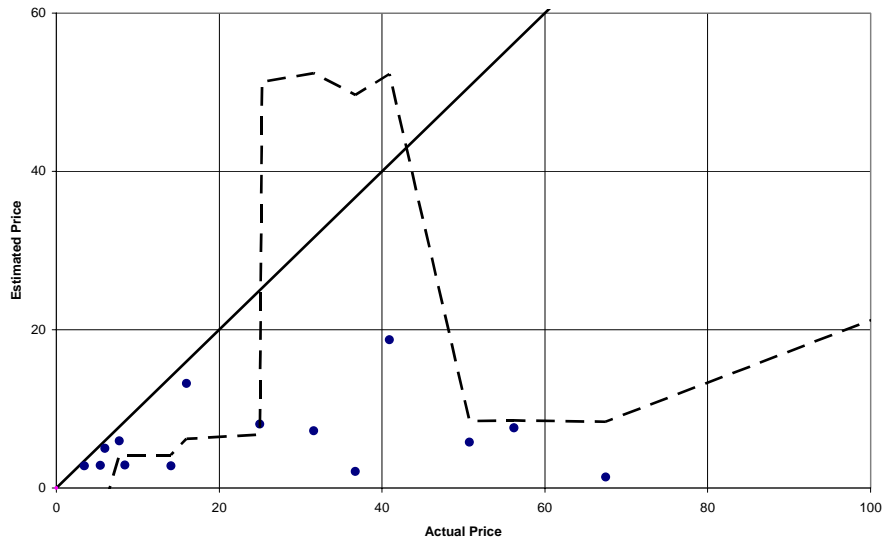
Internal Value - Conglomerates



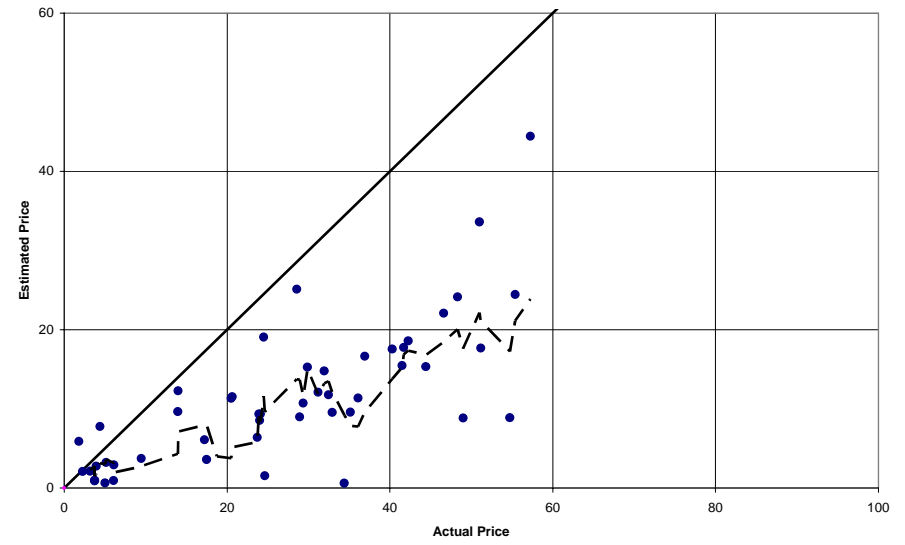
Internal Value - Consumer Cyclical



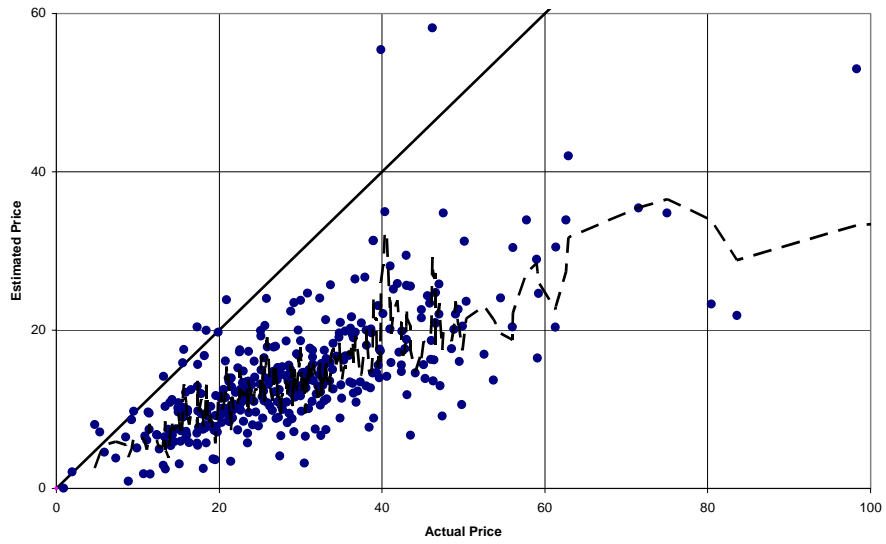
Internal Value - Consumer Non-Cyclical



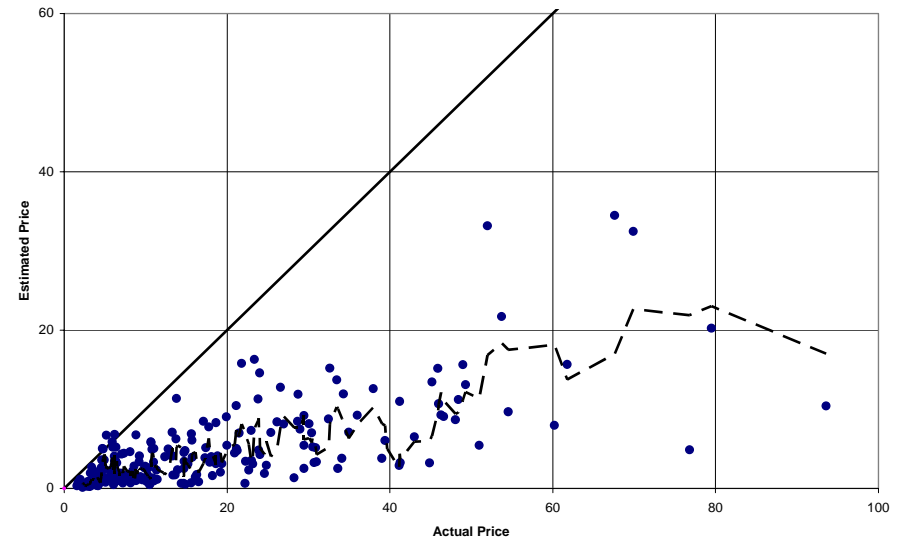
Internal Value - Energy



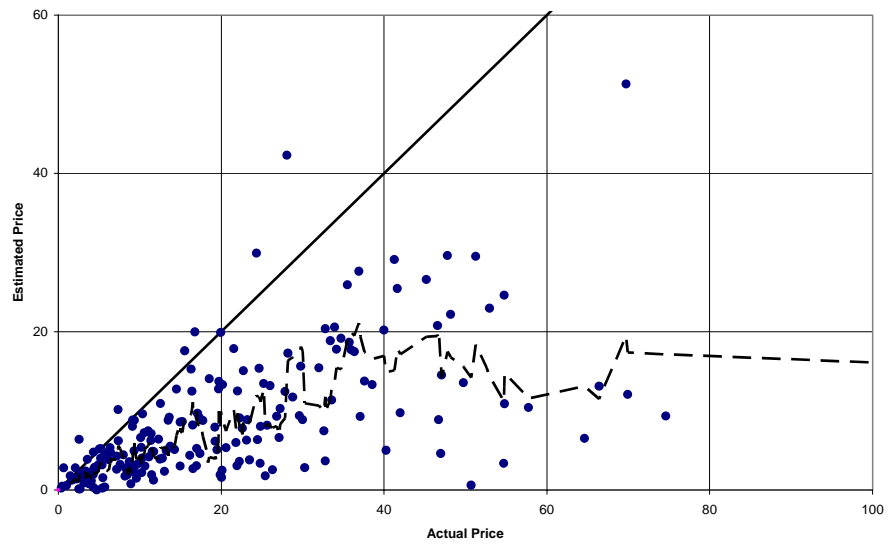
Internal Value - Financial



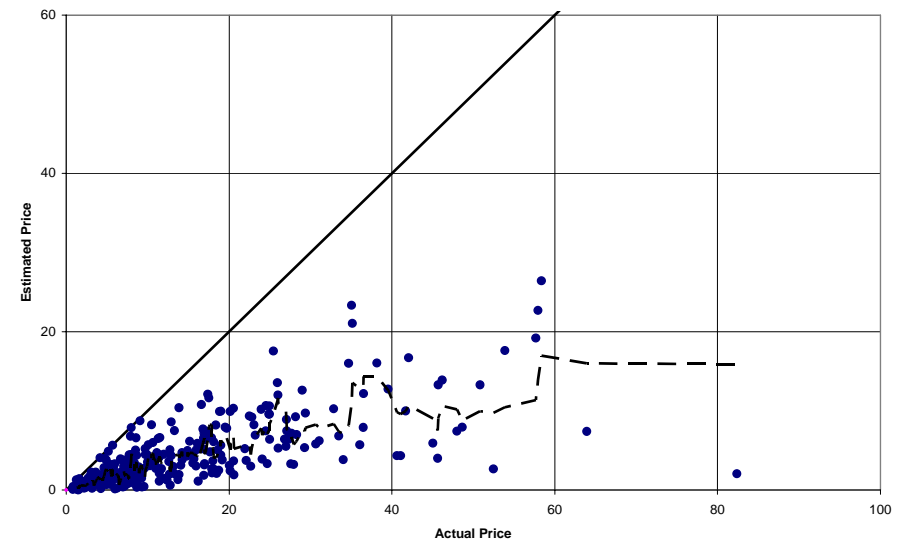
Internal Value - Healthcare



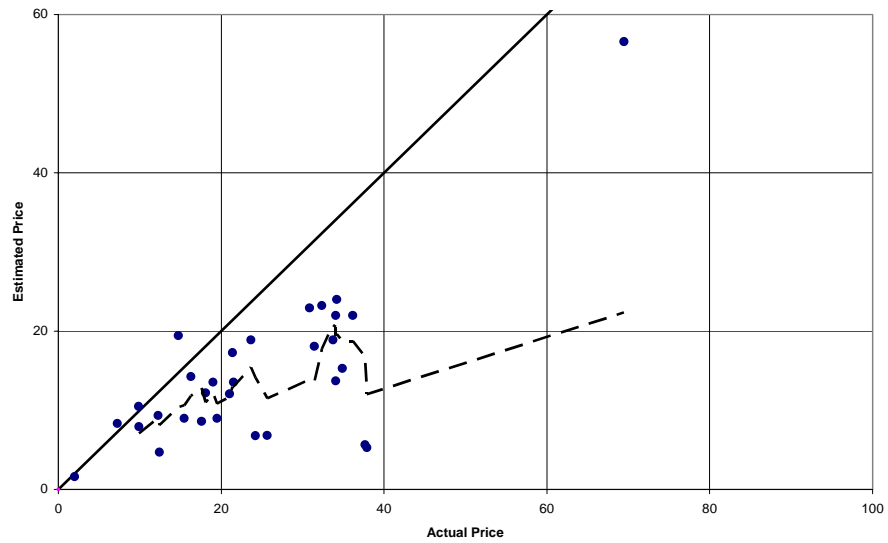
Internal Value - Services



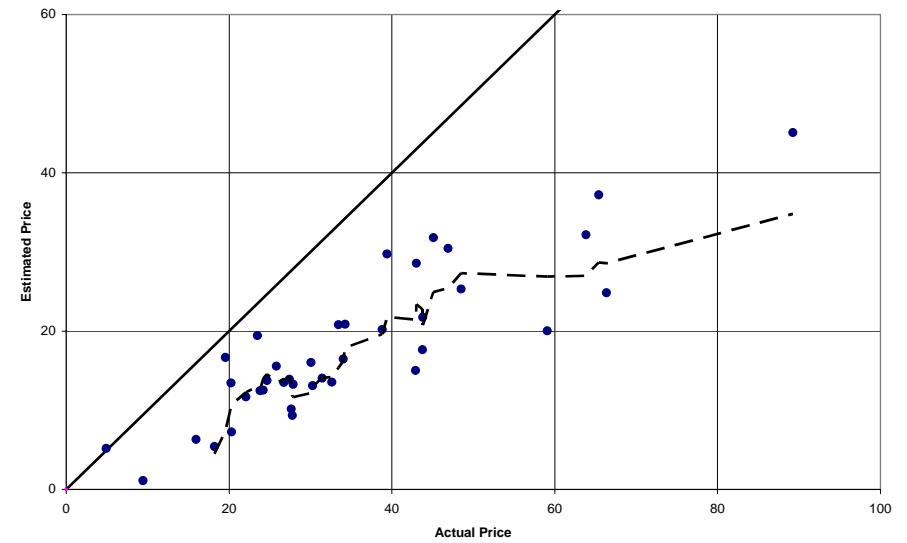
Internal Value - Technology



Internal Value - Transportation



Internal Value - Utilities



We can see that:

- There is an improvement in our prediction, in some sector more than others.
- The sectors that did not have a very low book value, like the financial sector, transportation or energy were not benefited.
- The Technology sector was the most benefited, due to the reasons we already stated (i.e. patents, other intangible assets).

## 4. Other measures.

To improve our predictions, we shall try more complex measures.

### 4.1 Internal + Dividends

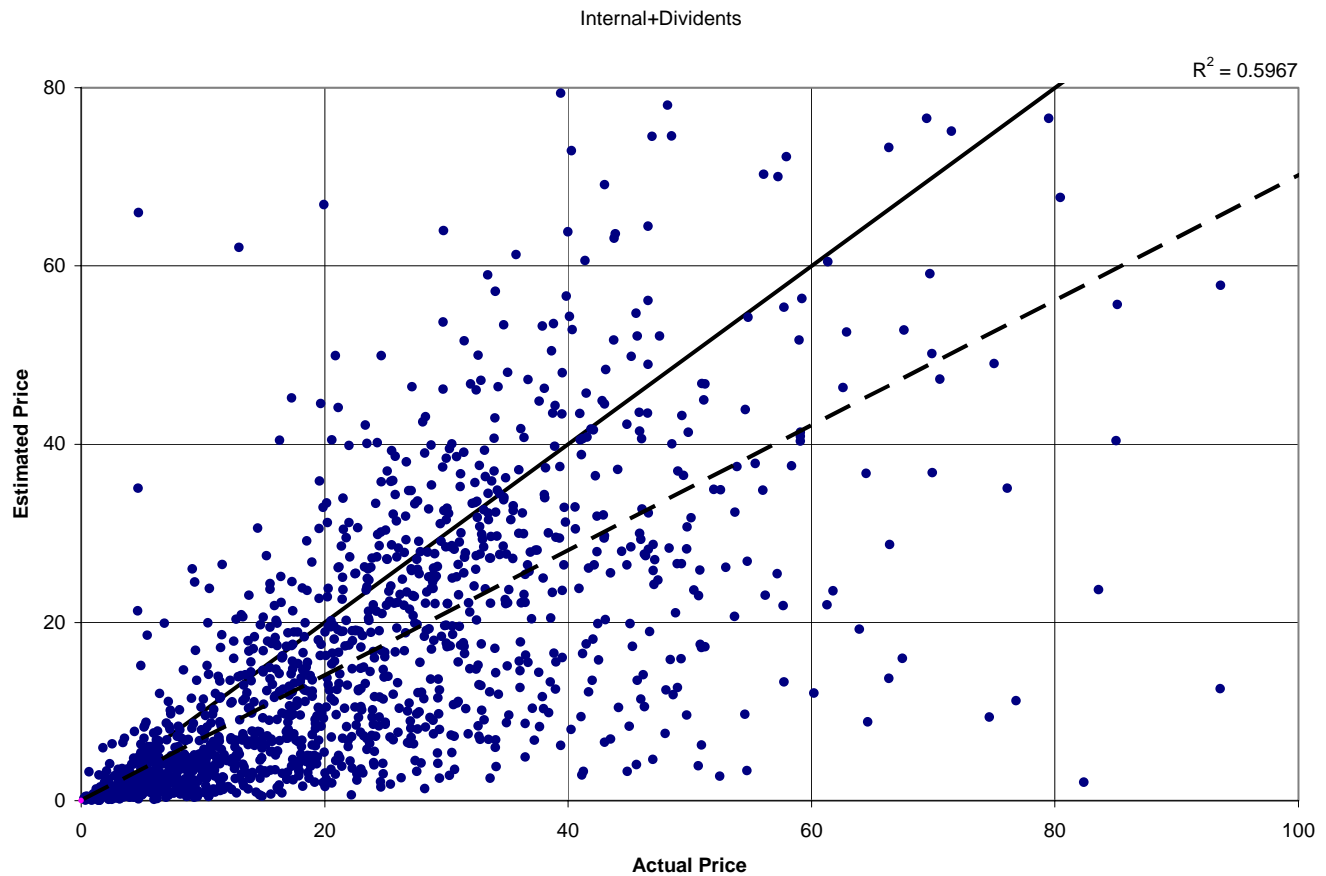
We start by adding the dividends to the internal value. The investor when buying stock is possibly also expecting dividends to be paid, something that would mean a return to his investment even if he is not trading the stocks. Our model will look like this:

- **Internal+Div = Internal Value** +  $\sum_{yr} a_{yr} \frac{Divident_{yr}}{Interest_{yr}}$

We notice that the risk involved is not calculated, ie the dividend is divided with the risk free interest rate.

As the graph shows, there is an improvement in our prediction, but the R<sup>2</sup> value is lower.

It seems that the stocks that pay dividends are overestimated due to the fact that we did not calculate the risk factor.



#### 4.2 Internal + Dividends (Corrected)

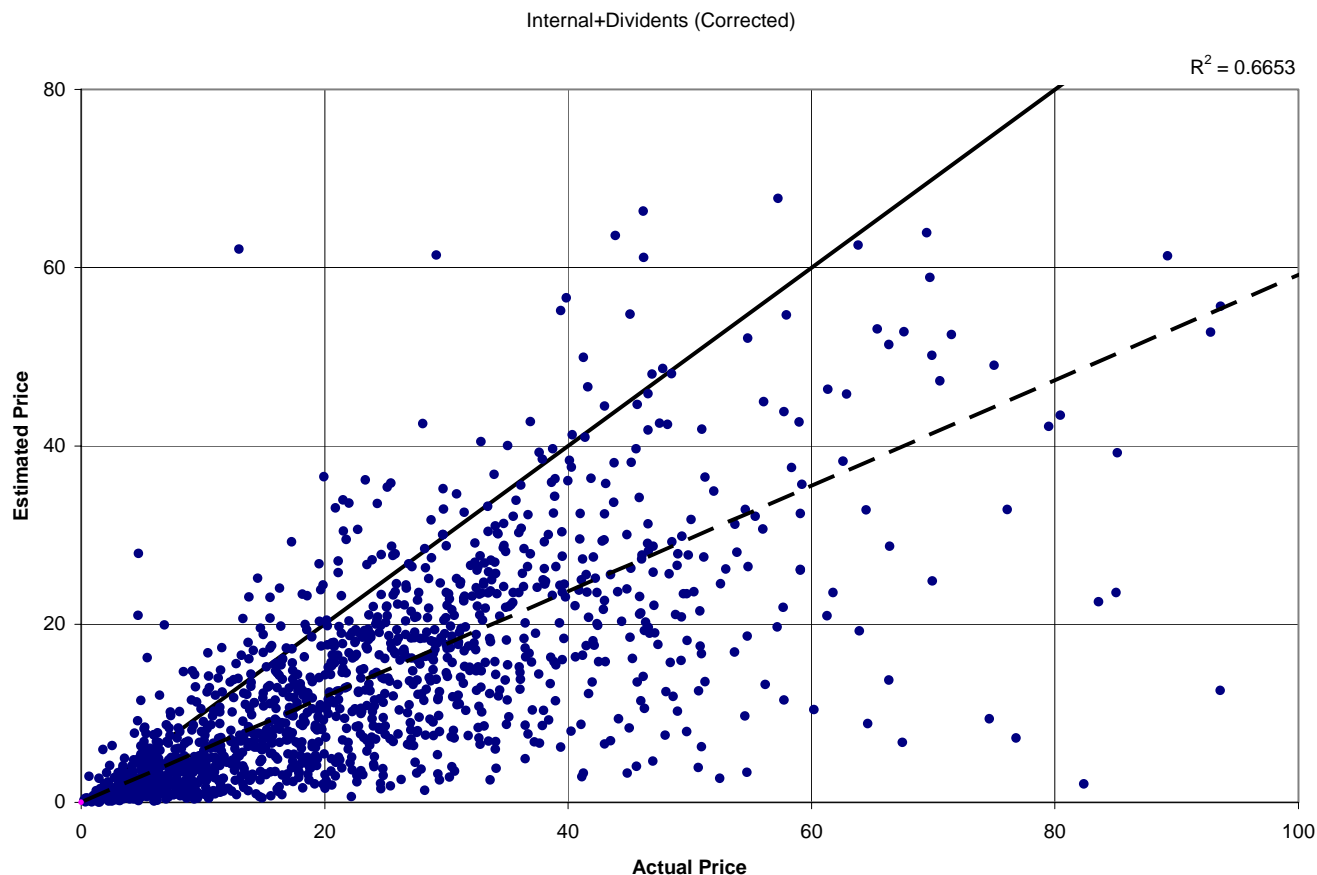
We will try to calculate the risk as a function of the market cap of a company. Our model is as follows:

- $$\text{Internal+Div 2} = \text{Internal Value} + \sum_{yr} a_{yr} \frac{\text{Divident}_{yr}}{\text{Interest}_{yr}} \cdot f(mCap)$$

Where  $f(mCap) = a \cdot mCap^b$  and  $a, b$  calculated through non-linear estimation.

The  $R^2$  value has improved a lot, as the dividend paying stocks are not overevaluated.





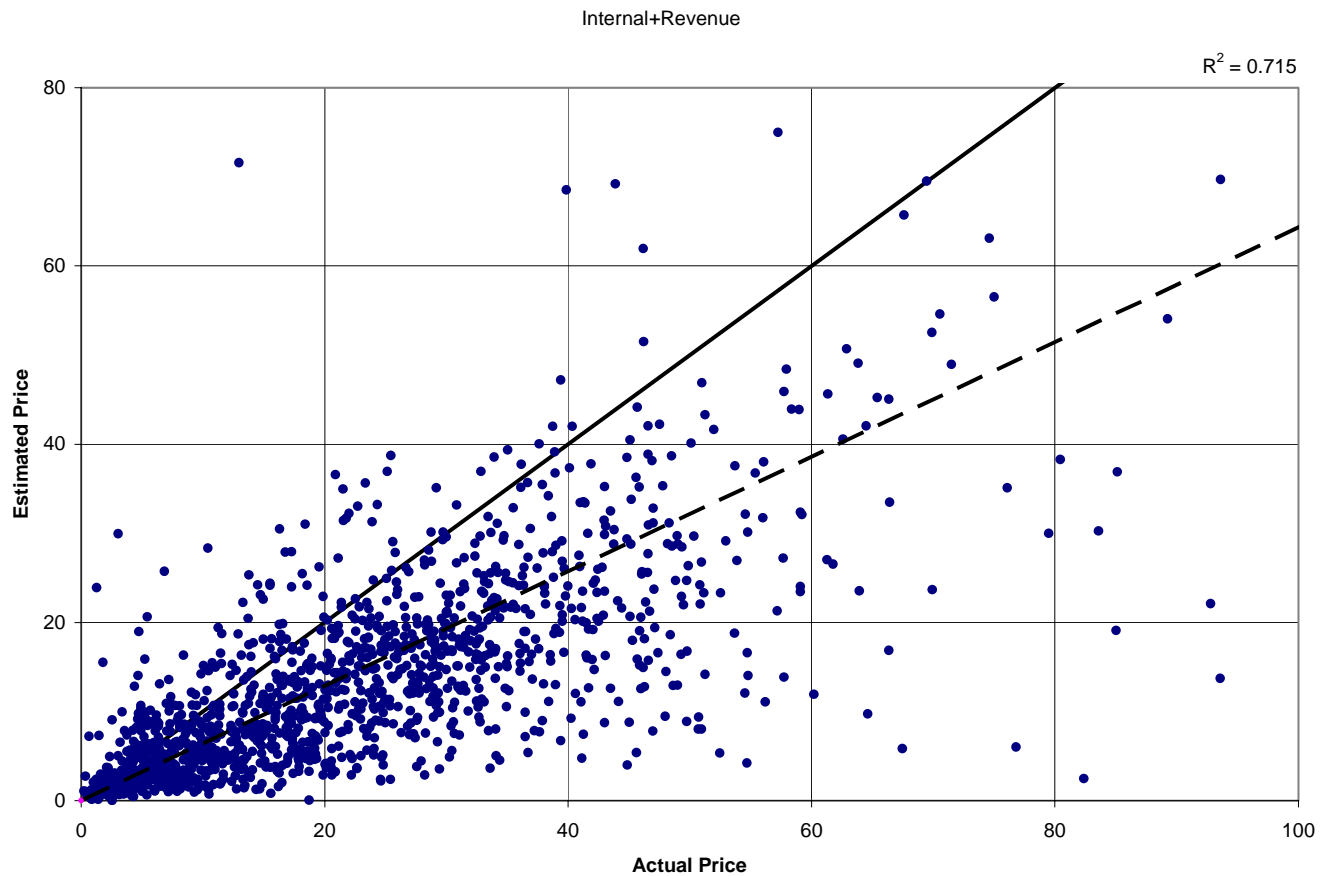
### 4.3 Internal Value + Revenue:

Supposing that some companies instead of giving dividends will use their revenues to invest in the company (e.g R&D), we could use a revenue based model instead of the dividends:

- $$\text{Internal+Rev} = \text{Internal Value} + \sum_{yr} a_{yr} \frac{\text{Revenue}_{yr}}{\text{Interest}_{yr}} \cdot b$$

Parameter **b** calculated through least squares.

This time the estimation is even better, as well as the  $R^2$  value. The calculation of **b** though, needs a good breakdown of the companies to have a clear meaning.



## 5. Investing

4 month investing comparison (January 1 - April 30 2004):

NYSE Composite: 0.4% loss.

NASDAQ Composite: 4.2% loss.

AMEX Composite: 3.4% gain.

Book value model : 4% gain.

Internal + Revenue model : 14% gain.