IS THE PRICE-TO-BOOK/RETURN ON EQUITY RATIO CONSTANT ACROSS SECTORS

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Abstract

This research paper investigates whether or not the Price-to-Book/ Return on Equity ratio is constant across the banking, retail, pharmaceutical and manufacturing sectors. The study makes use of statistical tests to determine if the ratio is constant. In addition, the research paper investigates the explicatory powers of the DuPont model, the Federal interest rate, and Consumer price inflation of the Price-to-Book/ Return on Equity ratio. This research documents evidence that the Price-to-Book/ Return on Equity ratio is not constant across sectors and that the explicatory powers of the DuPont model differ from sector to sector. The implications of these findings are that investors cannot apply the same Price-to-Book/ Return on Equity ratio across sectors when evaluating stocks relative to each other. This research highlights the importance of understanding the sector in which a stock operates, together with the importance of the decomposition of the Return on Equity into the DuPont components.

Keywords: Price-to-Book, Return on Equity, DuPont

Introduction

There are numerous valuation models available to investors today, some more complex than others. Significant research by Block (1964), Ohlson (1995), Fama and French (1992 &1995), Wilcox (1984 & 2005), Penman (1991) and Chung *et al* (2002), amongst others, has been performed on the valuation models with specific reference to the Price-to-Book Return on Equity (PB-ROE) model and their ability to predict stock prices. Among the various models, the PB-ROE valuation ratio has proven to be a successful predictor of future stock prices within a finite time horizon.

The value behind the PB-ROE valuation methodology is driven by the fact that the PB-ROE ratio is a two stage ratio. The ratio brings together both market factors and company specific factors. The market factors are considered in the Price-to-Book (PB) ratio and the company specific factors in the Return on Equity ratio. The research of Block (1964) describes the PB-ROE valuation ratio as completing the cycle of market and company analysis.

The PB-ROE valuation methodology takes all aspects of returns into consideration:

- yield
- growth in book value, and
- re-rating (Change in Price-to-Book ratio)

As can be seen from the above aspects, the price-to-book is a function of the distribution between dividend yield and book value growth.

The decomposition of the ROE gives the investor insight into how management is running the company. The decomposition of the ROE is found below:

$$ROE = \left[\left(\frac{Net\ income}{Revenue}\right) \times \left(\frac{Revenue}{Total\ Assets}\right) \times \left(\frac{Total\ Assets}{Equity}\right)\right]$$

The components of the DuPont can be summarised as net income margin, asset turn and leverage. Each component of the DuPont has different explicatory powers when it comes to the final ROE and, each component provides the investor with insight as to how management are generating returns or destroying value.

The net income margin highlights the profitability of the company. For example, how well is management is controlling costs, and is management growing the top line at the expense of gross margin? On the other hand the asset turn provides investors with insight into the efficiency of the company's assets, ultimately managements' efficiency in capital allocation.

Finally, the leverage ratio in the equation indicates how management is funding the growth, i.e. the level of gearing.

The decomposition of the DuPont grants investors insight into the engine room of the business. Looking at any one ratio in the DuPont model in isolation is relatively meaningless. The correct application of the DuPont model comes in understanding how the different ratios are interlinked. The DuPont model can be used both retrospectively to analyse historical ROEs and forecast ROEs. The historical normalised ROE can often be seen as a good proxy for future ROE in stable industries, as supported by Wilcox (1984) and Block (1964). Further research by Wilcox in 2005 confirmed that the explicatory power of the PB-ROE increases as the volatility of the ROE decreases. This finding of Wilcox (1984) is supported by the work of Chung *et al* (2002).

As highlighted above, the DuPont model is of great value when a company has a reasonable amount of history and the sector in which it operates is both mature and homogenous. The DuPont allows investors to determine which controlling variables have the most significant impact on the company's overall return and how these variables support the near term ROE forecast. The use of the historical DuPont components is essential in evaluating the forecast ROEs. With reference to the past, the investor is able to determine whether the forecast current balance sheet can support the forecast earnings, or whether additional capacity will be required and,/or if there is ability to increase leverage to support the capacity requirements.

Unlike the PB-ROE valuation methodology, the Price-Earnings ratio (PE), common to the income statement valuation models, is limited to earnings growth. Income statement valuation models often fail to take capital allocation into account, as the balance sheet efficiencies and inefficiencies are not evident from such models. By contrast, the PB-ROE model takes both the income statement and the balance sheet into consideration. In addition, the PB-ROE valuation model provides insight into management's allocation of capital, and it is through the allocation of capital that management either destroys or generates value. A company may have reported positive growth in EPS which will make the company look attractive on a forward PE basis. However, the earnings may have resulted in an ROE lower than the cost of capital or shareholders' required rate of return.

The above is an example of growing earnings at the expense of shareholders' value. Poor allocation of capital is not evident in the income statement valuation ratios. In the recent past, management have been enticed by performance based earnings linked to earnings per share (EPS) growth which has resulted in the demise of company valuations. True performance is ultimately unveiled through balance sheet analysis. Examples of the above include the large corporate scandals such as Enron, Worldcom and Xerox which have largely been driven by earnings manipulation.

Investors seek to identify companies that are able to generate a sustainable ROE. In today's highly competitive environment, companies are continually required to invest and reinvent themselves in order to maintain their competitive advantage and to generate investors' desired rate of return. When viewed in isolation, income statement valuation ratios can often be misleading, highlighting growth in earnings per share. Investors want to know how that increase in EPS was generated. Failure to understand a company's balance sheet and the use of PE ratios in isolation for assessing and selecting investments can result in investors misallocating capital to poor investments. Ultimately this will result in underperformance relative to the specific benchmarks, especially when valuations are seen to be stretched.

So-called value investors seek to identify companies that are trading at a discount to their intrinsic value. The PB-ROE valuation model is often seen as value investors' preferred valuation model because the PB part of the model provides a starting point in determining the discount or premium to book-value of the company. The PB-ROE valuation model is denoted below:

$$PB - ROE = \left(\frac{Market\ Cap}{Book\ value}\right) \div ROE$$

Investors often look at the PB ratio as their margin of safety should the company go bankrupt. A PB of less than one may indicate that a company is undervalued or that something is fundamentally wrong with the company. The value investor is seeking to maximise return through both a re-rating of the stock caused by the mismatch between PB and ROE and then through compounding of the ROE.

The valuation matrix below provides a high-level overview of the value investor's thought process when using the PB-ROE methodology.

Table 1: ROE and PB Valuation matrix

Overvalued with potential for de-rating Low ROE High PB	***Fair value*** High ROE High PB
Fair value Low ROE Low PB	***Undervalued with potential for re-rating*** High ROE Low PB

However, the PB ratio in isolation will not provide the investor with sufficient information to determine why the company is trading at the given level, since PB ratios differ from industry to industry. The ROE ratio provides the investor with insight into what is driving the PB rating of a specific stock. Research by Penman (1991) highlights that observed ROE is not a

good predictor of future profitability, but rather the components of the ROE. It is for this reason that we have highlighted the need to decompose the ROE into its various components to see how the components impact profitability and how these correlate to the price-to-book rating of the various companies. The PE valuation methodology along with other income statement valuation methods are one stage processes vs. the PB-ROE valuation methodology, which is a two stage valuation process. PE as mentioned above is only concerned with earnings while PB-ROE considers both earnings and the balance sheet. The one stage nature of the PE and other income statement valuation methods can be easily transferred between industries as they are seen to be a function of risk, growth, dividends, and other homogenous factors with final adjustments being made for company specific factors.

The transferability of valuation models can be discussed from two angles. One, the transferability of the methodology, and two, the absolute value determined using the specific valuation method. The absolute values for PE ratios are commonly used to value companies across multiple industries. Industries are not bound by a specific range of PE's. This is largely due to the one stage process the PE ratio follows. The transferability of the PB-ROE valuation methodology has been researched in depth and found true. To the researcher's knowledge, no research has been performed on the transferability of the absolute values.

Investors often use PE ratios as a form of ranking investments for portfolio construction. The transferability of the PE ratio makes it a widely used and oft preferred valuation method for ranking stocks. As discussed by Block (1984), there is no reason why investors cannot tie the PE ratio back to the balance sheet. This may highlight shortcomings such as excessive growth forecasts without considering the need for leverage which could result in a higher risk premium for a stock.

A ranking model using the PB-ROE framework would eliminate the exclusion of the balance sheet in evaluating stocks. Two of the weaknesses of the PB-ROE model are first, the user of the model as opposed to the model itself, and second, the second being the various explicatory powers of the ratio that are not captured by the ROE and the lack of history in certain sectors in different countries.

Users of the PB-ROE model often use constant PB-ROE ratio across sectors. The shortcomings could be significant in a ranking model that has stocks in multiple sectors. The implications could be positive or negative depending on the sector's PB-ROE relationship compared to the constant applied to the ranking model.

Similar to other valuation models, the PB-ROE model fails to highlight the explicatory powers of variables not captured in earnings or ROE. Typical examples of these variables are those that can be listed under the Porters five forces model. Though often not quantifiable,

such variables have an impact on the valuation of a company relative to its peers and on a sector by sector basis.

It has been highlighted that the PB-ROE model is a good valuation model for companies for which there is both a history and a stable ROE. This is often not the case when looking at stocks in emerging markets.

Section 1: Research objective

This research investigates whether the use of a constant factor is appropriate across sectors. In addition, the research looks at the explicatory powers of the ROE components and how they differ from sector to sector. Though not directly addressing the issue of explicatory powers of the non-financial variables, the research rather highlights the importance of the financial variables in the DuPont model. The research focuses on the companies listed in the developed markets, namely the United States of America. Therefore, the third weakness has not been addressed in this research report and could be considered as an area of further research on the topic.

Determining/assuming a PB-ROE ratio for a sector immediately implies the support of the mean reversion principle. Mean reversion of ROE has been researched and found to be common in stable industries. This is intuitive given that excessive profitability attracts competition which in turn normalises earnings over time for companies and sectors. Therefore, one would expect there to be a median PB-ROE relationship for sectors with stable histories. As a result, investors can determine the potential/desired ROE of the company based on its current PB rating or, inversely, the investor can calculate a sector based implied PB ratio. This would allow the investor to determine whether the company is undervalued relative to the industry in which it operates. This principle can be applied both retrospectively using historic PB's and ROE's and prospectively if forecast ROE's are available. This is fine when looking at sectors in isolation. The interest of this research lies in the ability to bring multiple industries together in a ranking model using the PB-ROE valuation model and to be able to avoid bias for a specific industry.

In the event that the PB-ROE relationship is found to be constant across sectors, the ability to build a ranking model would be easy as no adjustment factor would be required to put all of the investments on a level playing field. If the PB-ROE factor is not proven to be the same across the sectors, investors need to understand what differentiates the relationships and need to build this into their investment process.

Wilcox found that the PB-ROE relationship is linear when looking at specific sectors, and goes further to note that the PB-ROE relationship is useful when industries are ignored. A strong linear relationship was evident for Wilcox's (1984) sample. However, the slope of the

line was dependant on whether the companies were low or high return companies. Wilcox's (1984) initial research was very limited in terms of the time series used.

One would expect the PB-ROE relationship to be similar for companies in mature industries, due largely to the function of competition. This research paper attempts to expand on Wilcox's research on the PB-ROE model, with specific reference to the transferability of the PB-ROE relationship across different industries. Wilcox's (1984) research highlighted that the PB-ROE methodology was transferable across industries/sectors. However, Wilcox (1984) failed to address whether the PB-ROE relationship was constant across industries/sectors and whether or not this factor was transferable. Wilcox (1984) briefly touched on the slope of the PB-ROE line changing for companies with higher and lower ROE's, but there was no investigation into what caused the change in the slope of the line. Investors are interested in what drives PB ratings.

The first objective of this research paper is to determine if the PB-ROE relationship is constant across sectors, and the second objective is to determine the explicatory powers of the DuPont components in the PB-ROE ratio for different sectors. This paper attempts to compare sectors in which companies are relatively homogenous. The researcher has selected to evaluate if the PB-ROE relationship is constant across sectors by comparing the PB-ROE relationship of the retail, pharmaceutical and motor and electrical manufacturers to that of the banking sector. This research has two intended outcomes: 1. determine if the PB-ROE relationship is constant across sectors or not, and 2. determine if the components of the DuPont model have different explicatory powers across different sectors, and how this could support the findings in part one. The outcome of this research will assist investors who make use of the PB-ROE valuation methodology in their assessment of stocks across multiple sectors, since according to the researcher's knowledge, no empirical research has been performed on the PB-ROE relationship across multiple sectors.

The researcher has selected the New York Stock Exchange (NYSE) for the research. The NYSE is because the NYSE was the most appropriate exchange based on the population size of companies across the selected sectors. The researcher has attempted to capture the full economic cycles by using a twenty year time series, and has further attempted to reduce survivorship bias by performing the tests on companies in the following four time series: twenty, fifteen, ten and five years.

The methodology undertaken follows that of a statistical nature. Multiple statistical tests that test for the differences in means have been used to evaluate whether the PB-ROE relationship is constant across the different sectors. The use of sector means vs. individual companies in isolation is to eliminate the unsystematic company risk experienced by individual companies. In addition, the area of interest is that of the sector as a whole, not on a company level. An un-paired t-test and chi-squared test have been selected to test for the difference in means. The aforementioned tests are performed using the banking sector as

the benchmark. The banking sector has a significant amount of history, relatively stable ROEs and though not proven, it is often seen as a bellwether of the greater economy.

The aforementioned tests will provide the researcher with one of two outcomes: 1.The difference in means is statistical significance, and as a result the PB-ROE relationship is not constant between sectors and cannot be transferred; 2. The difference means across the sectors is not significant and the constant ratio can be transferred between sectors. The results will address the initial research question of whether the PB-ROE relationship is constant between sectors. In order to understand the results from the difference of means test, the regressions are performed on the PB-ROE relationship for each sector. The PB-ROE ratio is regressed against the components of the ROE, namely, net income margin, asset turn and leverage.

The selection of the aforementioned variables for the regressions was based on their importance in understanding the historical ROEs were achieved, how the forecast ROEs will be achieved and how these variables are all interlinked. It is anticipated that the regressions will highlight how variables have different effects across the various sectors. In addition it is anticipated that the regressions will highlight the most important variables for each sector. The information content of the regressions will therefore highlight the components of the DuPont that the investor should focus their attention on. The R-squared of the regressions will highlight the significance of the variables in determining the PB-ROE relationship.

In addition, the PB-ROE is regressed against both the annual Federal interest rate and the annual CPI inflation rate. The objective is to capture the impact of economic stance of the Federal Bank and the impact of inflation on the PB-ROE ratio.

The results of the un-paired t-tests indicate that the difference between means is statistically significant at the 95% confidence interval for two of the three sectors when compared to the banking sector. The retail sector is the exception where difference between means is not statistically significant at the 95% confidence interval.

The results of the chi-squared test varied across the sectors and time series. In some situations the results affirmed the results of the un-paired t-tests in section 4.1, and in other instances the results were contradictory. The incoherence and inconsistency of the results in section 4.1 and 4.2 indicate that the PB-ROE relationship is not constant across sectors and therefore cannot be transferred.

The regression model used highlighted the importance of the variables in determining the PB-ROE ratio, with specific reference to the banking, manufacturing and pharmaceutical sectors. All of these sectors had an R-squared in excess of 0.5. In line with our expectations, the regression model highlighted that the variables had different explicatory powers in the different sectors. The difference in explicatory powers further confirms the results of

section 4.1 and 4.2; that is, that the PB-ROE relationship differs from sector to sector and hence is not transferrable.

The paper layout is as follows:

Section 2 literature review.

Section 3 presents the data and sources used together with the methodology used to analyse the PB-ROE relationship across the different sectors. In addition, it discusses the controlling variables used in the regressions.

Section 4 presents the empirical findings of the research paper and a discussion on the findings of the results.

Section 5 presents the researcher's final conclusion and provides suggestions for future research on valuation ratios.

Section 2: Literature review

There have been a number of research papers published on the PB-ROE valuation model which highlight its strengths and weaknesses. Despite the attention given to this area of finance, the research on the difference in the relationship across sectors and what drives theses differences has received very little attention. This is despite its relative importance when using this valuation methodology in the investment process across multiple sectors.

PB-ROE valuation methodology and ROE decomposition

The significance of the PB-ROE relationship was discussed by Block (Sep.-Oct.1964). Research performed by Block (Sep.-Oct.1964) highlights the importance of the PB-ROE relationship based on its ability to draw together both internal and external factors of price, such as market and company specific factors. The research supports the description of the methodology as a two stage process.

Block (Mar. – Apr. 1964) focuses the first stage of the PB-ROE methodology, the PB ratio. Block (Mar. – Apr. 1964) highlights the importance of the book value in share valuations, especially given information content of the balance sheet in terms of current market values. Block (Mar. – Apr. 1964) highlights that investors are willing to pay a premium for price-to-book valuation for quality management who are able to grow both earnings and book value through efficient management of the company from operations through to capital allocation. On the other hand, Pares (1980) tackles the second stage of the ratio, the ROE. He seeks to expand and improve on the use of financial statements in practice. Pares (1980) critiqued the DuPont model and proposed an extension to it. The notion that once an investor understands the sector he will then be able to evaluate individual companies relative to the sector was highlighted. Pares (1980) said: *"*The analyst would then examine the different ratio coefficients over time and/or against corresponding industry averages. From this he is supposed to be able to identify the strengths and weakness of the company.*"*

Furthermore, Pares (1980) highlighted a weakness in conventional methods in financial analysis: conceptual clarity. He believed that looking at the multiple ratios in a piecemeal method would not provide the critical information content of the ratios. According to Pares (1980), "it would seem that the astute analyst will allow for the interrelationship between the different ratios in spite of the piecemeal method of analysis being used. One would expect the astute investor would decompose the ROE into its various components and understand the implications of changing one component on the remaining two components". He was less critical of the DuPont model, based largely on the ability to identify the links between the ratios that made up the ROE. Pares (1980) went one step further by decomposing the DuPont model to further understand the impact of leverage. The Return on Equity Decomposition model was developed which had five factors/components compared to the norm of three. The components were: margin, asset turnover, balance sheet gearing effect, income statement gearing effect and tax.

Though more focused on the first stage of the PB-ROE model, Block (Sep.-Oct.1984) concludes his research by stating that profitability is one of the most significant factors in determining the prices

paid for securities. Block (Sep.-Oct.1984) highlights that the use of asset-based valuation methodologies such as PB-ROE need not inhibit the concept of discounting future values. Rather, they provide the advantage of forcing the equity analyst to understand the assets supporting or need to support the anticipated growth. The key theme of understanding the balance sheet is in line with the work of Pares (1980). The research of Penman (1991) stated that ROE in absolute terms is not sufficient for determining future profitability and recommended that further research be performed on the decomposition of the ROE. Penman (1991), Pares (1980) and Block (Sep.-Oct.1984) highlight the importance of the PB-ROE model and the need for ROE decomposition.

This supports the use of the DuPont model in attempting to understand the differences between the PB-ROE relationship across the sectors selected for this research report. This research has provided further confirmation and support for the PB-ROE model without including insight into the relationship across sectors.

Predictability of PB-ROE Model

Penman's (1991) research is focused on what ROE means for pricing stocks. Penman (1991) looks at ROE as a measure of both risk and profitability, and his research indicated that ROE could best be interpreted as a profitability measure and not a risk measure. He further highlighted that observed ROE indicated future profitability (ROE) and therefore distinguishes PB ratios. Penman's (1991) research is seen to support the use of the PB-ROE valuation methodology provided the ROE is understood via decomposition of the DuPont Model. Fama & French (1992 and 1995) later focused on the impact of size on returns and the impact of higher PB valuation ratios on returns. The results indicated that small stocks tend to be less profitable than large stocks. Stocks with higher PB ratios tended to be more profitable than those with low PB Ratios. The work of Fama & French (1992 and 1995) was supportive of the PB-ROE model as a preferred valuation methodology. The work of Penman (1991) and Fama & French (1992 and 1995) was supported by research performed by Ohlson (1995).

Ohlson (1995) was instrumental in understanding the predictability powers of the PB-ROE model. He developed an equity valuation model that brought together the market value (Price) with the accounting fundamental (ROE). One of the key features of the model was the use of accrual-based accounting techniques for earnings. This is very important because as financial statements are prepared on the accrual basis under both US GAAP and IFRS. This new model allows the user to make use of financial data as presented in the companies' annual reports. Ohlson's (1995) model has been empirically validated, thereby supporting the researcher's idea of using a PB-ROE valuation ranking model. The model demonstrates that the company's market value is the sum of the book value and the present value of an infinite series of earnings net of capital charges.

Ohlson's (1995) model highlighted that the current PB ratio was a positive function of the expected future ROE's and growth and expected growth in book value. Future ROE's are predictable from past ROE's. Chung *et a l*(2002) expanded on Ohlson's (1995) research with specific reference to the time horizon over which the ROE impacts the PB ratio. Ohlson (1995) stated that the PB is a function of the present value of an infinite series of earnings net of capital charges. The fact that ROE cannot be forecast for an infinite horizon was the result in Chung *et al* (2002) undertaking this research. The findings of Chung *et al* (2002) were that the explicatory powers of ROE diminish within a finite

horizon. The finite time horizon determined by Chung *et al* (2002) is based on a five year forecast period. The explicatory powers of future ROE are found to be significant only over a three year period. Chung *et al* (2002) found that the PB-ROE relationship was stronger when accrual earnings were used for measuring ROEs vs. cash flow earnings. The results of Chung *et al*'s (2002) work provide further support for the use of a PB-ROE ranking model with a finite forecast period. *Chung et al* (2002) found that mean reversion was stronger for high ROE companies than for low ROE companies.

PB-ROE methodology and transferability between sectors

The issue regarding transferability was discussed by Wilcox (1984). Wilcox (1984) initially looked at two industries and found a strong linear relationship between the PB and ROE which highlights that investors are willing to pay more for companies that provide high ROE's. In addition, Wilcox (1984) found that ROE has the property of using the past as a useful predictor of the future over a wide range of industries and stock classes. Wilcox's (1984) research covered three industries over two periods: 1976 and 1989. He then took a sample of 1013 stocks across different sectors and plotted the PB-ROE relationship for one year, finding a strong linear relationship. Wilcox (1984) found that the slope of the best fit line differed for industries with high and low ROE's. Thus, his research indicates that the principle of PB-ROE relationship is transferrable, but does not address whether or not the PB-ROE relationship is constant between sectors.

Wilcox (2005) revisited the PB-ROE model and provided further evidence supporting the PB-ROE model's ability to explain cross-sectional differences in valuation and predict future stock returns. Unlike his previous work, Wilcox (2005) extended his time series to cover a much longer period. He noted clustering of residuals within industries in the t-test performed.

Despite the evidence in difference in PB-ROE relationships across sectors, no further work was performed to try and understand the explicatory powers behind the differences.

As is clear from the above literature review, there is sufficient literature covering the use of the PB-ROE valuation model as both an acceptable and preferred valuation methodology. In addition, the literature highlights the importance of the ROE decomposition. However, there is little to no research on whether there is a difference in the PB-ROE relationship across sectors, and if so, what drives these differences. It is for this reason the researcher has chosen explore this area.

Section 3: Data and Methodology

3.1 Data

The research paper looks at the relationship of the PB-ROE relationship across different sectors. The researcher has attempted to select sectors that are internally homogenous, and as such has selected the following sectors for the analysis: banking, retail, pharmaceutical and motor and electrical manufacturing. Each sector will be compared to the banking sector over the selected time series. The use of multiple time series is to reduce survivorship bias and increase the sample size. The number of companies with a twenty year history ranges from fifteen to fifty-one and five years of history from fifty-seven to 132 across the sectors selected for testing. The sample period covered is December 31, 1990 through December 31, 2009. The twenty year time series captures bear and bull markets, as well as multiple market shocks such as 1999 financial crisis, the dot.com bubble and September 11, 2001, to name a few.

To avoid bias, the researcher initially used all of the companies under the specified sectors actively listed on the New York Stock Exchange (NYSE) as at December 31 2009. The use of a single stock exchange such as the NYSE ensures the consistent use of accounting principles which ensures the homogeneity of the financial statement items used to calculate the financial ratios. The financial statements have been prepared using the principles of accrual accounting. The sample takes all companies with a minimum of five years' history into consideration. The sample is therefore not biased toward long established companies.

The data used in the research paper includes: PB Ratio, ROE ratio, market cap, total debt-to-equity, net income, total revenue, total assets and total equity. The ROEs, net income and total revenue are computed using accrual basis of accounting. This is consistent with the findings of Chung *et al* (2002), namely that the PB-ROE relationship is stronger when using accrual based earnings. This data was extracted annually at the end of the calendar year, and was extracted on a company level.

The PB-ROE relationship calculation along with the decomposition of the ROE was performed on an annual basis at the company level. The PB-ROE relationship was computed annually by taking the historic ROE divided by the price-to- book ratio. In order to get a reflection of the entire sector, the median of the PB-ROE, net income (NI), asset turn and leverage were calculated for each of the time series. The median for each of the above mentioned ratios was calculated excluding negative values to assume normalisation. The idea to exclude negatives was supported by research by Freeman (1992 and 1995), Ohlson (1995) and Penman (1982), namely that ROE is mean reverting over time. The reason for grouping the companies and using the median excluding negatives for each year is an attempt to reduce and/or diversify non-systematic risk associated with individual companies.

The decision to use the banking sector as the benchmark is based on the highly regulatory environment in which the sector operates. Though not proven, the banking sector is often seen as a bellwether for both the health and expectations of the economy as a whole by investment professionals.

The choice of the NYSE for the case study was supported by the number of companies listed under the specified sectors. In order to draw a conclusion from the sector samples, the NYSE was the exchange with the most companies and longest history in the required sectors.

All data used in this research report has been obtained from the Bloomberg data base. The PB and ROE ratios were obtained from Bloomberg to ensure consistency in the formulas used. The use of a single data base has been applied to ensure homogeneity of the financial data used for the research paper.

3.2 Methodology

The approach this research paper takes to addressing the research objectives is a statistical analysis approach. This approach was adopted from work performed by Wilcox (1985) and Chung *et al* (2002). The evidence of mean reversion of both PB and ROE in stable industries supports the use of means for testing. The research is focused on whether or not there is a difference in PB-ROE means across sectors. The most appropriate method of testing for difference in means is one of a statistical nature. Statistical regressions have been used to determine the explicatory powers of the DuPont model components on the PB-ROE ratio.

The data has been prepared as follows: the average PB-ROE relationship was computed for each year for all of the companies in the given time series. Negative PB-ROE ratios were excluded from the calculation of the average for any given year.

Three tests were performed to determine if the PB-ROE relationship was constant throughout the sectors considered in this research report. The tests are as follows:

1. An un-paired t-test was performed to investigate whether there is a difference in means for the different sectors when compared to the banking sector. The test was performed over each of the four time series for each of the sectors.
2. A chi-squared test was performed to evaluate the goodness of fits between the different sectors when compared to the banking sector. Again, the PB-ROE means were used for the test. This test serves to confirm the results of the first test.
3. The third test compares the controlling variables across the different sectors. The objective is to see what drives the PB-ROE relationship in the different sectors and if these variables can explain the results of test one and two.

The objective of test one and test two is the same, but the process is different. Applying two different tests will provide for a more conclusive argument should the results be supportive. The results of the tests are presented in section 4 of the report. First the results for the un-paired t-test and chi-squared test are presented and compared. The conclusion on whether the PB-ROE ratio is constant and can be transferred will be determined by the outcome of the aforementioned tests. The regressions will then be presented and discussed in the context of each sector and the results of the un-paired t-tests and chi squared tests.

3.2.1 Testing for difference in means

An un-paired t-test is used to test if the two samples are likely to have come from distributions with equal population means. An unpaired two sample t-test assuming unequal variances has been used to test the difference in means. The test performed is a parametric test, because the data is in the form of a ratio and the data sets are independent.

The use of this test is to determine if the PB-ROE relationship experienced in the banking sector is similar to that of the retail, manufacturing and pharmaceutical sectors. The test is performed on

each of the four time series. All of the times series are tested as the number of companies increases as the time series gets shorter.

The researcher is therefore able to consider the results of all four time series, and whether or not the results are accurate or a function of short term deviations from the mean. Hence significantly more credibility will be put on the twenty, fifteen and ten year time series than that of the five year time series. In addition, the long time series will reduce the impact of once-off economic cycles that may be industry specific. The long time series are expected to cover all of the economic cycles and include once off market shocks.

There is no statistical significance in the use of the banking sector as a benchmark. The objective is merely to evaluate each sector against the same benchmark. If the results conclude that the mean difference is insignificant for each sector in relation to the benchmark the constant PB-ROE relationship of the sectors will be considered transferable.

The null hypothesis has been set as follows:

H_O: $\mu_A=\mu_B$

H_1: $\mu_A\neq\mu_B$

Confidence interval used in testing the null hypothesis: 95%

The un-paired t-test is represented by the following formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S_{x1x2} \cdot \sqrt{\frac{2}{n}}}$$

Where

$$S_{x1\,x2} = \sqrt{\frac{S_{x1}^2 + S_{x2}^2}{2}}$$

The un-paired t-test is of a parametric nature and therefore requires a number of stringent assumptions. The distribution is assumed to be normal. Each observation must be independent of each other and the data must be continuous. The un-paired t-test should not be used when the differences between the two variances is expected to be large. The un-paired t-test works well where the sample population is large as opposed to small.

In the event that the t-tests are found to be in favour of the null hypothesis across all sectors the PB-ROE relationship will be considered transferrable. In the event the null hypothesis is rejected the PB-ROE relationship will not be considered transferable.

3.2.2 Testing for goodness of fit

A chi-squared test has been selected to determine the goodness of fit between the banking and other sectors. The chi-squared test is considered appropriate as it attempts to determine whether the PB-ROE relationships of the given sectors is similar or not to that of the banking sector. Should there be a difference, it needs to be determined whether the difference is due to a sampling error or a real difference. The expected PB-ROE relationship has been set to that of the banking sector in all three cases. The test was performed on each of the four time series over the three sectors.

The confidence interval used in the chi-squared test has been performed at the 95% confidence interval.

The results of the chi-squared test can be used as a source of confirmation for the results obtained from the un-paired t-test.

The null hypothesis has been set as follows:

H_O: $\mu_A=\mu_B$

H_1: $\mu_A\neq\mu_B$

Confidence interval used in testing the null hypothesis: 95%

Chi-square distribution is represented by the formula below:

$$Chi\ squared = \sum \frac{(a-e)^2}{e}$$

Where:

a = Observed Frequency in each category

e = Expected Frequency in the corresponding category

The chi-squared test is one of the most commonly used non-parametric statistical tests. This test has a number of strengths and weakness that need to be considered when evaluating the results of the tests. The ease at which the test can be computed is a clear advantage. In addition, the tests can be used on data which have been measured on a nominal scale. The chi-squared test does not require the assumption of normal distribution or variance assumptions about the population. The following are some of the key weakness of the chi-squared test; the test fails to give the strength of the relationship or its substantive significance, the test is very sensitive to sample sizes and the test is very sensitive to small expected frequencies. The chi-squared test has accepts weaker, less accurate data as an input than parametric test and as a result has less status despite being widely used. It is for this reason we have not performed a chi squared test in isolation.

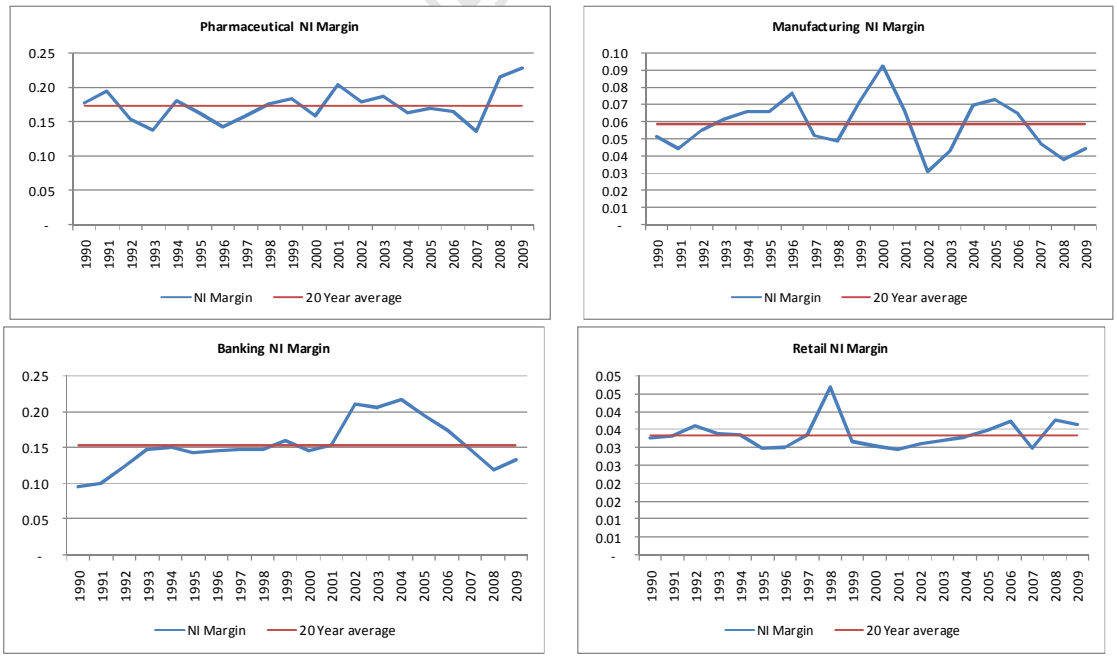
3.3 Regression model

In order to understand the results of the tests performed in 3.2.1 and 3.2.2 regressions have been run on the PB-ROE ratios. Penman (1991) highlighted the need to decompose the ROE to understand the driving factors behind the ROE. The information content of the DuPont analysis is paramount in understanding both the individual companies and sectors as a whole. The controlling variables selected for the regressions were therefore those of the DuPont mode: net income, asset turn and leverage. In addition to the aforementioned variables the Federal interest rate and consumer price inflation where selected to be included in the regression model. The information content of the DuPont model has been dissected below and the importance of each component of the model had been discussed.

Net income Margin (Net Income/Revenue)

The net income margin tells us how profitable a company has been and will be with forecasts. A retrospective analysis of the net income margin allows the investor to infer whether the current margins are sustainable, whether there is a trend in top-line growth at the expense of gross profit margin, whether management has control over operating costs and if the company experience significant cyclicality with respect the economic cycle. Using net income as opposed to earnings before interest and tax ensures the impact of both taxes and gearing is taken into consideration. Over time competition will result in normalisation of margins of a specific sector. The charts in figure 1.1 highlight the average margins achieved for each of the industries over a 20 year basis. The charts highlight the mean reversion of the margin over time and the sensitivity to economic cycles.

Figure 1.1: Net income margins 20 year series



Data source: Bloomberg

By looking at the industry as a whole the unsystematic specific risks companies face are diluted. On an individual company basis the investor is able to see if a company has the potential for margin expansion or if margins could fall under pressure relative to the industry. The last two components of the DuPont model help the investor deduce what may cause the margin expansion or contraction.

Asset Turn (Sales/Total Assets)

The asset turn indicates the efficiency of the company's use of assets to generate revenues. Stable long established industries provide investors with a solid benchmark to compare to companies in the given industry. The asset turn can highlight the inefficiency of a company's assets relative to its sector. This could be a result of poor allocation of capital by management to non-income generating assets or an obsolete or dated asset base which in turn highlights the need for significant capital expansion. This draws the investors' attention to the company's capital requirements and the risk of capital raising.

On the other side of the spectrum, excessive asset turn relative to the industry highlights a need for capital expansions, which in turn could flow through into lower margins if and when new capacity is added. Investors need to ensure the link is made between revenue growth and asset growth. Failure to link the two could result in overestimation of ROE due to the exclusion of asset growth to support the top line growth. Asset turn which transfers into improved net income margins highlights efficient and optimal capital allocation and hence, rational management. An example of poor allocation of capital is when management make large acquisitions at excessive valuations which result in large goodwill figures on the balance sheet. As the goodwill is not a tangible asset enhancing profitability, it dilutes the asset turn ratio and can ultimately depress the ROE. A company's balance sheet is therefore of great importance when forecasting growth.

Figure 1.2: Asset-turn 20 year time series

Data source: Bloomberg

The charts in figure 1.2 above highlight the significance of the asset base when comparing sectors. Investors need to familiarise themselves with the sector average before setting excessive return on asset targets. When combining both the net income and asset turn charts the investor is able to determine if the margin expansion or contraction is coming from increased or decreased asset utilisation or cost optimisation below the line. The extent to which asset growth will have a positive impact on the net income margin is a function of the source of finance for the capital expansion. As long as the return on assets is greater than the cost of funding, whether it be the interest charge on debt or the required rate of return by investors the, ROE will increase and vice versa.

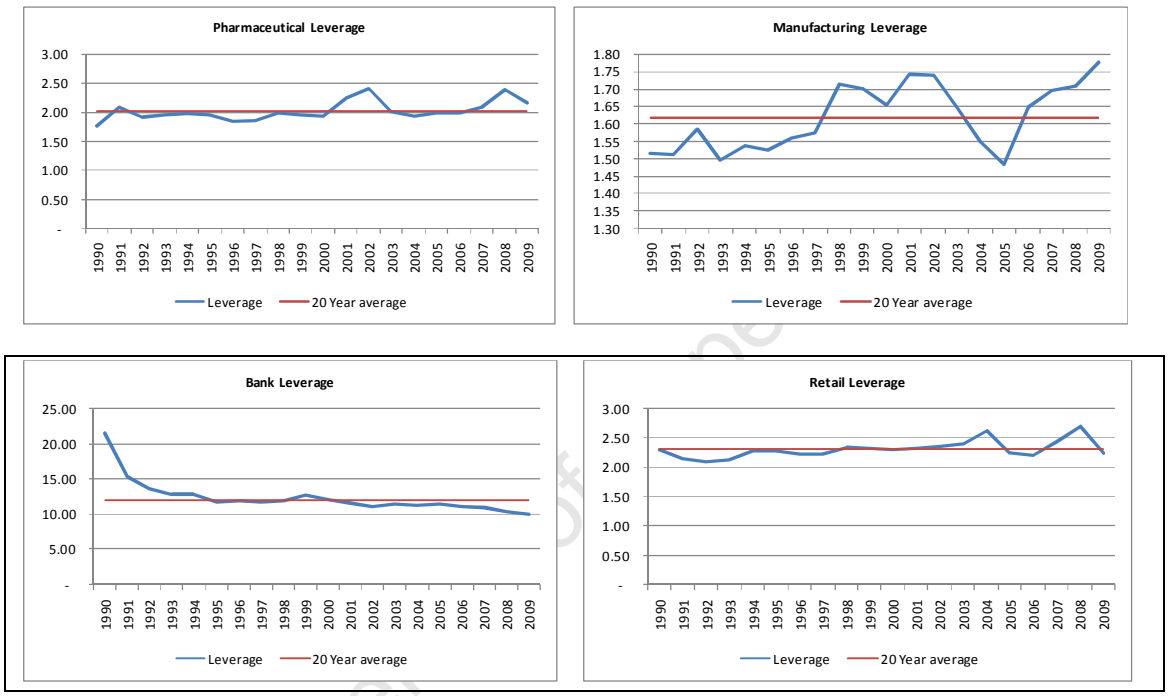
Leverage (Assets/Equity)

Leverage has the ability to make or break a company. Finding the ideal capital structure is an art, not a science. The leverage ratio highlights how a company is funding its assets. The two source of funding are debt and equity. The impact of leverage comes through in both the net income component of the DuPont via the interest expense line item and the asset turn via the total assets. Each industry and each company in the industries has a threshold when it comes to gearing. The threshold is a function of return on assets. As mentioned in the asset turn section above, the company can gear to the extent that the return-on-assets (ROA) is greater than the cost of funding. Once the company breaches this threshold it is no longer feasible to leverage. Bear in mind that excessive leverage is considered risky and can put undue pressure on companies. It is imperative that the investor understand the company's leverage position. The leverage ratio highlights the company's reliance on debt finance, and as a result, the exposure to both interest rate and liquidity risk.

By comparing companies to the sector average the investor is able to assess whether the company has scope for further gearing relative to its peers. Similar to asset turn, the investor cannot forecast top line expansion without the asset base to support the expansion, and similarly, the asset base cannot be increased without access to funding whether it is from free cash flow or additional gearing.

The charts in figure 1.3 below highlight the different levels of gearing across the sectors.

Figure 1.3: Leverage 20 year time series



Data source: Bloomberg

The discussion above highlights the importance of decomposing the ROE. Using a PE ratio in isolation to value companies can result in the misallocation of investments due to lack of understanding of the company's financial state at the time of investing. Linking of the earnings in the PE ratio to the underlying assets and liabilities of the company help the investor in assessing forecast earnings. The investor is able to analyse both the attainability and sustainability of the forecast earnings given the company's current balance sheet structure. The investor can then infer whether or not the company requires additional funding, if funding will be available, and how this may impact the investment case.

Federal Lending rate and Consumer Price inflation

In addition to the above variables, consideration was given to the consumer price inflation rate and the Federal Bank interest rate (Fed rate). Both variables are considered by the investor in determining their desired rate of return and are an integral part of equity valuations.

The Fed rate influences the PB-ROE ratio in both the PB and ROE components of the ratio. In the PB ratio, the Fed rate influences the price investors are willing to pay for stocks. The impact of an upward sloping yield curve is often negative for stock markets and hence depresses prices and vice versa. On a company level, the Fed rate influences the bank lending rates and required bond yields, and hence has a direct impact on the net income component of the DuPont, depending on the company's leverage. When forecasting changes in gearing, it would be foolish to ignore the Fed rate. It is therefore imperative to take cost of external finance into consideration, as this influences net income margins and potential debt covenants. The use of the aforementioned economic statistics is important as it highlights the industry's exposure to the variables.

We have estimated the following model for each sector.

$PB\text{-}ROE = \beta_0 + \beta_1 mrg + \beta_2 at + \beta_3 lev + \beta_4 r + \beta_0 Infl + \mu$

Where:

$\beta_1, \beta_2, \beta_3$ and β_4 are coefficients

β_0 = Constant term

μ = error term

mrg =Net Income margin

at = asset turn

lev = Leverage

r = interest rate

Inf - Inflation

The equation was estimated using ordinary least squares (OLS) using the Stata 11 program.

Before performing the regressions the data was tested for heteroscedasticity, multicollinearity and autocorrelation. This was done to ensure that we get best linear, unbiased estimates. We tested for heteroscedasticity using the Breusch-Pagan test. Multicollinearity was tested using the variance inflation factors (VIF). The VIF above 10 indicates that multicollinearity is a problem. The Durbin-Watson and Breusch-Godfrey test were both used to test for serial or autocorrelation. The former focuses on first order autocorrelation, while the latter tests for higher order autocorrelation.

These tests were performed on both the twenty year and ten year series for each sector. Refer to table 4.3 in section 4 for the results.

Heteroscedasticity means that the variances of the error terms are different. Estimating OLS in the presence of heteroscedasticity leads to inefficient estimators.

Multicollinearity means that the regressors are linearly related. Estimation of OLS in the presence of multicollinearity leads to imprecise estimation. Standard errors tend to be large in relation to the estimated coefficients

Autocorrelation means that there is correlation between the error term μ. This shows that the disturbance terms relating to any observation are influenced by the disturbance terms relating to other observations (Gujarati 2004). The presence of autocorrelation leads to inefficient estimators, which indicates that the OLS estimators are no longer the best.

Section 4: Results

4.1 Testing for differences in means

The underlying un-paired t-tests can be found in appendix A of the report.

The results of the two-sample t-tests are discussed by sector below. In situations where the null hypothesis has been rejected under the t-critical two-tail the researcher has considered the results of the t-critical one-tail for further confirmation. Only in such instances has the researcher presented both the t-critical one- and two-tailed results. The results of the t-tests have been tabulated for each sector and the specific time series.

Banking and retail

Table2.1: Unpaired t-test results matrix banking and retail

	20 years	15 years	10 years	5 years
t Critical two-tail	✔	✔	✔	✔

The results of the t-critical two-tail allow the researcher to conclude in favour of the null hypothesis for the banking and retail sector across the four time series. The results provide statistical significance that the PB-ROE relationship is constant and can be transferred from the banking sector to the retail sector.

Banking and pharmaceuticals

Table2.2: Unpaired t-test results matrix banking and pharmaceutical

	20 years	15 years	10 years	5 years
t Critical two-tail	✘	✘	✔	✔
t Critical one-tail	✘	✘	✘	✔

The results of the t-critical two-tail allows the researcher to reject in favour of the null hypothesis on both the twenty and fifteen year samples. The rejection in favour of the null hypothesis is further supported by the results of the t-critical one-tail which rejects in favour of the null hypothesis over the twenty, fifteen and ten year samples.

The rejection of the null hypothesis in the two largest time series indicates that over time the PB-ROE relationship is not transferable between the banking and pharmaceutical sector.

Banking and manufacturing

Table2.3: Unpaired t-test results matrix banking and manufacturing

	20 years	15 years	10 years	5 years
t Critical two-tail	✘	✘	✔	✔
t Critical one-tail	✘	✘	✔	✔

The results of the t-critical two-tail allows the researcher to reject in favour of the null hypothesis on both the twenty and fifteen year samples. The rejection in favour of the null hypothesis is further supported by the results of the t-critical one-tail which rejects in favour of the null hypothesis over the twenty, fifteen and ten year samples.

The rejection of the null hypothesis in the two largest time series indicates that over time the PB-ROE relationship is not transferable between the banking and manufacturing sector.

Table2.4: Key to un-paired t-test results matrices

Accept in favour of the null hypothesis	✔
Reject in favour of the null hypothesis	✖

4.2 Testing for goodness of fit

The underlying chi-squared tests can be found in appendix B.

The tests were performed across all of the time series for each sector in relation to the banking sector. The results are tabulated below.

Banking and retail

Table3.1: Chi-squared results matrix banking and retail

Chi-squared	20 years	15 years	10 years	5 years
Significant				
Non-significant	✔	✔	✔	✔

The above results indicate that the banking and retail PB-ROE relationship has a good fit across all of the time series tested. The results of the goodness of fit test support that of the unpaired t-test performed in section 4.1. The result of the Chi-squared test provides further evidence that the PB-ROE relationship is transferable between the banking and retail sector. The anticipated explanations for the above results are similar to that of the un-paired t-test found in section 4.1.

Banking and pharmaceuticals

Table3.2: Chi-squared results matrix banking and pharmaceutical

Chi-squared	20 years	15 years	10 years	5 years
Significant	✔			✔
Non-significant		✔	✔	

The above results are varied for the different time series. The lack of a good-fit of the twenty year time series is supportive of the results for the t-test of the twenty year series in section 4.1. Conversely the results of the fifteen year time series contradict the results of the t-test in section 4.1.

Banking and manufacturing

Table3.2: Chi-squared results matrix banking and manufacturing

Chi-squared	20 years	15 years	10 years	5 years
Significant				
Non-significant	✔	✔	✔	✔

The results of the chi-squared test for the fifteen and twenty year time series contradict the result of the un-paired test in section 4.1. The results for the five and ten year time series are found to be consistent with that of the un-paired t-test in section 4.1.

The results of both the un-paired and chi-squared test are found to be incoherent. Additionally, they are found to be inconsistent when compared to one another. The incoherence and inconsistency of the results over the time series indicate that the PB-ROE relationship is not constant across sectors.

Table3.3: Key to chi-squared test results matrices

Accept in favour of the null hypothesis	✔
Reject in favour of the null hypothesis	✕

4.3 Results discussion

The above results can be explained along the following lines:

Banking and retail

The following factors are considered key in terms of understanding why the investor would apply the same PB-ROE relationship to the banking and retail sector:

- Both sectors follow a very similar economic cycle
- The homogeneity and simplicity of the business models increases competition risk, provides limited barriers to entry and eliminates any first mover advantage. On an individual company basis investors do not want to pay up for returns that could be eroded in the future
- Exceptional returns are not anticipated given the competitive and regulatory environment
- Both sectors are highly geared relative to other industries. The risks associated with gearing often reduce the price investors are willing to pay for the associate returns

Based on the 20 year mean it is clear investors are willing to pay a price-to-book that is 66 percent higher for the same ROE in the pharmaceutical sector. It is important to note that the premium decreases over the time series and the inverse applies in the five year time series. The table below depicts the premiums and discount the market is willing to pay for ROE of the banking sector relative to the pharmaceutical sector.

Banking and pharmaceutical

The table below depicts the discount at which the banking sector once traded to the pharmaceutical sector.

Table3.4: Banking and pharmaceutical premium/ (discount)

	20 years	15 years	10 years	5 years
Premium/(discount)	-40.0%	-25.9%	-19.4%	47.6%

It is evident that there is not a constant premium or discount between the two sectors. The underlying cause for the premium/discount is considered to be industry specific. The following explanations are considered plausible for continual erosion of the premium at which the pharmaceutical sector traded relative to the banking sector:

- the structural change in the pharmaceutical industry over the past decade
- many of the major pharmaceutical companies have seen increasing exposure to patent cliffs
- lack of new patent drugs, and
- ever-increasing loss of market share to generics

The historical premium paid for the ROE of the pharmaceutical companies is perceived to be linked to the "barrier to entry" the pharmaceutical companies once possessed. The inelasticity of pharmaceutical products together with the patents' "barrier to entry" was considered to be a safeguard throughout economic cycles. Hence, the pharmaceutical stocks commanded a premium for their defensive nature. The defensiveness has been eroded by the factors listed above amongst others.

Banking and manufacturing

The table below depicts the discount at which the banking sector once traded to the manufacturing sector.

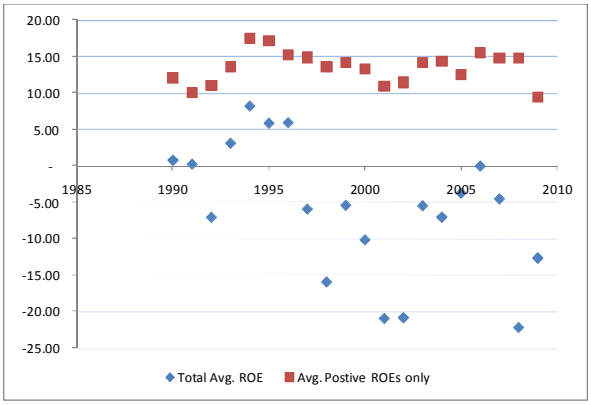
Table3.5: Banking and manufacturing premium/ (discount)

	20 years	15 years	10 years	5 years
Premium/(discount)	-29.4%	-13.2%	-10.2%	5.0%

Similar to the banking and pharmaceutical sector there is not a constant premium or discount between the sectors.

Despite excluding negative PB-ROEs from the mean calculation, the manufacturing sector in the United States has experienced significant volatility in ROE over the past two decades. The scatter plot in figure 2.7 depicts the volatility of the ROE for the manufacturing sector. The annual average ROE including and excluding the negative ROEs has been plotted. The volatility of the ROE implies the current ROE is not necessarily a good predictor of future ROEs.

Figure 3.6: Manufacturing ROE scatter plot, 20 year time series.



Out of the three sectors researched in relation to the banking sector, the manufacturing sector had the most negative observations. Thirty-five percent of ROE observations were found to be negative. Based on the above, this was considered to be the result of pure chance. This is despite the fact that the differences in means were not statistically significant in the ten and five year time series. The scatter plot in figure 3.7 highlights the importance of understanding the sector and whether or not ROE mean is a true reflection of the sector's performance. Significant volatility can distort the mean.

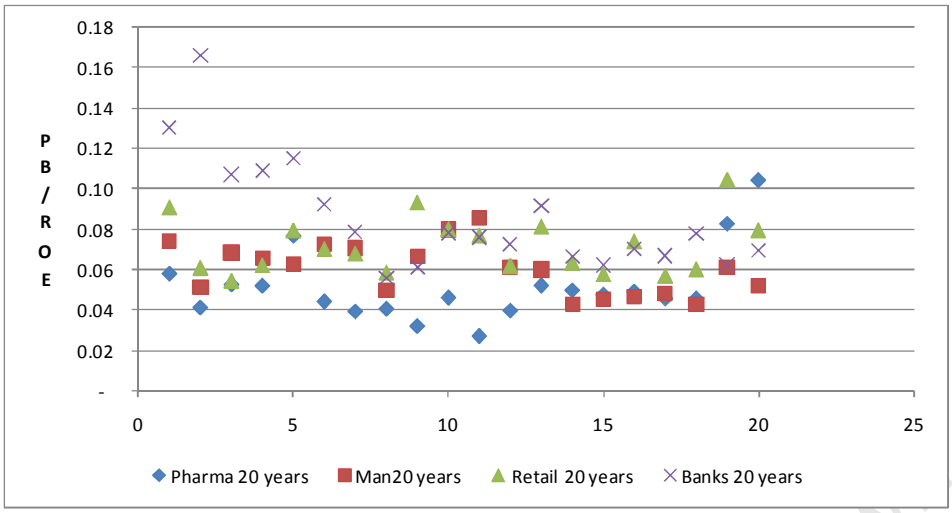
The results of the above tests indicate that it would not be appropriate to assume that the PB-ROE relationship is transferable between sectors and that the relationship does indeed differ from sector to sector. There are, however, time periods where convergence occurs.

The third test performed by the researcher attempts to uncover the reason for the differences in the PB-ROE relationship across the banking and pharmaceutical sector and the banking and manufacturing sector.

It is anticipated that the plausible explanations for the difference in PB/ROE relationships will be obtained from the regressions performed in section 4.3.

The scatter plot in figure 3.7 below highlights the diverse PB-ROE relationships across the sectors over the past twenty years.

Figure 3.7: PB-ROE Scatter plot, all sectors 20 year time series



The implications of the results from section 4.1 and 4.2 are of extreme importance to the investor seeking to rank his investments using the PB-ROE methodology. What is evident from the results of 4.1 and 4.2 is that if the investor were to apply the same PB-ROE ratio to all of the investments in the ranking model, the investor would have formed a bias toward the sector on which the initial PB-ROE ratio was based. The perils associated with using the same PB-ROE ratio are foregone investment opportunities and potential overstatement of upside resulting in underperformance. In addition, the results highlight the need to understand the sectors in which the investor is investing and how the PB-ROE ratio is affected by the various positive and negative attributes of the sector, and ultimately the underling company.

4.3.1 Regression Results

The results of the initial tests for the twenty year time series are tabulated below.

Table4.1: Initial econometric tests results matrix

Sector	*Heteroscedasticity*	*Multicollinearity*	*Autocorrelation*
Banking	✔	✘	✘
Retail	✘	✘	✘
Pharmaceutical	✘	✘	✔
Manufacturing	✘	✔	✔

Table4.2: Initial econometric tests results key

Present	✔
Not present	✘

For heteroscedasticity, we have used the robust standard errors to make corrections. This procedure reduces the standard errors in estimations and improves the efficiency of estimates.

To solve the problem of multicollinearity in cases where it was present, we have used more restrictions on the data, for example using averages in the case of outliers in the data. This tends to

reduce the multicollinearity problem as reflected by low VIFs, which could possibly improve the precision of estimates.

The remedy for autocorrelation was the Prais-Winsten transformation procedure. This involves differencing of the variables, making the transformed model satisfy the OLS assumptions and improve the efficiency of the estimates.

The table below summarises the results of the regressions performed on the twenty year time series for each sector.

Table4.3: Regression results (20 year series)

20 Year time series VARIABLES	(1) Banking	(2) Manufacturing	(3) Pharmaceuticals	(4) Retail
Mrg	-0.241	0.545**	0.409***	0.745*
	(0.150)	(0.201)	(0.129)	(0.392)
At	0.115**	0.0125**	0.0752*	0.109*
	(1.287)	(0.0207)	(0.0645)	(0.0609)
Lev	0.00469**	0.0961***	-0.0364	0.0282
	(0.00262)	(0.0180)	(0.0217)	(0.0294)
R	-0.00321*	0.000708	-0.00225	0.000522
	(0.00472)	(0.00120)	(0.00232)	(0.00173)
Inf	-0.0510	-0.0396***	-0.0429	-0.0277**
	(0.0310)	(0.00856)	(0.0329)	(0.0260)
Constant	0.176	-0.0454	-0.0696	-0.329**
	(0.145)	(0.0316)	(0.127)	(0.151)
Observations	20	20	20	20
R-squared	0.649	0.815	0.587	0.431

Banking sector

In the banking sector both the asset turn and leverage were found to be significant at the 5% level. Both have a positive effect on the PB-ROE ratio; this was in-line with expectations.

The significance of the positive leverage effect of the banks is intuitive because the more a bank can leverage itself, the more it can lend, and in turn, increase net interest margins. The relatively stable leverage ratio of the banking sector over the past decade is largely due to the highly regulated nature of the sector. Creative derivative structures, off-balance sheet financing and debt securitization are examples of how banks have attempted to cater for additional leverage while circumventing regulatory requirements, the results of which ultimately led to the financial crisis of 2008.

The positive effect of the asset turn, though intuitive, was not expected to be significant. Taking a basic banking model into consideration, a bank's income/profitability increases as it is able to increase the size of its loan book, which is a function of the bank's ability to leverage. A possible explanation for the significance could be that a higher asset turn indicates shorter maturity periods

often associated with higher yields. Another example could be less reliance on lending as a source of income. The asset turn is the most significant of the variables in the banking sector as indicated by a 1% increase in asset turn will improve the PB-ROE ratio by 11.5%.

The negative effect of the interest rates on the PB-ROE model is in line with our expectations. On an upward sloping yield curve, the profitability of banks are considered less than on a downward sloping yield curve. Growth in loan books often slows or becomes negative while net interest margins decline. As a result, the ROE of the banks fall under pressure in the near term. Financial sector stocks are generally less attractive when interest rates are rising, so the price investors are willing to pay for stock relative to its book value declines. The negative effect of inflation on the PB-ROE relationship corresponds with the negative effect of rising interest rates.

The margin was found to have a negative impact on the PB-ROE ratio. This effect was not significant and contrary to expectations.

Manufacturing sector

In the manufacturing sector both margin and asset-turn were found to be significant at the 5% level and leverage at the 1% level. The positive effects were in line with our expectations. Inflation had a negative effect at the 1% level, which was in line with our expectations.

Manufacturing follows an asset heavy business model and hence is a highly capital intensive sector. Net income expansion is a function of asset utilisation. Manufacturing facilities have a certain breakeven point with regard to output. Once the breakeven threshold has been exceeded, any additional output results in additional operating margin and ultimately net income margin. Manufacturing is synonymous with low margins, hence scale is essential. Scale is only achievable through capital expansion. Manufacturing companies are often able to leverage themselves using their asset base as a form of security. The manufacturing companies who are able to manage capacity utilisation with a balance of operating and financial leverage are often rewarded with premium PB-ROE ratios. This is indicated by the effect of a 1% increase in net margin and leverage improving the PB-ROE ratio by ~55% and ~10% respectively. The improvements in the PB-ROE highlight how difficult it is to improve the ratings beyond the sector averages. This is largely a function of economic cyclicality of the sector, competition, labour unions and commodity exposure.

The negative effect of inflation can be associated with the link to both wage and commodity inflation. Both forms of inflation are often not easily transferable to the consumer in the short term. Investors often try to estimate the exposure a company has to both wage commodity inflation and whether or not the company will be able to pass the inflation on or not. In the short-term, inflation has a negative impact on stocks and hence depresses the price investors are willing to pay for the stock, especially those with large exposures.

Pharmaceuticals sector

In the pharmaceutical sector, both margin and asset-turn were found to have a positive effect on the PB-ROE ratio at the 1% and 10% significant level respectively. Though not significant, leverage and the interest rate were found to have a negative effect on the PB-ROE ratio.

Similarly to that of the manufacturing sector, increased asset turn results in better asset utilisation. In the pharmaceutical sector the assets are often intangibles such as patents and trademarks. Higher than average asset turn ratios differentiates the good pharmaceutical companies from the poor. Higher asset turn is seen to be an indication of successful research that has been converted into an income generating asset. Similarly the quality assets in the pharmaceutical sector produce products that are able to command a premium and hence support net income margin growth and earnings stability. Depending on the average life of the intangible asset base of a pharmaceutical company, the earnings can be forecast with an element of certainty. Investors are willing to pay a premium for this certainty. The degree of certainty behind the earnings is highlighted by a 1% change in net income margin contributing ~40% to the PB-ROE ratio.

Mature pharmaceutical companies are often highly cash generative and leverage requirements are limited. Many of the large global pharmaceutical companies are often net cash. A plausible explanation for the negative effect of leverage on the PB-ROE ratio is that a company requiring leverage may not have any decent cash generative intangibles at present, which may be the result of poor capital allocation in the past and/or the uncertainty regarding whether the return on assets generated by the leverage will be sufficient to cover the financing costs. In addition, the matching principle of costs and revenue with specific reference to cash flow are very skewed in the pharmaceutical sector. This is largely due to the extensive and rigorous research and development process. The negative effect of leverage on the PB-ROE is not significant.

Retail sector

In the retail sector, both margin and asset turn had a positive effect on the PB-ROE ratio at the 10% significance level. Inflation had a positive effect at the 5% significance level.

Asset turn is essential for the retail sector with specific reference to inventories and accounts receivable where sales are on credit. High asset turn in the retail sector indicates excellent inventory management and excellent credit control procedures, both of which are key to consistent net income margins. The less a retailer is required to discount inventories for clearing purposes, the less margin pressure they face. Similarly, the less debtor delinquencies a retailer experiences, the better for both the net income margin and cash flow requirements of the company. Hence the impact of a 1% increase in leverage and net income margin improving the PB-ROE ratio by ~10% and 75% respectively.

Retailers provide investors with stable returns over time and are often considered low risk, depending on the nature of the retail. Investors are often willing to pay a premium for a retail stock that has management that are able to manage their assets efficiently and hence extract the most value from the company.

In most instances retail is a low margin, high turnover business. It is anticipated that the positive effect of inflation on the PB-ROE relationship is because the retailer is often able to pass the cost onto the consumer. Therefore, the risk associated with inflation across retail stores is often one of a positive nature. Investors are often willing to pay a premium for companies that are able to pass the cost of inflation on. Depending on the macro environment, investors may be applying or removing this premium.

The constant has a negative effect at the 5% significance level. This indicates that there are significant external factors that contribute and detract from the PB-ROE ratio.

The net margin variable for the manufacturing, pharmaceuticals and retail sectors is significant at the 5%, 1% and 10% levels respectively. A 1% change in net margin variable will result in a change in the PB-ROE ratio in excess of 40% across all three sectors. This highlights both the maturity and internal competitiveness of three sectors. Companies in these sectors that achieve superior margins to the sector average will therefore achieve superior valuation ratings.

The R-squared shows the goodness of fit of the model. In this case it shows how much of the variation in the PB-ROE ratio is explained by the variables used in this model. R-squared above 0.5 generally shows a good fit, which is the case for the banking, manufacturing and pharmaceutical sectors. The R-squared of the retail sector of 0.431 is the result of the significance of the constant at the 5% level.

The same regressions were performed on the ten year time series. The shorter time series maybe influenced by periodical economic shocks and could fail to capture the impact of the regressors. In addition, the shorter time period means a smaller sample which reduces degrees of freedom. As a result, we have focused on the results of the twenty year time series. The output of the ten year regressions are in appendix C. We also make time comparisons for each sector as shown in appendix C.

Section 5: Conclusion and implications

The objective of the research report was to determine if the PB-ROE ratio was constant across sectors and what the explicatory powers of the DuPont components were with regard to the PB-ROE ratio.

The results of the research indicated that the PB-ROE ratio was not constant across sectors and hence is not transferrable. An OLS regression equation was then used to determine the explicatory powers of the DuPont components. The results of the regressions highlighted that the explicatory powers of the DuPont components were different for each sector. In addition, the result of the regressions highlighted the importance of the DuPont model, as the R-squared of the banking, pharmaceutical and manufacturing sectors were in excess of 0.5 for the DuPont components. The research highlights the importance of understanding the DuPont model, its information content, and how the significance of the components differs from sector to sector.

The key implications for investors from this report include: the application of the same PB-ROE ratio across sectors could result in inaccurate ratings of stocks, the implications of which can be either positive or negative depending on the ratio used relative to the sector in which the stock under comparison falls. It is therefore recommended that when making use of a ranking model that employs the PB-ROE valuation methodology, the PB-ROE ratio should be evaluated relative to its given sector. This will allow for a like-for-like comparison between stocks across multiple sectors when assessing potential upside in the ranking model. Literature reviewed in this paper highlighted significant empirical evidence in favour of the PB-ROE model in predicting future stock returns in a finite period of one to five years. However, the main caveat of the research is that the model fails to work in sectors that are unstable. The use of a PB-ROE ranking model is therefore not always appropriate, depending on the type of stocks the investor is interested in. The PB-ROE model works best for stocks in sectors in which there is a significant amount of history, stable ROEs, homogenous products/services and highly competitive and regulated industries. The investor needs to understand and evaluate the characteristics, both financial and non-financial, of the sector before applying the PB-ROE model. Having a broader understanding of the sector will allow the investor to make appropriate us of the PB-ROE valuation model.

In instances where an investor is looking at a sector that has an unstable history in terms of ROEs, the investor should consider other valuation metrics. In addition, the investor could consider making use of cross-border PB-ROE relationships in the event that the given sector is stable in another country. Further research on the PB-ROE relationship could be to investigate the PB-ROE relationship for the same industries across borders.

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Appendices

Appendix A

Table 5.1: Un-paired t-test, banking and retail sectors

Banks and Retail Sector

t-Test: Two-Sample Assuming Equal Variances

	Banks 20 years	***Retail 20 years***
Mean	0.085284784	0.071681515
Variance	0.000763715	0.000188906
Observations	20	20
Pooled Variance	0.00047631	
Hypothesized Mean Difference	0	
df	38	
t Stat	1.971053095	
P(T<=t) one-tail	0.028016528	
t Critical one-tail	1.685954461	
P(T<=t) two-tail	0.056033055	
t Critical two-tail	2.024394147	

t-Test: Two-Sample Assuming Equal Variances

	Banks 15 years	*Retail 15 years*
Mean	0.071967135	0.070028624
Variance	0.000105948	0.000178854
Observations	15	15
Pooled Variance	0.000142401	
Hypothesized Mean Difference	0	
df	28	
t Stat	0.4448797	
P(T<=t) one-tail	0.329913431	
t Critical one-tail	1.701130908	
P(T<=t) two-tail	0.659826862	
t Critical two-tail	2.048407115	

t-Test: Two-Sample Assuming Equal Variances

	Banks 10 years	*Retail 10 years*
Mean	0.069738195	0.068946688
Variance	8.59717E-05	0.000209463
Observations	10	10
Pooled Variance	0.000147717	
Hypothesized Mean Difference	0	
df	18	
t Stat	0.145620982	
P(T<=t) one-tail	0.442919462	
t Critical one-tail	1.734063592	
P(T<=t) two-tail	0.885838925	
t Critical two-tail	2.100922037	

t-Test: Two-Sample Assuming Equal Variances

	Banks 5 years	*Retail 5 years*
Mean	0.063762081	0.073334766
Variance	2.6795E-05	0.000320761
Observations	5	5
Pooled Variance	0.000173778	
Hypothesized Mean Difference	0	
df	8	
t Stat	-1.148170455	
P(T<=t) one-tail	0.142034971	
t Critical one-tail	1.859548033	
P(T<=t) two-tail	0.284069942	
t Critical two-tail	2.306004133	

Table 5.2: Un-paired t-test, banking and pharmaceutical sectors

Banks and Pharma Sector

t-Test: Two-Sample Assuming Equal Variances

	Banks 20 years	*Pharma 20 years*
Mean	0.085284784	0.051174614
Variance	0.000763715	0.00031705
Observations	20	20
Pooled Variance	0.000540382	
Hypothesized Mean Difference	0	
df	38	
t Stat	4.64016312	
P(T<=t) one-tail	2.02896E-05	
t Critical one-tail	1.685954461	
P(T<=t) two-tail	4.05792E-05	
t Critical two-tail	2.024394147	

t-Test: Two-Sample Assuming Equal Variances

	Banks 15 years	*Pharma 15 years*
Mean	0.071967135	0.053347113
Variance	0.000105948	0.000229594
Observations	15	15
Pooled Variance	0.000167771	
Hypothesized Mean Difference	0	
df	28	
t Stat	3.936882765	
P(T<=t) one-tail	0.000248784	
t Critical one-tail	1.701130908	
P(T<=t) two-tail	0.000497567	
t Critical two-tail	2.048407115	

t-Test: Two-Sample Assuming Equal Variances

	Banks 10 years	*Pharma 10 years*
Mean	0.069738195	0.056216588
Variance	8.59717E-05	0.000359551
Observations	10	10
Pooled Variance	0.000222761	
Hypothesized Mean Difference	0	
df	18	
t Stat	2.02578584	
P(T<=t) one-tail	0.028936133	
t Critical one-tail	1.734063592	
P(T<=t) two-tail	0.057872265	
t Critical two-tail	2.100922037	

t-Test: Two-Sample Assuming Equal Variances

	Banks 5 years	*Pharma 5 years*
Mean	0.063762081	0.094102232
Variance	2.6795E-05	0.002213378
Observations	5	5
Pooled Variance	0.001120087	
Hypothesized Mean Difference	0	
df	8	
t Stat	-1.433382045	
P(T<=t) one-tail	0.094825111	
t Critical one-tail	1.859548033	
P(T<=t) two-tail	0.189650222	
t Critical two-tail	2.306004133	

Table 5.3: Un-paired t-test, banking and manufacturing sector

Banks and Manufacturing sector

t-Test: Two-Sample Assuming Equal Variances

	Banks 20 years	*Man20 years*
Mean	0.085284784	0.060229658
Variance	0.000763715	0.000159259
Observations	20	20
Pooled Variance	0.000461487	
Hypothesized Mean Difference	0	
df	38	
t Stat	3.688221533	
P(T<=t) one-tail	0.00035181	
t Critical one-tail	1.685954461	
P(T<=t) two-tail	0.00070362	
t Critical two-tail	2.024394147	

t-Test: Two-Sample Assuming Equal Variances

	Banks 15 years	*Man15 years*
Mean	0.071967135	0.062457354
Variance	0.000105948	0.00011764
Observations	15	15
Pooled Variance	0.000111794	
Hypothesized Mean Difference	0	
df	28	
t Stat	2.463158278	
P(T<=t) one-tail	0.010091248	
t Critical one-tail	1.701130908	
P(T<=t) two-tail	0.020182496	
t Critical two-tail	2.048407115	

t-Test: Two-Sample Assuming Equal Variances

	Banks 10 years	*Man10 years*
Mean	0.069738195	0.062606284
Variance	8.59717E-05	0.000600612
Observations	10	10
Pooled Variance	0.000343292	
Hypothesized Mean Difference	0	
df	18	
t Stat	0.860714334	
P(T<=t) one-tail	0.200357675	
t Critical one-tail	1.734063592	
P(T<=t) two-tail	0.400715349	
t Critical two-tail	2.100922037	

t-Test: Two-Sample Assuming Equal Variances

	Banks 5 years	*Man5 years*
Mean	0.063762081	0.066934282
Variance	2.6795E-05	0.000924716
Observations	5	5
Pooled Variance	0.000475756	
Hypothesized Mean Difference	0	
df	8	
t Stat	-0.229952896	
P(T<=t) one-tail	0.411949562	
t Critical one-tail	1.859548033	
P(T<=t) two-tail	0.823899124	
t Critical two-tail	2.306004133	

Appendix B

Table 6: Results of the chi-squared test

Chi Squared test Banks and Retail @ 5% confidence interval

	20 years	15 years	10 years	5 years
1990/12/31	1.1730			
1991/12/31	6.6164			
1992/12/31	2.5609			
1993/12/31	2.0110			
1994/12/30	1.0932			
1995/12/29	0.5149	0.2980		
1996/12/31	0.1419	0.2198		
1997/12/31	0.0133	0.0081		
1998/12/31	1.7053	0.3927		
1999/12/31	0.0046	0.0756		
2000/12/29	0.0015	0.0300	0.0323	
2001/12/31	0.1525	0.2423	0.4060	
2002/12/31	0.1123	0.0496	0.0470	
2003/12/31	0.0139	0.0416	0.0731	
2004/12/31	0.0321	0.0459	0.0178	
2005/12/30	0.0233	0.0021	0.0077	0.0003
2006/12/29	0.1388	0.1112	0.0689	0.0224
2007/12/31	0.3989	0.0817	0.0607	0.0008
2008/12/31	2.8202	3.2281	3.2369	3.6682
2009/12/31	0.1426	0.0124	0.0147	0.0526
Distribution	**19.670**	**4.839**	**3.965**	**3.744**
Degrees of freedom	19	14	9	4
Critical value	30.10	23.70	16.90	9.49

Chi-squared	20 years	15 years	10 years	5 years
Significant				
Non-significant	✔	✔	✔	✔

Chi Squared test Banks and Manufacturing @ 5% confidence interval

	20 years	15 years	10 years	5 years
1990/12/31	2.3958			
1991/12/31	7.9355			
1992/12/31	1.4005			
1993/12/31	1.7132			
1994/12/30	2.3610			
1995/12/29	0.4244	0.2991		
1996/12/31	0.0803	0.0642		
1997/12/31	0.0708	0.0109		
1998/12/31	0.0505	0.0919		
1999/12/31	0.0035	0.1913		
2000/12/29	0.1214	0.2294	0.3916	
2001/12/31	0.1800	0.2127	0.3448	
2002/12/31	1.0860	0.5646	0.4267	
2003/12/31	0.8232	0.8033	0.8126	
2004/12/31	0.4814	0.0124	0.0343	
2005/12/30	0.7708	0.5683	0.6057	0.3995
2006/12/29	0.5274	0.3269	0.1136	0.0429
2007/12/31	1.5687	0.7680	0.7387	0.6607
2008/12/31	0.0032	0.8322	8.4948	6.8574
2009/12/31	0.4473	0.0611	0.1254	0.0274
Distribution	**22.4451**	**5.0364**	**12.0881**	**7.9880**
Degrees of freedom	19	14	9	4
Critical value	30.10	23.70	16.90	9.49

Chi-squared	20 years	15 years	10 years	5 years
Significant				
Non-significant	✔	✔	✔	✔

Chi Squared test Banks and Pharma @ 5% confidence interval

	20 years	15 years	10 years	5 years
1990/12/31	3.9968			
1991/12/31	9.3508			
1992/12/31	2.7695			
1993/12/31	2.9975			
1994/12/30	1.2777			
1995/12/29	2.4972	1.5750		
1996/12/31	1.9640	1.0532		
1997/12/31	0.4193	0.0923		
1998/12/31	1.3697	0.9603		
1999/12/31	1.3204	0.5001		
2000/12/29	3.1208	1.8461	2.2201	
2001/12/31	1.4738	1.6663	0.9029	
2002/12/31	1.7004	1.4775	1.2281	
2003/12/31	0.4292	0.6238	0.9039	
2004/12/31	0.3501	0.4153	0.6006	
2005/12/30	0.6333	0.4313	0.8650	0.6550
2006/12/29	0.6700	0.5800	0.4110	0.2269
2007/12/31	1.3342	0.6381	0.1762	0.2638
2008/12/31	0.6404	0.6054	0.6538	21.7199
2009/12/31	1.6960	0.8630	0.5128	1.8556
Distribution	**40.011**	**13.328**	**8.474**	**24.721**
Degrees of freedom	19	14	9	4
Critical value	30.10	23.70	16.90	9.49

Chi-squared	20 years	15 years	10 years	5 years
Significant	✔			✔
Non-significant		✔	✔	

Appendix C

Table 7.1 Regression results, banking 20 year and ten year series

VARIABLES	(1) Banking 20 years	(2) Banking 10 years
Mrg	-0.241	-0.0804**
	(0.150)	(0.0218)
At	-0.115**	0.0521
	(1.287)	(0.201)
Lev	0.00469**	0.0134**
	(0.00262)	(0.00806)
R	-0.00321*	-0.0036*
	(0.00472)	(0.0021)
Inf	-0.0510	-0.0704**
	(0.0310)	(0.0230)
Constant	0.176	0.364**
	(0.145)	(0.131)
Observations	20	9
R-squared	0.649	0.874

Table 7.2 Regression results, retail 20 year and 10 year series

VARIABLES	(1) Retail 20 years	(2) Retail 10 years
Mrg	0.745*	0.682*
	(0.392)	(0.726)
At	0.109*	0.107
	(0.0609)	(0.129)
Lev	0.0282	0.0183
	(0.0294)	(0.0512)
R	0.000522	-5.87e-05
	(0.00173)	(0.00277)
Inf	-0.0277**	0.027**
	(0.0260)	(0.0551)
Constant	-0.329**	-0.292
	(0.151)	(0.375)
Observations	20	10
R-squared	0.431	0.313

Table 7.3 Regression results, pharmaceutical 20 year and 10 year series

VARIABLES	(3) Pharmaceuticals 20 years	2 Pharmaceuticals 10 years
Mrg	0.409***	0.297**
	(0.129)	(0.119)
At	0.0752*	0.0870
	(0.0645)	(0.115)
Lev	-0.0364	-0.0240*
	(0.0217)	(0.00899)
R	-0.00225	-0.00194
	(0.00232)	(0.00177)
Inf	-0.0429	0.0847**
	(0.0329)	(0.0224)
Constant	-0.0696	-0.156
	(0.127)	(0.106)
Observations	20	10
R-squared	0.587	0.934

Table 7.3 Regression results, manufacturing 20 year and 10 year series

VARIABLES	(1) Manufacturing 20 years	(2) Manufacturing 10 years
Mrg	0.545**	0.593
	(0.201)	(0.337)
At	0.0125**	0.354**
	(0.0207)	(0.113)
Lev	0.0961***	0.00543
	(0.0180)	(0.00561)
R	0.000708	-0.00585**
	(0.00120)	(0.00471)
Inf	-0.0396***	-0.0126
	(0.00856)	(0.0846)
Constant	-0.0454	-0.287
	(0.0316)	(0.240)
Observations	20	10
R-squared	0.815	0.760