HØGSKOLEN I OSLO
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# The Volatility of Quality and Quality Persistence

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## Sammendrag

Jeg har rekonstruert kvalitets-indikatoren, som definert av Asness, Frazzini og Pedersen (2013), på et panel av 265 børsnoterte amerikanske selskaper og analysert dens tidsutvikling. Jeg finner at nåværende kvalitets forklaringsevne på fremtidig kvalitet, er sterkt betinget av kvalitetens volatilitet. Siden kvalitet er en variabel som hypotetisk prises i den grad den indikerer fremtidig nivå av seg selv, bør kvalitetens volatilitet ha innvirkning på relative priser. I regresjoner av pris over book på kvalitet og kvalitet interagert med en dummy variabel basert på kvalitetens volatilitet, finner jeg en tendens i den forventede rettingen, men svakt. Disse resultatene har hovedsakelig to implikasjoner. Først, i praktiske verdsettelser gir resultatene indikasjon på nytteverdien av å bruke fremskrevne resultater. Sist, den svake prisingen av stabil kvalitet kaster lys på «kvalitets-anomalien» og interessante områder for videre forsking.

## Abstract

I have reconstructed the quality indicator as defined by Asness, Frazzini, and Pedersen (2013), for a panel of 265 listed US firms and analyzed its persistence. The results show that conditioning on volatility of quality strongly discriminates the relative explanatory power of current quality on future quality. It is hypothesized that quality should only be priced if it predicts future values of itself. Implicit on volatility's effect on quality persistence, it is argued that the volatility of quality should be priced in an efficient market. In regressions of the price-to-book ratio on quality and quality interacted with a dummy based on the volatility of quality, the results show a tendency in the hypothesized direction, but weak. These results have two main implications. First, the results have implications for the relative viability of using extrapolation of past results in practical valuation. Second, the weak price of the volatility of quality cast further light on the "quality anomaly" and interesting topics for further study.

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## Forord

Denne oppgaven avslutter min Master i Økonomi og Administrasjon ved Høyskolen i Oslo og Akershus. Jeg har tatt hovedprofil i finans og lenge vært interessert i verdipapirprising og kapital markeder. Det falt derfor naturlig å velge en problemstilling som treffer krysningspunktet mellom fundamentalanalyse og variasjon i verdipapirprising.

Jeg vil rette en takk til Muhammad Azeem Qureshi, som har gitt gode kommentarer og råd underveis.

Oslo, 29.5.2015

Gard Greger Kjærland Olsen

## Content

# 1 Introduction

In the paper "Quality Minus Junk" (2013), Asness, Frazzini and Pedersen synthesize several of the findings in the asset price literature into a quality indicator based on Gordon's growth formula. Interestingly they find that quality explains little of the cross-sectional variation in the price-to-book ratio, and that a portfolio that goes long on high quality stocks and short on low quality stocks, produces high risk adjusted returns. As an anomaly not explained by the standard factor models, or apparent risk based explanations it begs further study.

Asness, Frazzini and Pedersen (2013) argue that in a rational and thus forward looking market quality is only priced, if it predicts future quality characteristics. They show that quality is persistent, but do not however, explore if there are explanatory variables able to differentiate among relative quality persistence.

**This thesis will address the following research questions:**

- Do conditioning on the past volatility of quality, discriminate relative quality persistence?"
- And if so: Is the volatility of quality reflected in equity prices?

By relative quality persistence it is meant the relative explanatory power of a firm's current quality on future quality. Quality is defined as in Asness, Frazzini and Pedersen (2013) and reconstructed on a panel of 265 US firms constituting 13 047 quarterly quality observations.

On the first question, this thesis hypothesizes that stable quality will be more persistent quality. The causal explanation behind the hypothesis is straight forward. In a market economy, with fierce competition, fast and unpredictable technological change, shifting demand preferences and periodically large and persisting imbalances between supply and demand, firms with stable quality, presumably have so for a structural reason. Indeed, the results from Dichev and Tang (2009), points in this direction. They sort firms into quintiles based on the volatility of past earnings and find that 53.78% of the low volatility quintile, consists of public utilities. These are firms often identified as natural monopolies and regulated. As such, they conceivably are firms more isolated from the factors of change in the market economy. The thesis does not delve further into the causal factors, but focus on the empirical relationship between the relative stability of quality and its persistence.

To analyze quality persistence the framework Dichev and Tang (2009), which find that conditioning on earnings-volatility strongly discriminates on earnings persistence, is used. In this thesis, stability of quality is operationalized as the relative standard deviation of past quality and conditioning on this variable is shown to strongly discriminate on quality persistence. (See Appendix 1, Table 4, Panel A, B and C)

The hypothesis about the second research question follows from the findings on the first. I find that, current high and stable quality indicates higher future quality than current high and unstable quality and current low and stable quality indicates lower future quality than current low and unstable quality (See Figure 1b, 1c and Figure 2). Since quality is an indicator of the relative price-to-book ratio, only to the extent it predicts future quality (Asness, Frazzini and Pedersen (2013)), the hypothesis is that the volatility of quality affects the slope between quality and the market price-to-book ratio. Specifically, less volatile quality should have a steeper slope with the price-to-book ratio than more volatile quality. This rests on several other assumptions discussed in section 4.4.2.

The second question is researched by regressing price-to-book on quality and quality interacted with a dummy based on the volatility of quality. The regression results show some tendency in the hypothesized direction, but weak and not consistently through time. Given volatility's strong implications for quality persistence, this is surprising.

The findings of the thesis have two main implications. Firs, the results have implications for the relative viability of using extrapolation of past results in practical valuation. Second, the weak pricing of stable quality cast further light on the “quality anomaly” -an interesting topic for further study.

# 2 Theory and Literature:

This literature section is meant to explain why we should care about quality, provide background for the analysis of quality persistence and the inspiration for the conditioning variable.

The analysis of quality, its price, and possible causes of its price, is at test of market efficiency (Asness, Frazzini and Pedersen (2013)). Accordingly, the theories on assets price formation are central to the formulation of the research questions and the interpretation of the results.

## 2.1 Firm Quality

The asset price literature documents several anomalies related to firm characteristics. Gross profits to assets are shown to have roughly the same explanatory power as the book-to-market ratio on cross-sectional returns (Novy-Marx (2013)). Share issuance predict returns more statistically significant than momentum, size and book-to-market considered individually (Pontiff and Woodgate (2008)) and also predict returns in 41 non US countries (Mclean, Pontiff, Watanabe (2009)). Firms with high GSCORE, a measure of growth, outperform firms with low GSCORE (Mohanram (2005)). Earnings with high levels of accruals are less persistent and abnormal returns may be achieved by exploiting investor’s apparent inability to distinguish between the accrual and cash flow components of earnings (Sloan (1996)). Investors in distressed stocks has underperformed versus the market and adjusted for risk (Campbell, Hilscher and

Szilagyi (2010)). Stocks excess returns are not strictly proportional to its market beta (Black, Jensen and Scholes (1972)) and a “Betting Against Beta” factor that is long the low beta and short the high beta stocks, produce significant risk adjusted returns (Frazzini and Pedersen (2013)).

Asness, Frazzini and Pedersen (2013) create a theoretically motivated quality indicator, which gather the anomalies in a unifying framework. The anomalies are seen as expressions of one common theme, the outperformance of quality stocks.

Several practitioners have also expressed similar views and are known to emphasize quality in their investment strategies. A leading industry proponent of “quality” is GMO’s Jeromy Grantham which have motivated MSCI’s quality index (Novy-Marx(2013)), other practitioners have also emphasized quality as a part of their strategy e.g. Joel Greenblatt “The Little Book that Beats the Market” (2006), and more earlier Benjamin Graham(1949), Warren Buffet is also famous for his focus on quality stocks[1] and Berkshire Hathaway’s returns may be largely explained by a “Betting Against Beta” and “Quality Minus Junk” factor (Frazzini, Kabiller and Pedersen (2013)) . While value is easy to quantify and have been extensively studied, “quality” is a more ambiguous variable. Is it measured by gross profitability as in Novy-Marx (2013) or as EBIT on tangible assets as in Greenblatts formula (Novy-Marx (2013)), or some other metric?

Asness, Frazzini and Pedersen (2013) define a firm’s quality as characteristics that investors would pay for, everything else being equal. To identify such characteristics they use Gordon’s growth formula, rewritten to explain the price-to-book ratio. (See appendix 5 for the algebra)

$$\frac{P}{B} = \frac{ROE*payout\ ratio}{Re-g}$$

The quality indicator is defined by the elements in the right hand side of the price-to-book equation and named profitability, growth, payout and safety. Each component is

[1] Berkshire Hathaway Inc. annual report 2008

calculated as the average z-score's on several variables meant to robustly capture each element.

$$\text{Quality indicator} = \tfrac{1}{4}\,(\text{average profitability z-scores}) + \tfrac{1}{4}(\text{average growth z-scores}) + \tfrac{1}{4}(\text{average payout z-scores}) + \tfrac{1}{4}\,(\text{average safety z-scores})$$

(See section 3.3 for the complete constituencies.)

The theoretical motivation for studying the quality variable takes inspiration from Cochrane (2011).

> "*Market-to-book ratios should be our left-hand variable, the thing we are trying to explain, not a sorting characteristic for expected returns."* Cochrane (2011)

This is linked to the markets role as a capital allocator, where an ideal market is one where prices are accurate signals for resource allocation and the economic consequences of market efficiency, depend on to which degree, this is true (Fama (1970)). Asness, Frazzini and Pedersen (2013) ask: "*Do the highest quality firms command the highest prices so that these firms can finance their operations and invest?"* The analysis of the quality indicator is a research of this question.

Asness, Frazzini and Pedersen (2013) do a comprehensive study of the price and returns to quality and use all US and global common stocks included in the merged CRSP/Xpressfeed databases, a total of 39 308 firms, in their analysis.

For the market to put a price on the quality indicator, quality as measured from information available today must indicate something about the future level of quality (Asness, Frazzini and Pedersen (2013)). In Gordon's formula, ROE is on incremental capital employed, payout is future dividends or repurchases, growth is future growth and the safety/risk is the discount rate on future distributions. Thus a rational market will be forward looking on these variables.

It is shown that quality is persistent and portfolios formed on average current quality, keep their quality rank monotonically through the ten year horizon of the test (Asness, Frazzini and Pedersen (2013)). With some exceptions, this also holds for the different components.

To evaluate the price of quality, Asness, Frazzini and Pedersen (2013) runs cross-sectional regressions of the price-to-book ratio on each firm's quality score.

$$P_t^i = \text{a} + \text{b}Quality_t^i + \varepsilon_t^i$$

Where $P_t^i$ is the standardized price-to-book of firm i at time t, $Quality_t^i$ is the quality score of firm i at time t and $\varepsilon_t^i$ is the idiosyncratic error.

Quality affects prices, but only has an average R-square of 12% in the long sample (US 1956 – 2012) and 6% in the broad sample (Global 1986-2012). The cross-sectional coefficients range between 0.07 and 0.60 in the long US sample and 0.15 and 0.32 in the broad global sample. The coefficient measure the standard deviation change in price-to-book, when quality is changed by one standard deviation (Asness, Frazzini and Pedersen (2013)).

Given that the quality indicator is built on a total of 21 components all expected to have an effect on the price-to-book ratio, the low R-square is surprising. Asness, Frazzini and Pedersen (2013) put forward three possible explanations.

*a) Markets prices fail to fully reflect these characteristics for reasons linked to behavioral finance or constraints (e.g. an inability to lever),*

*b) Market prices are based on superior quality characteristics than the ones we consider, and*

*c) The quality characteristics are correlated to risk factors not captured in our risk adjustment.*

To examine these explanations a self-financing portfolio that is long high quality stocks and short low quality stocks was constructed, the Quality Minus Junk factor. The QMJ factor show a significant four factor alpha[2] of 0.97 percent per month, in the US long sample, and a significant alpha of 0.93 percent per month, in the broad global sample. The QMJ factor is high during market downturns and rather than exhibit crash risk benefit from "flight" to quality during crisis (Asness, Frazzini and Pedersen (2013)). Accordingly, the evidence from the return studies are inconsistent with explanation b) and c) (Asness, Frazzini and Pedersen (2013)).

Asness, Frazzini and Pederson (2013) also show that price and returns are linked. Past high prices predict future low return to the QMJ factor and past low prices predict high returns.

## 2.2 EMH, CAPM and Improved Equilibrium Models:

The analysis of quality is done within the framework of a standing hypothesis of market efficiency. A review of the theoretical context where research of quality becomes interesting will follow.

Generally an efficient market is one which fully reflects all available information about an assets prospective return. This is an ideal market where the price signals provide investors with accurate signals for resource allocation. To get to a testable proposition however, we need to specify exactly what we mean by fully reflect (Fama (1970)). The process of price formation must be specified, i.e. we must have an equilibrium theory which defines what the right price or right expected return should be. Thus by fully reflect all information, we imply that current prices produce equilibrium expected returns (Fama (1970)).

This is a statement with wide empirical consequences and provides the general framework for the empirical work on market efficiency. Basically it states that there is no trading system that could consistently produce returns above what is expected by the equilibrium model (Fama (1970)).

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[2] $r_t = \alpha + \beta^{MKT}MKT_t + \beta^{SMB}SMB_t + \beta^{HML}HML_t + \beta^{UMD}UMD_t + \varepsilon_t$

### 2.2.1 The Capital Assets Pricing Model

As explained in the last section, EMH only has empirical content within the framework of a model explaining market equilibrium. Here follows a brief summary of the development of CAPM, the first model to provide EMH with such content. Despite limited explanatory power of actual cross-sectional returns (Fama and French (1992)), CAPM provides an important normative model for rational investor behavior.

Markowitz (1951) proposed that economically rational investors are only concerned with expected return and the variance of this expectation. Additionally investors are only concerned with the mean and variance on their total assets.

The framework shows the value of diversification. Simply put, if we have two securities with the same expected return and variance, but where the returns are not perfectly and positively correlated, we get a better mean-variance relationship by combining the two, than if each where held separately. By continuing in this fashion and adding new securities and optimizing the mean-variance relationship, Markowitz (1951) showed that investors would produce the efficient frontier. That is, the optimal mean-variance combinations possible given the risky securities constituting the market.

The work of Markowitz was carried further by Tobin (1958). Tobin introduced a riskless security and showed that optimal mean-variance combinations are found along the tangent between the risk free rate and the efficient frontier. Sharpe (1964), Lintner (1965) and Mossin (1966) went further and independently derived CAPM.

Sharp (1964) extend this normative theory of investor behavior into an equilibrium theory for the pricing of risky assets. Sharp (1964) basically showed that the required return on a security is dependent on its sensitivity to the market portfolio. That is, the return required dependent on its exposure to undiversifiable systemic risk.

$$E[r_e] = r_f + \beta(r_m - r_f)$$

Where $E[r_e]$ is expected return the respective security, $r_f$ is the risk free rate, $r_m$ the return on the market portfolio and $\beta$ the slope coefficient.

This is CAPM and the standard equilibrium model in theoretical finance, which gave EMH its empirical content. CAPM is important in that it was the first rigorous model explaining cross-sectional variance in expected return (Nygaard lecture (2015)).

### 2.2.2 Improved Equilibrium Models

In their test of CAPM Fama and MacBeth (1973) established a two pas regressions framework. The first phase estimates the assets or portfolios sensitivity to the market factor, by regressing assets/portfolio return on market return. The second phase uses the time-series coeffsients from the first regressions as explanatory variables in cross-sectional regressions of assets/portfolio returns. I.e. return on $(\text{assets or portfolio})_{it}$ is regressed on its $\text{beta}_i$. The average cross-sectional coefficients are used to evaluate the market factors effect on cross-sectional return and the intercept to evaluate systematic deviations from the model. Fama and MacBeth (1973) also constructed portfolios for the beta estimation to reduce "errors-in-variables-problems". The methods became an important framework in later studies. Fama and MacBeth (1973) concluded that the hypothesis of the CAPM could not be rejected by their empirical results.

Almost twenty years later, in their influential paper Fama and French (1992), the authors find no support for the most basic prediction of CAPM. On data from 1963 – 1990 they find that the previously documented positive relation between beta and cross-sectional returns disappear. Thus the standard model for explaining equilibrium expected returns had been disproved. Fama and French (1993) propose a new model where the expected return on a security is explain by the sensitivity on three factors, the market return, the return to a small cap minus large cap factor and the return to high book-to-market minus low book-to-market factor. The systemic risk of a security was seen as related to these three dimensions. If one agrees on this risk interpretation, the empirical test of EMH is moved from a test of CAPM to a test of the multifactor model. Carhart (1995) introduced a four factor model, which also including a short term momentum factor meant to capture the findings of Jegadeesh and Titman (1993).

The quality factor in Asness, Frazzini and Pedersen (2013) is analyzed within the theoretical framework presented in the previous section. As mentioned, the Quality Minus Junk factor shows positive CAPM alpha, three and four factor alpha, and thus provide an anomaly to the standard equilibrium models.

## 2.3 Earnings Persistence

Up until 1982 the body of research on the times-series of earnings concluded that annual changes, was more or less unpredictable, i.e. earnings followed a random walk (Freeman, Ohlson and Penman (1982)). However, Freeman, Ohlson and Penman (1982) find that book rate of return is mean reverting and that the book rate of return is correlated with future earnings changes. A relatively high rate of return implies earnings are unusually good and a low rate of return implies earnings are temporarily depressed. The random walk hypothesis for earnings was rejected.

Sloan (1996) showed that the persistence of earnings, measured as operating income on total assets, is dependent on the relative level of accruals in earnings. Lev and Thiagarajan (1993) link future earnings change to a quality of earnings score. The earnings quality score in their study is constructed from elements deemed by professionals to be leading indicators, like abnormal changes in inventory, accounts receivables, gross profitability and order backlog. Lev and Thiagarajan (1993) identifies these elements by reviewing written pronouncements of analysts. Penman and Zhang (2002) investigate the combined role of conservative accounting and investment on current earnings as an indicator of future earnings.

As Dichev and Tang (2009) point out however, these are all studies on short term prediction of earnings, while in application there is need for long term forecasts. This limitation in the literature leads to one motivation behind the research of Dichev and Tang (2009).

Dichev and Tang (2009) also points to the findings of Graham, Harvey and Rajgopal (2005), as motivating their research.  In a survey of 401 corporate manager's Graham, Harvey and Rajgopal (2005) find that managers at large believe volatility of earnings and the predictability of earnings are linked. More specifically;

> *"Managers believe that missing an earnings target or reporting volatile earnings reduces the predictability of earnings, which in turn reduces stock prices because investors and analysts dislike uncertainty."* Graham, Harvey and Rajgopal (2005).

Driven by these motivations Dichev and Tang (2009) explore how conditioning on earnings volatility affect the predictability of earnings, with the hypothesis that stable earnings are more persistent and predictable. To address this question they specify a simple prediction model as the regression of future earnings on current earnings.

$$E_{t+1} = \beta_0 + \beta_1 E_t + u_t$$

Where $E_{t+1}$ is earnings in the year t+1, $E_t$ is earnings in year t, $u_t$ is idiosyncratic error and the earnings variable is net income before extraordinary items scaled by total assets.

Dichev and Tang (2009) define earnings volatility as the standard deviation of earnings scaled by total assets for the past five years. This variable has a highly non-normal distribution, which would produce problems if directly included in a regression setup. To relieve this problem, regressions within sorts of the conditioning variables was used.

This method enables comparison of slope coeffsients and R-squares within different levels of the variables deemed to have impact on earnings prediction. Dichev and Tang (2009) view the slope coefficient in the regression above as a measure of earnings persistence and relate R-square to predictability.

The R-square of a model is the explained sum of squares (ESS) over the total sum of squares (TSS), where TSS is the sum of squared deviations between the observations and the mean of the explained variable and ESS is the sum of squared deviation between the model and the mean of the explained variable. Thus, an R-square of one implies a perfect linear relationship between the predictor and the predicted variable. So inside the confines of the model, R-square is a measure of what usually is meant by predictability.

However, R-square of models based on different samples, which is the case when doing regressions in the different sorts, is not directly comparable. Dichev and Tang (2009) use a bootstrap method and simulate the distribution of the R-squares to test for difference.

Dichev and Tang (2009) find that low volatility earnings are significantly more predictable than high volatility earnings. In the high earnings volatility quintile the regression coefficient of $E_t$ on $E_{t+1}$ is 0.507 with an R-square of 0.296, while in the low volatility quintile the regression coefficient is 0.934 with an R-square of 0.704. This is compared to a full sample coefficient of 0.652 with an R-square of 0.398.

Conditioning on earnings volatility is also shown to be incremental and stronger than competing explanatory variables, e.g. the accrual effect documented by Sloan (1996). To test the comparative implications for earnings persistence from conditioning on earnings volatility and level of accruals, Dichev and Tang (2009) do a similar analysis on accruals. The regressions within the different quintiles formed on accruals produces a similar pattern of results as conditioning on earnings volatility. Comparing the results, they find that the decline in persistence coefficients across earnings volatility quintiles is moderately larger than for accruals and the comparative decline across quintiles is larger in the R-squares. Their statistical test shows that the comparative differences are statistically significant.

To test longer term predictive power, $E_{t+5}$ is regressed on $E_t$. In the high volatility quintile the coefficient is 0,177 and the R-square is 0,031, while in the low volatility quintile the coefficient is 0,805 with an R-square of 0,315 (Dichev and Tang (2009)).

> *"In fact, a literal reading of these numbers implies that it is easier to predict earnings five years ahead for low volatility firms than to predict earnings one year ahead for high volatility firms."* Dichev and Tang (2009)

Analysis of quality persistence outside its role in the "quality anomaly" is interesting for the same reasons as analysis of earnings persistence. As an aggregate measure of a range of fundamentals it should have practical utility in valuation. The table beneath show the results from Dichev and Tang (2009) for regressions within quintiles formed on the volatility of earnings. These are interesting when compared with the results for quality persistence presented in appendix 1.

| Panel B: Regression Results by Quintiles Based on Earnings Volatility | | |
|---|---|---|
| | β1 (Persistence) | Adj. R-square |
| Quintile 1 | 0,934 | 0,704 |
| Quintile 2 | 0,888 | 0,57 |
| Quintile 3 | 0,838 | 0,463 |
| Quintile 4 | 0,755 | 0,414 |
| Quintile 5 | 0,507 | 0,296 |
| Difference (Quintile 1 - Quintile 5) | 0,427 | 0,408 |
| p-value on Difference | < 0,001 | < 0,001 |

# 3 Method, Data and Description:

This section describes the sampling procedures, the construction of the quality indicator and the methods used to analyze the thesis questions.

## 3.1 Sampling Procedure:

1. A list of public US firms listed on NASDAQ, NYSE and AMEX as of February 2015 was generated[3]. The list includes 4 629 firms.
2. Firms with market capitalization less than USD 300 million, financial services and firms without sector information were excluded. This leaves us with 1 877 firms.
3. Of the remaining 1877 firms, 500 firms were randomly selected using the random numbers generating function in Excel. Real Estate Investment Trusts and firms with no financials previous to 2009 were excluded. This leaves 268 firms.
4. Income, cash flow and balance sheet were extracted from Eikon, on to separate spread sheets. All available accounting information in the Eikon database was extracted.
5. Line items needed for the calculation of quality were aggregated into one spread sheet and calculated following the methodology of Asness, Frazzini and Pedersen (2013).

Firms on NASDAQ, NYSE and AMEX, represents the waste majority of US listed firms and a large proportion of the global market capitalization of equities (Asness, Frazzini and Pedersen (2013)). It also represents the single largest pool of equities with uniform accounting standards and a large variety of industries[4].

[3] http://www.nasdaq.com/screening/companies-by-region.aspx?region=North America&country=United+States&sortname=marketcap&sorttype=1
[4] https://publications.credit-suisse.com/tasks/render/file/?fileID=AE924F44-E396-A4E5-11E63B09CFE37CCB

## 3.2 Survivor Bias

Ideally one would draw a panel (or take the complete population) at some historic date and follow the development of the panel through time. Because of delisting's this proved practically impossible for this thesis using the Eikon database.

According to data provided in Macey, O'Hara and Pompilio (2004), the proportions of voluntary and involuntary delisting's on NYSE and NASDAQ, in the period from 1998 to 2002, was 53 % and 47 %, with total delisting's running at about 14% of firms annually. Involuntary delisting's are due to poor performance by the firms while voluntary delisting's come from mergers, go private transactions and decisions to list on other exchanges. The sampling procedure of selecting current firms with more than six years of accounting and price data biased the sample towards the best performing firms and the ones with a surviving history. The length of accounting history varies greatly among firms and we see decay in numbers of observations as we move backwards in time. There will be bias in the estimates based on the sample constructed in this thesis, if the relationships studied vary systematically with survivorship.

## 3.3 Quality Calculation:

The methodology of Asness, Frazzini and Pedersen (2013) is followed as closely as possible. The quality indicator has 21 sub-components, to simplify I use 19 in the reconstruction and exclude idiosyncratic volatility and Olhsons's O. This will likely have a small impact on the results as the quality indicator is designed to be robust and is constructed from many correlated metrics (Asness, Frazzini and Pedersen (2013)).

### 3.3.1 The Quality Indicator

As Specified in QMJ 2013 Appendix A.

Quality indicator = ¼ (average profitability z-scores) + ¼(average growth z-scores) + ¼(average payout z-scores) + ¼ (average safety z-scores)

Standardized variables are calculated by subtracting the cross-sectional mean and dividing by the cross-sectional standard deviation for each component.

#### *3.3.1.1 Profitability*

The profitability component is defined as the average z-score of gross profits on assets, return on equity, return on assets, cash flow on assets, gross margin and low accruals.

$$\text{Profitability} = \frac{1}{6}\left(Z_{gopa} + Z_{roe} + Z_{roa} + Z_{cfoa} + Z_{gmar} + Z_{acc}\right)$$

GPOA is equal to revenue minus costs of goods sold divided by total assets. ROE is net income divided by book equity. QMJ uses shareholders equity minus preferred stocks. I use total shareholder equity as reported, a change that produce no material difference in this sample. ROA is net income divided by total assets. CFOA is free cash flow divided by total assets, where free cash flow is defined as operating cash flow minus capital expenditures. QMJ uses net income plus depreciation minus change in working capital as an estimate of operating cash flow. I use operated cash flow as reported. GMAR is revenues minus costs of goods sold divided by total revenue. ACC is depreciation minus change in working capital divided by total assets. Working capital is defined as current assets minus current liabilities minus cash and short term instruments plus short term debt and income tax payables. Where firms have negative book equity, the ROE component is excluded from the aggregate quality indicator.

#### *3.3.1.2 Growth*

The growth component is defined as the average z-score of five year growth in the profitability components. I use four year growth.

$$Growth = \frac{1}{6}(Z_{\Delta gopa} + Z_{\Delta roe} + Z_{\Delta roa} + Z_{\Delta cfoa} + Z_{\Delta gmar} + Z_{\Delta acc})$$

- $\Delta GOPA = (GP_t - GP_{t-4}) / AT_{t-4}$ , where GP is gross profit and AT is total assets.
- $\Delta ROE = (I_t - I_{t-4}) / BE_{t-4}$ , where I is net income and BE is book equity.
- $\Delta ROA = (I_t - I_{t-4}) / AT_{t-4}$
- $\Delta CFOA = (CF_t - CF_{t-4}) / AT_{t-4}$ , where CF is free cash flow.
- $\Delta GMAR = (GP_t - GP_{t-4}) / R_{t-4}$ , where R is revenue.
- $\Delta ACC = (ACC_t - ACC_{t-4}) / AT_{t-4}$

#### *3.3.1.3 Safety*

The safety component is defined as the average z-score on low beta, low idiosyncratic volatility, low leverage, low bankruptcy risk (Ohlson's O and Altman's Z) and low earnings volatility. As mentioned I exclude Ohlson's O and idiosyncratic volatility from the metric.

$$Safety = \frac{1}{6}(Z_{bab} + Z_{ivol} + Z_{lev} + Z_O + Z_z + Z_{evol})$$

BAB is equal to minus market beta (see estimating beta section). LEV is minus total debt over total assets, where total debt is total interest bearing short term and long term debt. Altman's Z-score (Altman 1968) is a weighted average of working capital, retained earnings, earnings before interests and taxes, market equity and sales:

$$Altman's\ Z = (1{,}2WC + 1{,}4RE + 3{,}3EBIT + 0{,}6ME + Sales)/AT$$

QMJ uses EVOL defined as the standard deviation of quarterly ROE over the past 60 quarters. Since the sample in this thesis includes negative equity firms I use ROA volatility instead and calculate it as the standard deviation in ROA over the past 16 quarters.

#### *3.3.1.4 Payout*

The payout component is defined as the average z-score on net equity issuance (EISS), net debt issuance (DISS) and total net payout over profits (NPOP).

$$Z = \frac{1}{3}(Z_{eiss} + Z_{diss} + Z_{npop})$$

EISS is minus one-year percent change in split-adjusted numbers of shares (SHROUT), $-\ln(SHROUT_t/SHROUT_{t-1})$. DISS is minus one year change in total debt (TOTD) – $\ln(TOTD_t/TOTD_{t-1})$. Total debt is long term debt plus short term debt. QMJ also add minority interest and preferred stocks, I do not. NPOP is equal to the sum of total net payout over the past four years, divided by the total profits for the period. Net payout is calculated as net income minus changes in book equity and total profits is defined as gross profits.

### 3.3.2 Treating Outliers:

To deal with influential observations' problems, I analyzed each component of quality before calculating z-scores. The sample includes negative equity firms, while ROE measures only have economic meaning when there is positive equity. Accordingly, ROE metrics are only calculated where equity is positive.

Cross-sectional return on equity has large and influential outliers. As shareholder equity approach zero, extremes in both directions occur. Extreme observations in ROE cause large fluctuations in cross sectional means and standard deviations between periods.

When cross-sectional standard deviations and means jump around, so will z- scores and produce noise in the Z-scores for all firms.

To deal with outliers consistently the customary extreme 1% cut-off is done.
Based on scatter plots, sorting and maximum-minimum studies of each variable at each cross-section, cut-offs where constructed. To simplify, these are approximates and excludes 1 % <u>or less</u> of observations on each variable in each cross section. The respective cut-off values are:

- If ROE is +/-1,2
- If ROA is +/- 2
- If CFOA is +/-4
- If **Δ**GOPA is+/-6.
- If **Δ**ROE is+/-6.
- If **Δ**ROE is +/-6.
- If **Δ**ROA is +/- 2.
- If **Δ**GMAR is +/- 10

Of the total 19 components, 11 were relatively free of outliers and were kept untouched. In addition, I excluded firm tickers INSY, BDSI and RMTI from the sample. These firms produced extreme values in most of the quality components and in most of the cross-sections. The causes of the extreme values were continued issuance of shares, sustained large losses and large negative free cash flows. Since many of the quality components are scaled by beginning assets and equity, this combination produce extreme observation and may point to a weakness of the quality indicator as an indicator of the relative price-to-book ratio.

### 3.3.3 Estimating Beta

When estimating beta for each firm per quarter, I follow the methodology of Asness, Frazzini and Pedersen (2013), which is the procedure outlined in Frazzini and Pedersen (2013). Volatilities are estimated using the last 250 trading days and correlations using

the last 750 days. Following the reasoning that correlations move more slowly than volatilities.
To simplify I use the raw market returns and S&P 500 as a proxy for the market portfolio.

Daily prices for the sample firms were extracted from Eikon. The Data more reason than to May 2001 are synchronous among the firms, while in the data prior to that date reported trading days differ among firms. Accordingly estimated beta's is excluded from the quality metric prior to May 2001.
To reduce the influence of outliers the methodology of Vasicek (1973) and Elton, Gruber, Brown, and Goetzmann (2003) is used. This shrinks the times series estimated beta ($\beta_i^{TS}$) towards the cross sectional mean ($\beta^{XS}$).

$$\hat{\beta}_i = w_i \hat{\beta}_i^{TS} + (1 - w_i)\hat{\beta}^{XS}$$

Beta of firm i is thus a weighted average of the cross-sectional average beta among firms and beta as normally calculated.  To simplify Frazzini and Pedersen (2013) set $w_i = 0,6$ and $\hat{\beta}^{XS} = 1$ for all periods and assets. I do the same.

### 3.4 Calculating Volatility of Quality

In this thesis I operationalize a new variable, which is called the volatility of quality (qvol). The variable is defined as the relative standard deviation of quality in the past 16 quarters (qvol).

$$qvol_{it=q} \equiv \frac{\sqrt{(16-1)^{-1} * \sum_{t=q}^{q-16}(Q_{it} - \bar{Q}_i)}}{(16-1)^{-1} \sum_{t=q}^{q-16} Q_{it}}$$

Where $Q_{it}$ is quality of firm index i at time index t and

$$\bar{Q}_i = (16-1)^{-1} \sum_{t=q}^{q-16} Q_{it}$$

### 3.5 Absolute Deviation

Absolut deviation of quality is a variable calculate as the absolute value of the change in quality from t-1 to t. time is measured in quarters.

$$(Absolute\ deviation)_{it} = \sqrt{(Q_{it} - Q_{it-1})^2}$$

### 3.6 Calculating Standardized Price-to-Book

For the purpose of this study, $P/B_{it}$ is calculated by dividing the market capitalization ($P_{it}$) of the firm with book equity ($B_{it}$). Standardized price-to-book ratios are calculated by subtracting the cross-sectional mean and dividing with the cross-sectional standard deviation.

$$Z\left(\frac{P}{B_{it}}\right) = \frac{\left(\frac{P}{B_{it}} - \overline{\frac{P}{B_t}}\right)}{SD\left(\frac{P}{B_t}\right)}$$

The extreme 1% of P/B observations was excluded from the data.

### 3.7 Persistence Regressions

The objective of the persistence regressions is to provide evidence on the empirical relationship between the volatility of quality and its persistence, with the hypothesis that stable quality is more persistent quality. The goal is to research the explanatory power of current quality on future quality.

(1) $$Q_{it+1} = \beta_0 + \beta_1 Q_{it} + u_{it}$$

where $Q_{it}$ is quality of firm i at time t and $u_{it}$ the idiosyncratic error.

This equation is estimated using OLS for the entire sample, in quintiles formed on qvol and quintiles formed on absolute deviation in the prior period. The quintiles are formed by doing annual sorts on the conditioning variable. This leads to 15 sorts the first at December 1999 and the last at December 2013.

The quality indicator is calculated for a panel of firms. Often the panel data is driven by a motivation to control for time fixed unobserved effects masking the relationship of the independent and dependent variable. We can then use a fixed effects model to control for unobserved time fixed effects. However, I argue why this is not the appropriate technique to analyze the research question in this thesis. A simple fixed effects model would be (Woolridge 2013),

(2) $y_{it} = \beta_1 x_{it} + a_i + u_{it}$

where $a_i$ is the time fixed unobserved effect, assumed correlated with $x_{it}$ and affecting the level of y.

(3) $\bar{y} = \beta_1 \bar{x_\iota} + a_i + \overline{u_\iota}$

The fixed effects estimator is pooled OLS on time-demeaned variables, which effectively controls for the effect of $a_i$. This is achieved by subtracting equation (2) from (3).

(4) $$y_{it} - \bar{y_\iota} = \beta_1(x_{it} - \bar{x}_i ) + u_{it} + \bar{u}_i$$

The pooled OLS estimator on equation (4) is,

$$\hat{\beta}_1 = \frac{Cov\,((y_{it} - \bar{y}),(x_{it} - \bar{x}_\text{I}))}{Var(x_{it} - \bar{x}_{it})}$$

where covariance is Cov(y,x) = E[(x-E[x])(y-E[y])]

So in the numerator of the OLS estimator we have,

$$E[((y_{it} - \bar{y}_i) - E[y_{it} - \bar{y}_i])((x_{it} - \bar{x}_i) - E[x_{it} - \bar{x}_i])$$

Since,

$E[y_{it} - \bar{y}_i] = 0$ and $E[x_{it} - \bar{x}_i] = 0$ the numerator of the OLS estimator become,

$$E[(y_{it} - \bar{y}_i)(x_{it} - \bar{x}_i)]$$

Shifting to the variable notation

$$E[(Q_{it+1} - \bar{Q}_i)(Q_{it} - \bar{Q}_i)]$$

This is the covariance of quality for each firm's deviations from time-series mean between cross-sections in the sample. This is essentially a measure of auto-covariance tendency in the sample.

This thesis hypothesize that stable quality is more persistent, with the interpretation that persistent quality is quality that stays more similar across time, than other quality in the universe of firms. Auto-covariance tendency in the sample would not capture the tendency of a firm's quality to stay about its mean. E.g. if firms with stable quality, have small variations around a relatively stable mean value, it may very well constitute very low auto-covariance. In a fixed effects specification where we run pooled OLS on time demanded observations, such a firm would contribute little to quality "persistence".

While in fact a firm with weak "quality persistence" with the respect to its autoregressive coefficient could strongly affect the persistence coefficient in equation (1). Consider the case of CWT, which is a firm "selected" by the low volatility of quality quintile in all 15 sorts.

The firm has remarkable stable quality over the 15 year period, consistently above the quintile mean. Since the mean quality of the different quintiles is reasonably stable, CWT affects the slope positively in regression on all time horizons. On the other hand an AR(1) model of CWT's quality series shows fast mean reversion towards its times series mean.

By design, the fixed effects transformation controls away the time fixed "structural" effect on firm quality we want to capture given the research question and hypothesized relationship. In line with the methods used by Dichev and Tang (2009) to study earnings persistence, I use simple regressions of future quality on current quality (equation one). This is done within different quintiles of the sample formed on the conditioning variable (qvol).

The simple regression of future on current quality within quintiles captures the autoregressive tendency of the whole quintile. In other words, a persistent firm would be one that consistently stays above or below mean quality of the quintile. The tendency can be compared with other quintiles formed on the conditioning variable, thus provide evidence on the research question.

Quintiles of the sample are based on the variables qvol and absolute deviation. The quintiles are constructed the following way. First, the sample is sorted on qvol from low to high on each sort date, with the sort dates being December of each year from 1999 through 2013. Then quintile 1 (lowest) on qvol is formed by adding quintile 1 firm's from each sort date. The same procedure is done for both conditioning variables.

## 3.8 Testing the Price of Quality and its Volatility

The quality indicator is constructed to be a model of cross-sectional variance in the price to book ratio. The elements of quality, profitability, growth, safety, and payout, are inspired by Gordon's formula rewritten to incorporate price-to-book ratio. It is important to note, that while Gordons's formula is an absolute valuation model and thus explain the theoretical price-to-book ratio, the quality indicator is a relative measure meant to explain the cross-sectional variation in the ratio among firms.

Accordingly, when analyzing the price of quality and the volatility of quality we need to compare the cross-sectional distribution in the indicator with that of the market. This is done along the lines of Asness, Frazzini and Pedersen (2013), with cross-sectional regressions of price-to-book on the quality indicator.

$$P/B_{it} = \beta_0 + \beta_1 Q_{it} + u_{it}$$

where $P/B_{it}$ is the standardized price-to-book ratio of firm i at time t, $Q_{it}$ is quality of firm i at time t and $u_{it}$ is the idiosyncratic error.

Quality is a weighted average of z-scores and thus has an easy interpretation. A quality of one implies that the firm has average profitability, growth payout, and safety components one standard deviation from the cross-sectional mean. To ease the interpretation and mute outliers, I used standardized price-to-book ratios. Asness, Frazzini and Pedersen (2013) used Fama, Macbeth (1973) regression and used standard errors adjusted for heteroskedasticity and autocorrelation up to a lag length of 12 months. I use the standard regressions setup and report robust standard errors in cross-sections where the Breusch-Pagan test is significant at the 0.05 level.

To empirically test if the volatility of quality is priced, I use regressions of future quality on current quality and quality interacted with a dummy based on the level of qvol. The dummy is coded 1 if the observation is in the lowest quintile formed on qvol and zero for all other observations.

$$P/B_{it} = \beta_0 + D_1 + \beta_1 Q_{it} + \beta_2 Q_{it} * D_1 + u_{it}$$

where $P/B_{it}$ is the standardized price-to-book ratio of firm i at time t, $Q_{it}$ is quality of firm i at time t, $D_1$ is the low qvol dummy and $u_{it}$ is the idiosyncratic error.

$\beta_2$ measures the change in the slope between price-to-book and quality by moving from the full sample to the lowest quintile formed on qvol. The specification above is the one I use in the results presented. Other specifications were also tried but discarded due to data constraints. (E.g. interacting quality with all quintiles formed on qvol.) The hypothesized expected sign on $\beta_2$ is positive. Stable quality is expected to have a steeper slope with the price-to-book ratio relative to less stable quality.

# 4 Analysis and Results:

The analysis and results are divided into three parts. The first section reports the results on quality persistence, the second reports the results on the price study and the third discusses hypothesis assumptions and theory in relation to the findings.

## 4.1 Descriptive Statistics on The Volatility of Quality:

As Dichev and Tang (2009) find for the earnings volatility variable, qvol has a non-normal distribution. It has positive skewness and excess kurtosis. At the left side it is bounded by zero and skew to the right by extreme values. The architecture of this analysis is meant to deal with this problem and use regressions within quintiles formed on the conditioning variable to analyze its effects.

## 4.2 Quality Persistence:

The analysis of quality persistence follows the framework established in Dichev and Tang (2009) for earnings persistence. In addition to emulating a good framework it simplified comparisons of the results for quality with those for earnings. The results on quality persistence are presented in appendix 1:

### 4.2.1 Results from one Year Predictive Horizons:

$$Q_{it+1} = \beta_0 + \beta_1 Q_{it} + u_{it}$$

Appendix 1, Table 2, Panel A, B and C and presents the results from the one year predictive horizon. Panel A shows the results from regressing future quality on current quality in the full sample. The persistence coefficient in the full sample is 0.61 with an R-square of 0.38.

Table 2 Panel B shows the results from fitting the model within quintiles formed on qvol, with quintile 1 being the subsample with the lowest qvol and quintile 5 being the subsample with the highest qvol. Panel C does the same with sorts formed on the absolute deviation variable (see 3.5).

Table 2 Panel B shows a qualitative pattern in both the persistence coefficients and the R-squares, when conditioning on qvol. Both the coefficients and the R – squares are monotonically distributed across the quintiles. Within quintile 1, the persistence coefficient is 0.82 with an R-square of 0.66. Within quintile 5 the persistence coefficient is 0.31 with an R-square of 0.10. This indicates that over one year horizon, current quality is a relatively strong predictor of future quality, conditional on past quality being relatively stable. A literal interpretation would be that stable quality (quintile 1) explains 66 % of the variance in future quality and unstable quality (quintile 5) only 10 %. At the same time stable quality is also materially more persistent with the difference in coeffsients between quintiles being 0.51. This would likely have material impact on relative valuation as is later illustrated.

If we think of these as AR(1) coefficients a difference of 0.51 produces large differences in mean reversion. Just consider the graph in appendix 3 which shows a stylized example where we have two AR(1) processes both with an unconditional expectation of 0.1. Process A has a coefficient of 0,8 and process B has a coefficient of 0,3 and a time t observation for both processes is 0,75. The unconditional expectation are choosen after median quality in Table 1 and the time t observations after the mean quality of the high-high and high-low portfolios in figure 3, which will be discussed later. When considering the implications for future expected quality from conditioning on level of qvol, the difference among quintiles seems economically important.

To test for statistical difference between the high and low qvol quintile a dummy specification as shown in Appendix 1, Table 3 is used.

$$Q_{it+1} = \beta_0 + D_1 + D_5 + \beta_1 Q_{it} + \beta_2 Q_{it} D_1 + \beta_3 Q_{it} D_5 + u_{it}$$

$D_1$ is a dummy coded one if the observation is in the lowest quintile based on the volatility of quality and coded zero for all other observations. $D_5$ is coded one if the observation is in the highest volatility of quality quintile and zero for all other observations.

The slope on the interaction of current quality with the low qvol dummy is positive and significant at 0.001 level. I.e. the persistence coefficient on the low volatility of quality quintile is significantly different and higher than what's experienced in the rest of the sample.

The slope on the interaction of current quality with the high qvol dummy is negative and significant at the 0.001 level. I.e. the persistence coefficient in the high volatility of quality is significantly different and smaller than what's experienced in the rest of the sample.

To test the difference in R-square among quintiles, one needs to use a bootstrap method to simulate the distributions of the R-squares (Dichev and Tang 2009). This became outside the scope of this thesis.

The tests results support the hypothesis that conditioning on the volatility of quality impacts the persistence of quality and the explanatory power of current quality on future quality.

Panel C shows the results from persistence regressions when quintiles are formed on a variable I call absolute deviation. The variable is meant as a competing and complementary variable to volatility of quality. Inspiration for this variable comes from existing research that show that transitory items and $|E_t - E_{t-1}|$ has significant impact on earnings persistence (Litov and Frankel (2009)), and mean reversion of book rate of return shown by Freeman, Ohlson, Penman (1982).

One could argue that by capturing recent absolute change it may be complimentary to qvol in capturing firm's stability, since qvol equal-weights resent and more past observations of quality. This possibility is not explored further here and the variable is mainly included as a benchmark to compare the results from qvol.

Panel C shows that conditioning on absolute deviation of quality in the previous period to time t, produces qualitatively the same results as qvol on quality persistence. The regression results are not monotonically distributed over the quintiles and are weaker than what experienced when conditioning on qvol, but the discrepancy in the persistence coefficient and R-square between the extreme quintiles seems meaningful. A statistical test on this differences where not conducted. Again the quintiles are sorted from low to high on the conditioning variable, thus the result indicates that firms with the lowest absolute deviation in quality, in the previous period (quarter), have more persistent quality than firms with the highest absolute deviation in the previous period.

### 4.2.2 Results for eight year Predictive Horizons:

Appendix 1, Table 4, Panel A, B and C present the results for long term predictive horizon. Panel A shows the results from unconditional regressions in the full sample, Panel B shows the results of regressions in the highest quintile formed on qvol and Panel C shows the results in the lowest qvol quintile.

Panel A present a useful benchmark for the results in Panel B and C. In panel A quality at time t+1, t+2, through t+8 are regressed on current quality. The results show that the predictive power of current quality deteriorates at a steady pace as the predictive horizon expands. The full sample results decline from a persistence coefficient of 0.61 and a R-square of 0.38 at the one year horizon, to a persistence coefficient of 0.36 and a R-square of 0.14 at the five year horizon and a persistence coefficient of 0.27 and a R-square of 0.08 at the eight year horizon.

Panel B shows the results of the same regressions within the highest qvol quintile. From a lower base, the results show the same steady decrease in predictive power as the horizon expands through t+4. At the five year and six year horizons coefficients and R-squares has a small upswing, while at the seven year and eight year horizons, current quality has no statistically significant explanatory power. The persistence coefficients start at 0.31 at the one year horizon decline to 0.14 at the four year horizon and increase to 0.26 at the six year horizon. R-Square follows the same pattern and declines from 0.10 at the one year horizon to 0.017 at the four year horizon and increase to 0.05 at the six year horizon. Compared to the results from the full sample, current quality in the high qvol quintile seems to have materially less explanatory power on future quality.

Panel C shows the results of the regressions in the lowest qvol quintile. The results show that current quality has (relatively) strong predictive power on future quality over long horizons, conditional on quality being stable. From a level of 0.82 for the persistence coefficient and 0.66 for the R-square at the one year horizon, persistence coefficient and R-square decline to 0.71 and 0.44 at the five year horizon and 0.53 and 0.20 at the eight year horizon. A literal interpretation of these results suggest that current quality, conditional on being stable, has more predictive power on quality five years ahead, than current quality in the full sample have on quality one year ahead. And current quality in the lowest qvol quintile, have more predictive power on quality eight years ahead, than current quality in the highest qvol quintile has for quality one year ahead.

The three graphs in Appendix 1, Figure 1 creates a graphical view of the regression results presented in Appendix 1, Table 4, Panel A, B and C. The graphs show the future mean quality for portfolios formed on current quality within, the full sample (Figure 1a), the highest qvol quintile (Figure 1b), and the lowest qvol quintile (Figure 1c). In Figure

1d the graph shows the difference in mean quality of quintile 5 and 1 formed on current quality, within the full sample, the highest qvol quintile and the lowest qvol quintile.

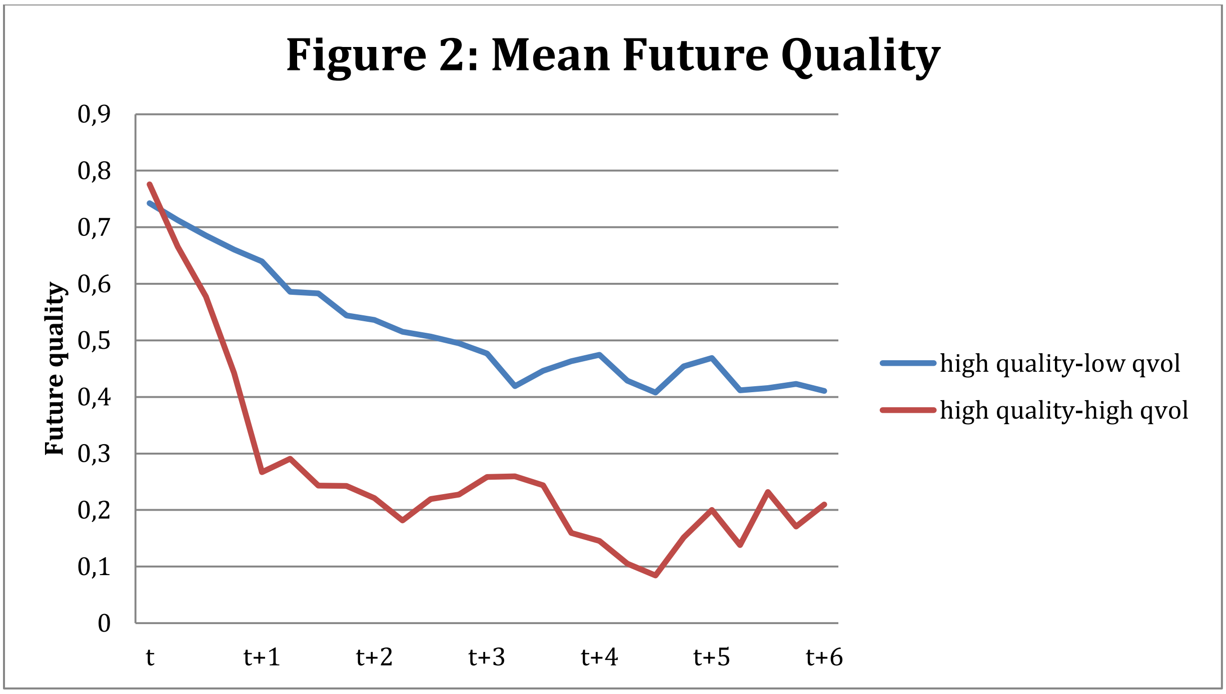
Figure 1a shows the mean reversion of quality in the full sample. From a dispersion in the highest and lowest quintile formed on current quality of 1.62, the dispersion is reduced to 0.6 five years later. The portfolios keep a consistent quality rank for the five year horizon.

Figure 1b shows the mean reversion in the highest qvol quintile. From a dispersion in the highest and lowest quintile formed on current quality of 1.21, the difference is reduced to 0.26 five years later. Thus differentiating on current quality as a way to differentiate on a firm's future quality is less effective within the highest volatility of quality quintile, versus the full sample. The portfolios formed on current quality, within the highest qvol quintile also shift quality rank.

Figure 1c shows that mean reversion is weaker in the lowest qvol quintile compared to the full sample benchmark. From a dispersion of 1.57, the dispersion is reduced to 0.96 five years later. Inversely to the results for the highest qvol quintile, differentiating on current quality as a means to differentiate on future quality is more successful in the lowest qvol quintile, versus the full sample. The result versus the benchmark seems to be driven by a somewhat slower mean reversion in the highest quality portfolio and a materially slower mean reversion in the lowest quality portfolio. This is consistent with the results of the persistence regressions in Table 5, Panel A and B.

Figure 1d illustrates the results discussed above and shows the differentiating ability of current quality within the full sample, within the lowest qvol quintile and the highest qvol quintile.

Dichev and Tang (2009) find the same pattern of results for earnings. They notice however, that high volatility earnings have a larger dispersion of current earnings than their full sample and low volatility of earnings subsample. Since extreme earnings are shown to mean revert faster and thus could be a confounding factor behind the observations of faster mean reversion of high volatility earnings. They construct a control for the current difference in the dispersion of earnings. The quality indicator shows no such pattern. Dispersion in current quality in the highest volatility of quality quintile is actually lower than the full sample and lowest volatility quintile. Accordingly the current dispersion control is not done in this analysis. In Figure 2 however, the current quality is match on two portfolios with different qvol thus having a similar control effect, but only on a subset of the sample.




Quality is measured in standard deviations and time in years.

Figure 2 controls for the level of quality and differentiate on volatility of quality by sorting the sample in the following manner. First, at each sort date, the sample is sorted into 20 subsamples based on the level of quality where subsample 20 has the highest quality. Then each subsample is sorted into quintiles based on qvol. The high quality - high qvol portfolio is constructed by adding the firms in the highest qvol quintile of subsample 17 – 20 based on the level of quality. The high quality – low qvol portfolio is constructed by adding the firms in the lowest qvol quintile of subsample 17-20 based on the level of quality. The sorts were done annually starting at December 1999 and ending at December 2013. From the figure we see that the procedure is successful in controlling for the level of current quality.

The quality indicator is the weighted sum of the z-scores on profitability, growth, payout and safety, measured on the basis of a firms past performance. A difference in quality of about 0.25 to 0.3 standard deviations, extended for several years, seems economically meaningful. The different conditional expectations of future quality, between high and low qvol portfolios, may substantial affect the current price-to-book ratio.

It is impossible from this analysis to gauge the precise relationship, but consider the following example as an illustration.

A 0.3 standard deviation move imply a move by ROE of 7 % in the sample.

Firm A:

- Book value = 10 , ROE = 10% , $r_e$ = 10% , g=0 $D_1$=1
- Following Gordon's formula, price-to-book would thus be one.

Firm B:

- Book value = 10 , ROE = 17% , $r_e$ = 10% , g = 0 and $D_1$ = 1.7

If firm B maintains a ROE of 17% and thus a dividend of 1.7, for six years, before reverting to 10 %, it would imply a price-to-book ratio of about 1.3 as per Gordon's formula, i.e. a 30 % difference in present value.

A difference in quality of 0.3, imply an average score of 0.3 standard deviations higher on the various elements of quality. The example above simulates the economic consequence of only changing one of the elements of quality by the indicated amount in Figure 2. The assumptions in the example are necessarily arbitrary and other assumptions would produce other results.

In Appendix 4 graphs of future median quality from the high quality – low qvol portfolio and the high quality – high qvol portfolio, from each annual sort, is presented. Figure 2 represents the aggregate of these sorts. The graphs in Appendix 4 show that stable quality beats unstable quality in every annual sort, based on cumulative median future quality, over the horizon of this panel. This indicates that the persistence results are not dominated by the results from one sort, but express the general tendency throughout the sample.

This analysis only compares the effect of conditioning on qvol with the presumed effect of absolute quality deviations in the previous period. Other effects will be also at play. The quality indicator consists of ROA, the persistence of which persistence has been extensively studied. As discussed earlier, level of accruals and deviations from the mean has significant and incremental value as a conditioning variable when constructing predictive models of earnings (Dichev and Tang (2009), Sloan (1996)). Introducing more comparisons and specify models to single out the incremental effect of qvol and other relevant variables, would be interesting. E.g. a model with future quality regressed on current quality and quality interacted with a variety of explanatory variables like Frankel and Litov (2009) does for earnings.

## 4.3 The Price of Quality and Volatility of Quality:

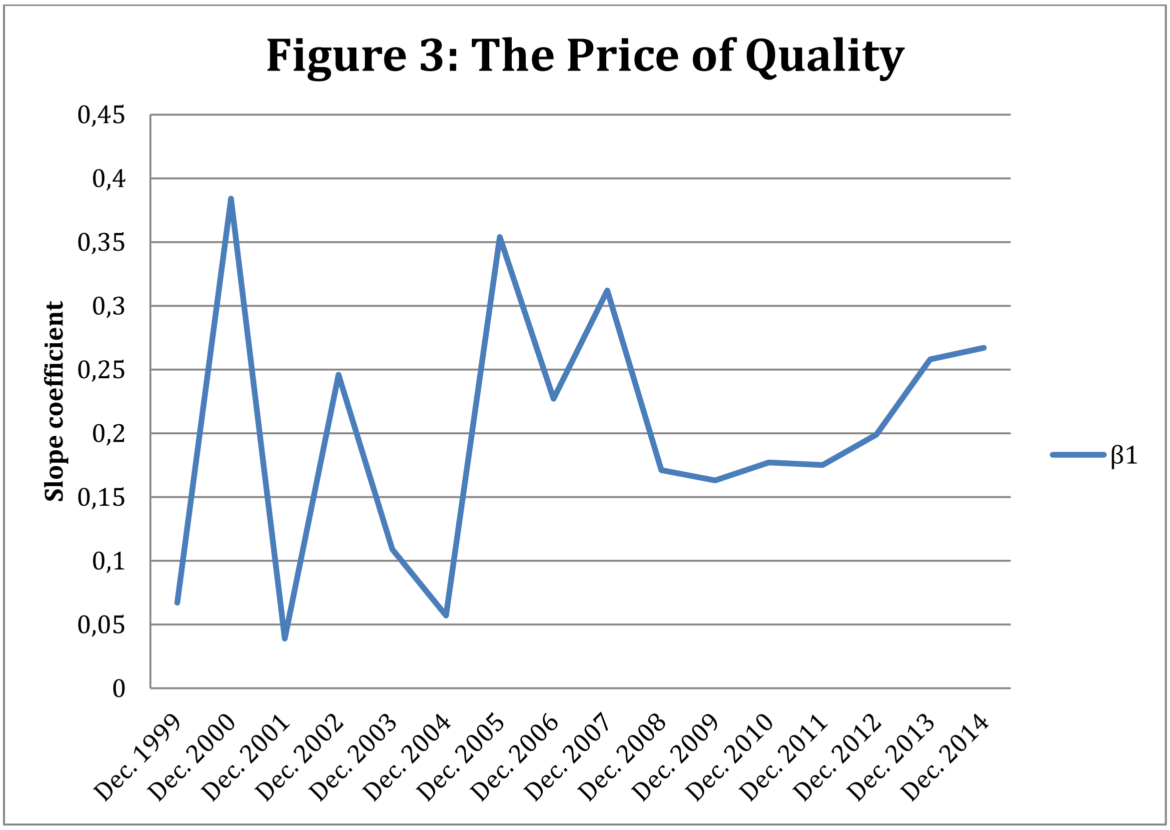
This section discusses the results from cross-sectional regressions of the standardized price-to-book ratio on the quality indicator and quality interacted with a dummy for the volatility of quality. These empirical tests aim to provide evidence on the second research question: Is the volatility of quality reflected in equity prices?

### 4.3.1 Regression Results for the Price of Quality

Appendix 2, Table 1 Panel B, show the results from simple regression of standardized price to book on quality. The extreme 1% of price-to-book is excluded from the sample.

$$P/B_{it} = \beta_0 + \beta_1 Q_{it} + u_{it}$$

The overall results are consistent with the findings of Asness, Frazzini and Pedersen (2013). All cross-sectional coefficients are positive, with 11 out of 16 being significant at the 5% level. The average $\beta_1$ is 0.20 and the average R-square is 0.034. The results are illustrated in Figure 3.




Comparing the above Figure 3 with Figure 5 in the appendix to Asness, Frazzini and Pedersen (2013), we observe that both graphs fluctuate within the same range. In addition to showing that quality as constructed in this thesis is priced, it also indicates that the quality indicator has been successfully reconstructed. Quality is priced, but as Asness, Frazzini and Pedersen (2013) notice, explain a very small fraction of the cross-sectional variation in the price-to-book ratio.

#### 4.3.2 Regression Results for the Price of Volatility of Quality

The cross-sectional regressions from the specification beneath, provides the results shown in appendix 2, Table 3.

$$P/B_{it} = \beta_0 + \beta_1 Q_{it} + \beta_2 Q_{it} {*} D_1 + u_{it}$$

Where $P/B_{it}$ is the standardized price-to-book value for firm i at time t, $Q_{it}$ is quality of firm i at time t, $D_1$ is a dummy coded one if the observation is in the lowest qvol quintile and zero for all other observations and $u_{it}$ is the residual of firm i at time t. Again the extreme 1% of price-to-book is excluded from the sample.

$\beta_2$ is the coefficient of interest in this regression. It measures the change in the slope between price-to-book and quality when moving from the full sample to lowest qvol quintile. The regression results show that $\beta_2$ is significant in 3 out 16 cross-sectional regressions at the 5% level. Two of the coeffsients are consistent with the hypothesized and positive and one is negative. 9 out 16 coefficients are positive and the averages for all cross sections are 0,207. These results provide no basis for strong conclusions. The results provide some evidence that the volatility of quality is priced but weak and inconsistence across time.

The empirical test of quality and its price may be improved using Fama and MacBeth (1973) regressions. This became outside the scope of this thesis.

## 4.4 Findings, Assumptions and Theory

The previous section reported the results on quality persistence and its price. The next three sections discuss the assumptions behind the hypothesized relationships and interpretation of the results in relation to theory.

### 4.4.1 Quality as a Model for the True Price-to-Book Ratio

This section makes some comments on how the quality indicator may relate to the true price-to-book ratio.

Quality is operationalized from Gordon’s formula,

$$\frac{P}{B} = \frac{ROE * payout\ ratio}{r_e - g}$$

As,

(Quality indicator)$_{it}$ = ¼ (average profitability z-scores) + ¼(average growth z-scores) + ¼(average payout z-scores) + ¼ (average safety z-scores)

(See the method section for the full list of constituencies.)

There are obvious issues in going from Gordon's formula to the Quality indicator. If one agrees that the dividend discount model is the true model of investment value, Gordon's formula is a special case conditional on constant growth and constant discount rates. The inputs to Gordon's formula is future ROE, future payout, future discount rates and future growth. Thus and all other issues aside, quality should only be an indicator of the relative price-to-book ratio if it is persistent. It is on this account the thesis may improve the model, or more precisely identify a subset of firms where the quality indicator may be a better approximation. In the example to Figure 2 it is shown how two firms with the same current "quality", will deviate in theoretical value depending on the volatility of quality. Given the assumptions of the example, the difference in future quality indicated by Figure 2 is shown to imply a 30% difference in current price-to-book ratio. To be clear, Figure 2 indicate a future dispersion in quality of 0.2 – 0.37, this is a weighted average of the elements in quality, measured in standard deviations and based on a total of 19 subcomponents. This should be a relatively robust indication of actual superior performance, experienced by the stable quality portfolio.

There are (of course) other issues in this operationalization of the price to book ratio. Which underlying variables should be included? How should they be measured? How should they be weighted in the indicator? These questions are outside the scope of this thesis, but should be viable concerns when scrutinizing the results of the empirical tests.

Generally the results from analyzing quality persistence show: Current high and stable quality indicates higher future quality than current high and unstable quality and current low and stable quality indicates lower future quality than current low and unstable quality. This leads to an assumed strengthening of the slope between the quality indicator and the true model for the price-to-book ratio, when moving from the full sample to the lowest quintile formed on qvol. This follows directly from the logic of the example just considered. E.g. everything else being equal, a persisting high ROE affects price-to-book positively and more than a temporary high ROE and a persisting low ROE affect price-to-book negatively and more than a temporary low ROE. Again, the assumed relationship will have to be an approximation. (E.g. price-to-book is not linearly related to ROE persistence, see appendix 5.)

As explained above the quality indicator will have to be a rough approximation. Accordingly it will have significant model errors caused by unobserved effects not included in the model. Conditioning on volatility may be correlated with such unobserved factors in an unknown way and confound the perceived model improvement.  For the assumed strengthening of the slope to occur, these unobserved effects needs to be unrelated to the volatility of quality, or more precisely not positively correlated with increased stability and negatively correlated with the true price-to-book ratio.

In Damadoran (2012) it is argued that Gordon's formula is most applicable for firms in a "*steady-state*". Following the same logic and on the basis of the findings in this thesis, the quality indicator may by a better approximation, conditional on being stable.

### 4.4.2 The Relationship of Quality and Market Price to Book Equity

When analyzing the relationships between the quality indictor and price-to-book ratio determined in the market, we basically analyze the relationships between two models.

This leads to the necessary assumptions about the second research question and its hypothesis.

- Is the volatility of quality reflected in equity prices?
- With the hypothesis that, less volatile quality should have a steeper slope with the market price to book ratio than more volatile quality.

This hypothesis rests on three general assumptions: First, the quality indicator must be an approximation of the true model for the price-to-book ratio, second, conditioning on volatility of quality must have the implied effect on the indicator discussed above and third, the market determined price-to-book ratio also needs to be an approximation of the true model. The third assumption implies some degree of market efficiency, with the result that the market determined price-to-book ratio reflect some of the quality information from conditioning on qvol.

The results from the empirical test show, at best, weak support for this hypothesis. Given the apparent strong improvement of the model when operating in the stable quality subset, this is surprising. In addition to the methodology issues mentioned, I propose, like Asness, Frazzini and Pedersen (2013) for quality itself, three possible explanations:

a) market prices fail to reflect stable quality, or
b) market prices are based on superior quality characteristics, or
c) stable quality is correlated with systematic risk factors not controlled for in the safety component of quality.

An empirical analysis of the possible explanations is an interesting topic for further study.

### 4.4.3 Theoretical and Practical Relevance of Quality and its Persistence

Why should we care about quality and its persistence? As previously discussed, Asness, Frazzini and Pedersen (2013) show that many of the findings in the assets price literature can be reconciled to an indicator model, constructed to explain the cross-sectional variation in the price-to-book ratio. Finding that quality is weakly priced and a Quality Minus Junk factor with strong risk-adjusted returns is far more interesting, I think, than the standalone results on the individual components. That is because quality is operationalized from valuation theory and considers a range of sub-components to capture each element. This makes it less likely to just capture a historical pattern produced by chance alone. Given the amount of research done in the field of asset pricing, it is not that surprising that some such patterns have been found.5 What are theoretically surprising however, are the empirical properties of the quality variable. On this account, analyzing the price of quality may represent a better empirical test of EMH, than analyzing the returns to fundamental characteristics at a standalone basis without the theoretical link to valuation.

Quality and its persistence also add to the "fundamental's research" in accounting. There seems to be a considerable body of research done on earnings prediction, motivated by its central role in valuation, and to research how "fundamental's information" is reflected in equity prices (e.g. Sloan (1996), Lev and Thiagarajan (1993), Abarbanell and Bushee (1997) Penman and Zhang (2002)). But as Dichev and Tang (2009) point out it is mostly concerned with short run forecasts. According to themselves, Dichev and Tang (2009) is the first to document the strong effect on long term earnings predictability from conditioning on volatility. Graham and Dodd (1940) seem to have been well aware of such an effect, however, and points to inherent stability as the most important element in determining if past results, are a useful guide to the future[6]. The quality indicator is an aggregate of a range of fundamentals relevant in valuation. Thus the findings on quality persistence add to the understanding of their long run behavior as a group and should be of practical utility in valuation.

[5] The patterns are (of course) more surprising when found across regions and time.
[6] Security Analysis, Graham and Dodd 1940, page 472-473

# 5 Conclusion

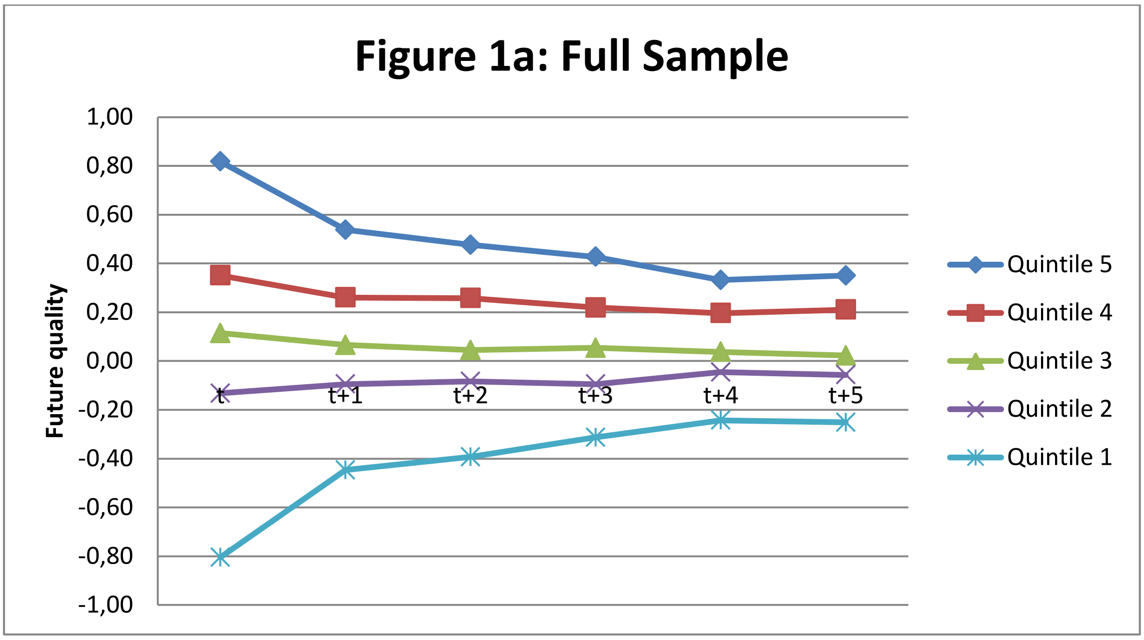
This thesis analyses quality persistence and its price. The sample results suggest that conditioning on the volatility of past quality, strongly discriminates quality persistence. By comparing future quality on portfolios with stable and unstable current quality, the discriminating effect appears to be economically meaningful.

It is argued in this thesis that the effect from conditioning on the volatility of quality should be reflected in equity prices of an efficient market. The empirical tests suggest, however, that the volatility of quality is at best weakly captured in prices.

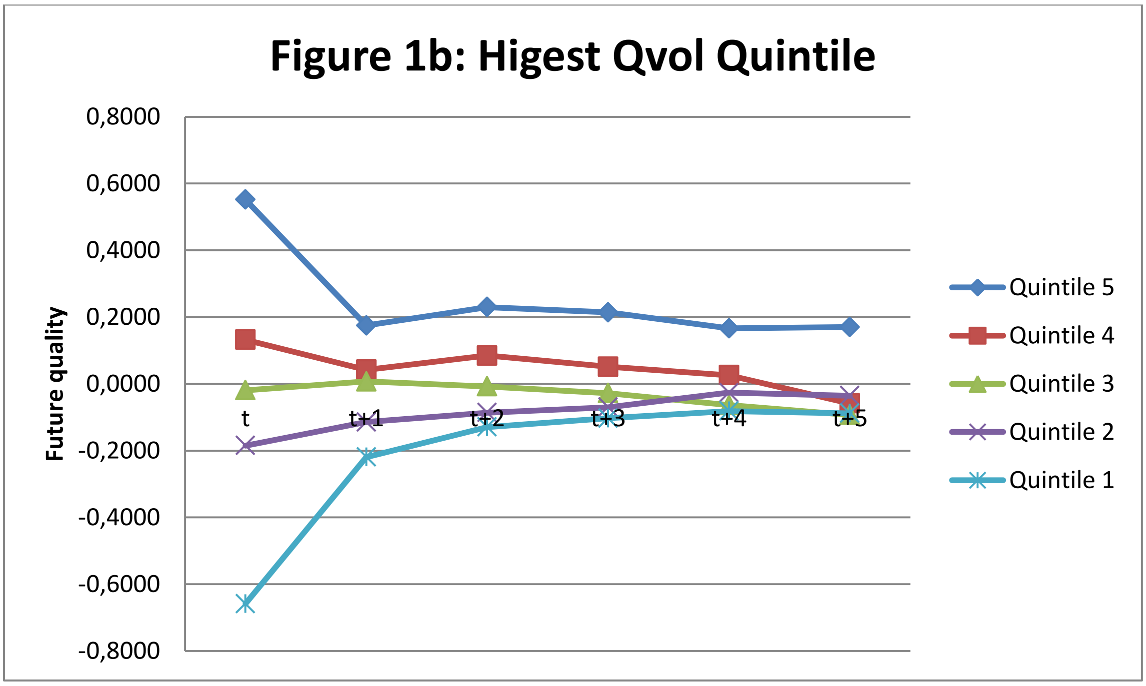
The results have two main implications. First, the results on quality persistence may have implications for the viability of using extrapolations of past results in practical valuations. Second, the weak price of quality adds to the "quality puzzle" and identifies interesting topics of further study.

# 6 Appendix 1: Quality Persistence

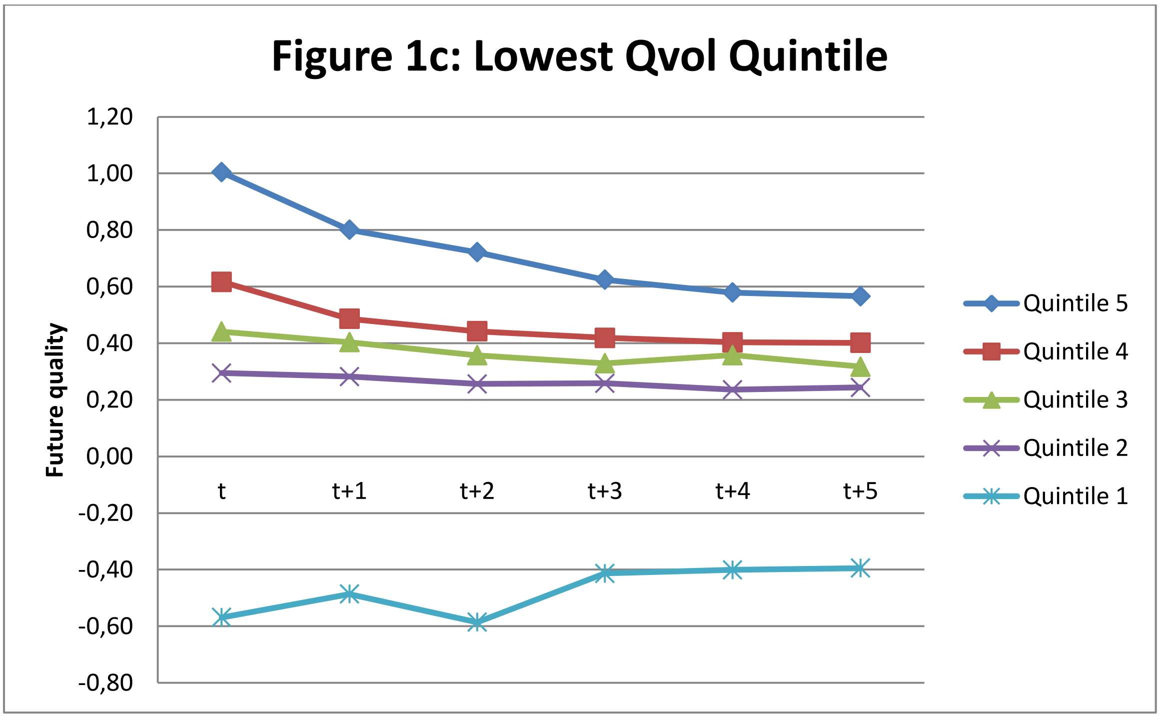
## 6.1 Figure 1: Mean Reversion of Five-year Future Quality



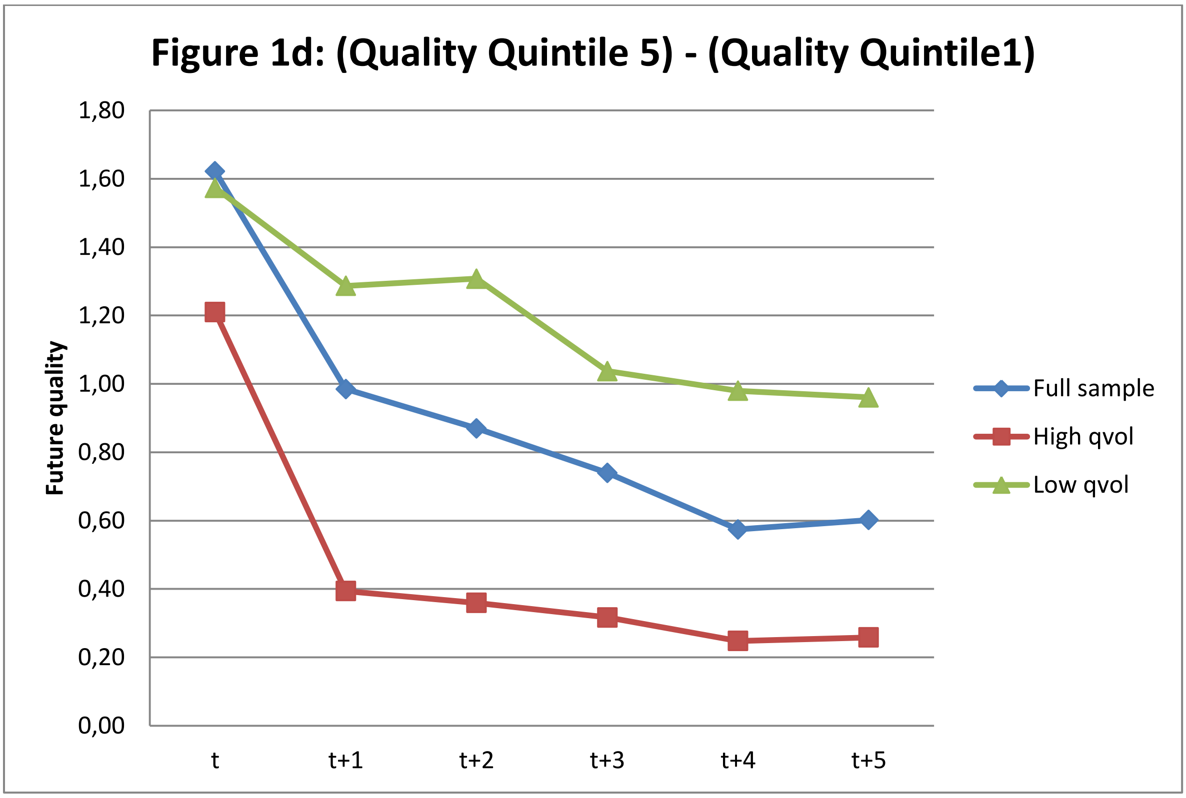

In Figure 1a, the full sample is sorted into five quintiles formed on the level of current quality. The graphs show mean future quality of each quintile.



In Figure 1b, the sample is first sorted into quintiles on the level of volatility of quality, and then the highest quintile is divided into quintiles on the level of current quality. The graph shows mean future quality for the different portfolios formed on the level of current quality, within the highest volatility of quality quintile.

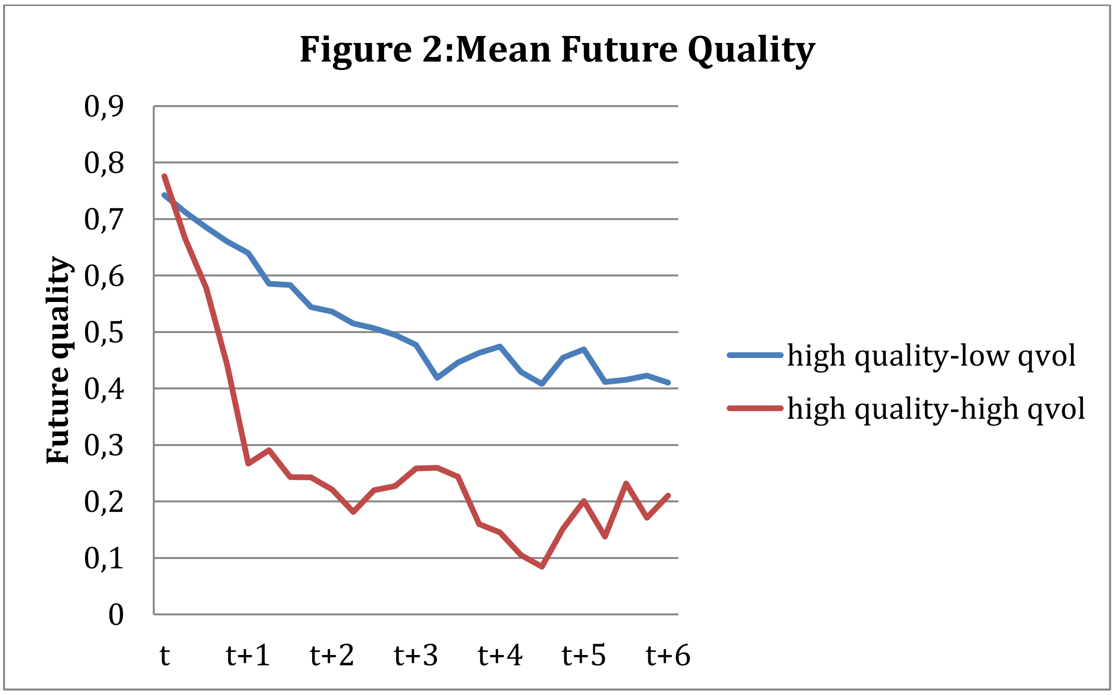



In Figure 1c, the sample is first sorted into quintiles on the level of volatility of quality, and then the lowest quintile is divided into quintiles on the level of current quality. The graph shows mean future quality for the different portfolios formed on the level of current quality, within the lowest volatility of quality quintile.




In Figure 1d, the graph shows the difference in mean future quality between quintile 1 and 5 formed on the level of current quality, within the full sample, within the highest qvol quintile and within the lowest qvol quintile.

## 6.2 Figure 2: Future Quality in High Quality - High Qvol Portfolios versus Quality in High Quality - Low Qvol Portfolios




The two portfolios are constructed in the following manner. First, at each sort date, the sample is sorted into 20 subsamples based on the level of quality where subsample 20 has the highest value. Then each subsample is sorted into quintiles based on the volatility of quality. The high quality - high volatility of quality portfolio is constructed by adding the firms in the highest volatility of quality quintile of subsample 17 – 20 based on the level of quality. The high quality – low volatility of quality portfolio is constructed by adding the firms in the lowest volatility of quality quintile of subsample 17-20 based on the level of quality. The sorts were done annually starting at December 1999 and ending at December 2013. Time is measured in years.

## 6.3 Table 1: Descriptive Statistics

| Descriptive statistics: | N | Mean | Median | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Quality indicator (Q(it)) | 13047 | 0.063 | 0.109 | 0.623 | -4.866 | 3.076 |
| Volatility of quality (qvol) | 10778 | 7.905 | 0.962 | 236.592 | 0.047 | 22059.710 |
| Absolute deviation (\|Q(it)-Q(it-1)\| | 12939 | 0.187 | 0.110 | 0.250 | 0.000 | 4.376 |

## 6.4 Table 2: Results From Quality Persistence Regressions

$$Q_{it+1} = \beta_0 + \beta_1 Q_{it} + u_{it}$$

### 6.4.1 Panel A: Regression Result for the Full Sample

| | $B_0$ | $\beta_1$ (persistence) | Adj. R-square | p-value | N |
|---|---|---|---|---|---|
| Full sample | 0.021 | 0.612 (0.014) | 0.378 | 2E-16 | 3125 |

### 6.4.2 Panel B: Regression Results by Quintiles of Qvol

| Quintiles by Qvol | $\beta_0$ | $\beta_1$ (persistence) | Adj. R-square | p-value | N |
|---|---|---|---|---|---|
| Quintile 1 | 0.008 | 0.816 (0.026) | 0.661 | 2E-16 | 509 |
| Quintile 2 | 0.038 | 0.611 (0.034) | 0.392 | 2E-16 | 510 |
| Quintile 3 | 0.021 | 0.562 (0.039) | 0.290 | 2E-16 | 511 |
| Quintile 4 | -0.040 | 0.264 (0.046) | 0.060 | 0.000 | 507 |
| Quintile 5 | -0.010 | 0.311 (0.041) | 0.099 | 2.2E-13 | 509 |

### 6.4.3 Panel C: Regression Results by Quintiles of |Q(it) – Q(it-1)|

| Quintiles by Level of \|Q(it)-Q(it-1)\| | $\beta_0$ | $\beta_1$ (persistence) | Adj. R-square | p-value | N |
|---|---|---|---|---|---|
| Quintile 1 | 0.049 | 0.687 (0.028) | 0.486 | 2E-16 | 620 |
| Quintile 2 | 0.010 | 0.732 (0.038) | 0.349 | 2E-16 | 675 |
| Quintile 3 | -0.003 | 0.740 (0.032) | 0.463 | 2E-16 | 619 |
| Quintile 4 | -0.008 | 0.647 (0.029) | 0.434 | 2E-16 | 620 |
| Quintile 5 | -0.005 | 0.493 (0.032) | 0.279 | 2E-16 | 601 |

Numbers in parentheses of panel A. B and C are standard errors. See the method section (Section 3) for variable definitions.

## 6.5 Table 3: Results from Regression with Qvol Dummy Interaction

$$Q_{it+1} = \beta_0 + D_1 + D_5 + \beta_1 Q_{it} + \beta_2 Q_{it} D_1 + \beta_3 Q_{it} D_5 + u_{it}$$

| | Coefficient Value | Adj. R-square | P-value | N |
|---|---|---|---|---|
| $\beta_0$ | 0.012 | 0.370 | 0.325 | 2546 |
| $\beta_1$ | 0.515 | | 2E-16 | |
| $\beta_2$ | 0.295 | | 6.4E-15 | |
| $\beta_3$ | -0.204 | | 0.000 | |

$D_1$ is a dummy coded one if the observation is in the low quintile (quintile 1) on volatility of quality and coded zero for all other observations. $D_2$ is a dummy coded one for observations in the high quintile on volatility of quality (quintile 5) and zero for all other observations. Numbers in parentheses are standard errors.

## 6.6 Table 4: The Implication of Qvol for Long Term Quality

### 6.6.1 Panel A: Regressions in the Full Sample

| Full Sample: | β0 | $\beta_1$ (persistence) | Adj. R-square | p-value | N |
|---|---|---|---|---|---|
| $Q_{it+1} = \beta_0 + \beta_1 Q_{it}$ | 0.020 | 0.611 (0.014) | 0.377 | 2E-16 | 3125 |
| $Q_{it+2} = \beta_0 + \beta_1 Q_{it}$ | 0.018 | 0.545 (0.015) | 0.303 | 2E-16 | 2866 |
| $Q_{it+3} = \beta_0 + \beta_1 Q_{it}$ | 0.019 | 0.457 (0.017) | 0.216 | 2E-16 | 2611 |
| $Q_{it+4} = \beta_0 + \beta_1 Q_{it}$ | 0.023 | 0.329 (0.018) | 0.115 | 2E-16 | 2355 |
| $Q_{it+5} = \beta_0 + \beta_1 Q_{it}$ | 0.018 | 0.356 (0.019) | 0.139 | 2E-16 | 2111 |
| $Q_{it+6} = \beta_0 + \beta_1 Q_{it}$ | 0.023 | 0.326 (0.026) | 0.110 | 2E-16 | 1876 |
| $Q_{it+7} = \beta_0 + \beta_1 Q_{it}$ | 0.022 | 0.299 (0.022) | 0.101 | 2E-16 | 1650 |
| $Q_{it+8} = \beta_0 + \beta_1 Q_{it}$ | 0.022 | 0.270 (0.024) | 0.080 | 2E-16 | 1433 |

### 6.6.2 Panel B: Regressions in the Highest Qvol Quintile

| Highest Qvol Quintile | β0 | $\beta_1$ (persistence) | Adj. R-square | p-value | N |
|---|---|---|---|---|---|
| $Q_{it+1} = \beta_0 + \beta_1 Q_{it}$ | -0.011 | 0.311 (0.041) | 0.099 | 2.2E-13 | 509 |
| $Q_{it+2} = \beta_0 + \beta_1 Q_{it}$ | 0.029 | 0.296 (0.046) | 0.079 | 4.8E-10 | 458 |
| $Q_{it+3} = \beta_0 + \beta_1 Q_{it}$ | 0.024 | 0.297 (0.049) | 0.081 | 2.1E-09 | 414 |
| $Q_{it+4} = \beta_0 + \beta_1 Q_{it}$ | 0.009 | 0.144 (0.053) | 0.018 | 0.005 | 371 |
| $Q_{it+5} = \beta_0 + \beta_1 Q_{it}$ | -0.013 | 0.152 (0.057) | 0.017 | 0.008 | 333 |
| $Q_{it+6} = \beta_0 + \beta_1 Q_{it}$ | -0.026 | 0.260 (0.064) | 0.050 | 0.000 | 290 |
| $Q_{it+7} = \beta_0 + \beta_1 Q_{it}$ | | not significant | | | |
| $Q_{it+8} = \beta_0 + \beta_1 Q_{it}$ | | not significant | | | |

### 6.6.3 Panel C: Regressions in the Lowest Qvol Quintile

| Lowest Qvol Quintile | β0 | $\beta_1$ (persistence) | Adj. R-square | p-value | N |
|---|---|---|---|---|---|
| $Q_{it+1} = \beta_0 + \beta_1 Q_{it}$ | 0.008 | 0.816 (0.026) | 0.661 | 2E-16 | 509 |
| $Q_{it+2} = \beta_0 + \beta_1 Q_{it}$ | -0.048 | 0.806 (0.032) | 0.584 | 2E-16 | 462 |
| $Q_{it+3} = \beta_0 + \beta_1 Q_{it}$ | -0.004 | 0.678 (0.034) | 0.480 | 2E-16 | 418 |
| $Q_{it+4} = \beta_0 + \beta_1 Q_{it}$ | -0.037 | 0.713 (0.041) | 0.420 | 2E-16 | 376 |
| $Q_{it+5} = \beta_0 + \beta_1 Q_{it}$ | -0.490 | 0.712 (0.044) | 0.444 | 2E-16 | 334 |
| $Q_{it+6} = \beta_0 + \beta_1 Q_{it}$ | -0.039 | 0.650 (0.052) | 0.350 | 2E-16 | 294 |
| $Q_{it+7} = \beta_0 + \beta_1 Q_{it}$ | -0.023 | 0.551 (0.066) | 0.215 | 3.5E-15 | 254 |
| $Q_{it+8} = \beta_0 + \beta_1 Q_{it}$ | -0.029 | 0.530 (0.071) | 0.202 | 2.0E-12 | 216 |

Panel A. B and C show regressions of future quality on current quality. T+1 mean quality one year ahead from the sort date is regressed on current quality. T+1 mean quality two year ahead of the sort date is regressed on current quality and so forth. Numbers in parentheses are standard errors.

## 6.7 Table 5: The Persistence of High and Low Quality in the Lowest Qvol Quintile

### 6.7.1 Panel A: Persistence of High Quality

$$Q_{it+1} = \beta_0 + D_1 + \beta_1 Q_{it} + \beta_2 Q_{it} D_1 + u$$

| | Coefficient value | Adj. R-square | P-value | N |
|---|---|---|---|---|
| $\beta_0$ | 0.0146 | 0.663 | | 508 |
| $\beta_1$ | 0.847 (0.031) | | 2.00E-16 | |
| $\beta_2$ | -0.096 (0.045) | | 0.034 | |

This panel shows regression results within the lowest quintile formed on qvol. Quality at t+1 is regressed on current quality and quality interacted with a dummy coded one if the observation is in the highest quintile formed on level of quality and zero for all other observations. Numbers in parentheses are standard errors.

### 6.7.2 Panel B: Persistence of Low Quality

$Q_{it+1} = \beta_0 + D_1 + \beta_1 Q_{it} + \beta_2 Q_{it} D_1 + u_{it}$

| | Coefficient value | Adj. R-square | P-value | N |
|---|---|---|---|---|
| $\beta_0$ | 0.064 | 0.664 | | 508 |
| $\beta_1$ | 0.713 | | 2E-16 | |
| $\beta_2$ | 0.182 | | 0.015 | |

This panel shows regression results within the lowest quintile formed on qvol. Quality at t+1 is regressed on current quality and quality interacted with a dummy coded one if the observation is in the lowest quintile formed on level of quality and zero for all other observations. Numbers in parentheses are standard errors.

# 7 Appendix 2: The Price of Quality and the Price of Qvol

## 7.1 Table 1: Descriptive Statistics

| Descriptive statistics: | N | Mean | Median | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Quality indicator (Q(it)) | 3413 | -0.063 | -0.292 | 0.762 | -1.236 | 4.299 |
| Price-to-book ratio | 3409 | 0.066 | 0.112 | 0.619 | -3.344 | 3.076 |

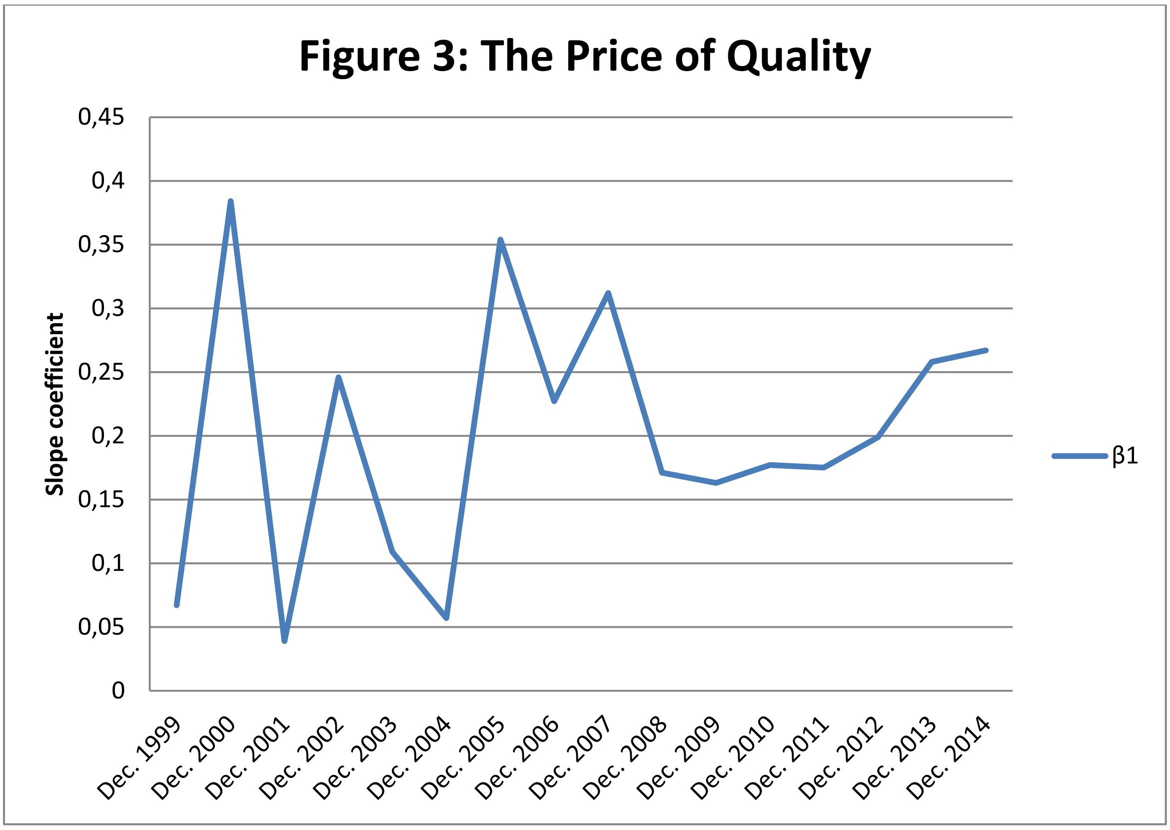
## 7.2 Table 2: Sample Price of Quality

$$P/B_{it} = \beta_0 + \beta_1 Q_{it} + u$$

| Cross-section | $B_1$ | p-value | R-square |
|---|---|---|---|
| Dec. 2014 | 0.267 | 0.003* | 0.037 |
| Dec. 2013 | 0.258 | 0.004* | 0.035 |
| Dec. 2012 | 0.199 | 0.020* | 0.023 |
| Dec. 2011 | 0.175 | 0.052 | 0.016 |
| Dec. 2010 | 0.177 | 0.047* | 0.017 |
| Dec. 2009 | 0.163 | 0.030* | 0.022 |
| Dec. 2008 | 0.171 | 0.013* | 0.030 |
| Dec. 2007 | 0.312 | 0.000* | 0.065 |
| Dec. 2006 | 0.227 | 0.013* | 0.033 |
| Dec. 2005 | 0.354 | 0.000* | 0.077 |
| Dec. 2004 | 0.057 | 0.488 | 0.003 |
| Dec. 2003 | 0.109 | 0.224 | 0.009 |
| Dec. 2002 | 0.246 | 0.000* | 0.104 |
| Dec. 2001 | 0.039 | 0.709 | 0.001 |
| Dec. 2000 | 0.384 | 0.002* | 0.069 |
| Dec. 1999 | 0.067 | 0.502 | 0.003 |
| Mean | 0.200 | | 0.034 |

This table shows results from cross-sectional regressions of standardized price to book on the quality indicator. The regressions exclude the extreme 1% of the P/B distribution. * indicates slope coefficients significance at the 0.05 level.

## 7.3 Figure 3: The Sample Price of Quality




This figure gives a graphical view of the regression results from Panel B above. $\beta_1$ is the slope coefficient in the cross-sectional regression of standardized price-to-book on the quality indicator.

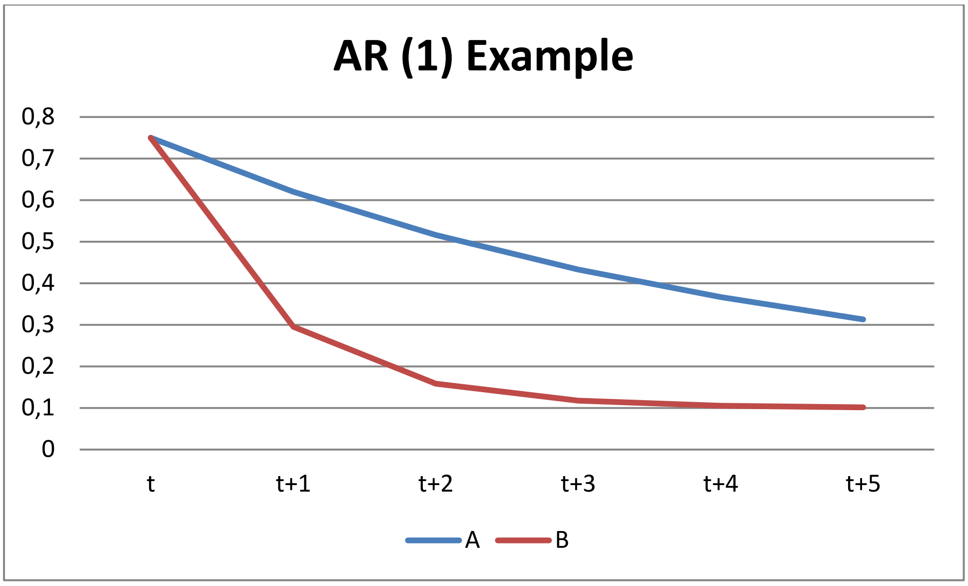
## 7.4 Table3: Sample Price of the Qvol

$$P/B_{it} = \beta_0 + \beta_1 Q_{it} + \beta_2 Q_{it} * D_1 + u_{it}$$

| | $\beta_1$ | P- value $\beta_1$ | $\beta_2$ | P- value $\beta_2$ | adj R-square | N |
|---|---|---|---|---|---|---|
| Dec. 2014 | 0.207 (0.134) | 0.125 | 0.434 (0.215) | 0.045* | 0.121 | 221 |
| Dec. 2013 | 0.151 (0.133) | 0.259 | 0.452 (0.253) | 0.075 | 0.067 | 216 |
| Dec. 2012 | -0.033 (0.436) | 0.939 | 0.423 (0.641) | 0.511 | 0.035 | 207 |
| Dec. 2011 | -0.011 (0.382) | 0.977 | -0.011 (0.563) | 0.984 | 0.053 | 199 |
| Dec. 2010 | 0.118 (0.317) | 0.704 | -0.304 (0.575) | 0.597 | 0.026 | 189 |
| Dec. 2009 | -0.015 (0.119) | 0.896 | 0.347 (0.238) | 0.145 | 0.033 | 181 |
| Dec. 2008 | -0.055 (0.151) | 0.714 | 0.417 (0.345) | 0.229 | -0.006 | 183 |
| Dec. 2007 | 0.315 (0.119) | 0.009 | 0.421 (0.282) | 0.137 | 0.065 | 177 |
| Dec. 2006 | 0.441 (0.107) | 0.000 | -0.496 (0.304) | 0.104 | 0.082 | 159 |
| Dec. 2005 | 0.565 (0.101) | 0.000 | -0.905 (0.225) | 0.000* | 0.177 | 150 |
| Dec. 2004 | 0.171 (0.129) | 0.189 | 0.104 (0.803) | 0.803 | -0.001 | 144 |
| Dec. 2003 | 0.512 (0.121) | 0.000 | -0.459 (0.302) | 0.131 | 0.001 | 132 |
| Dec. 2002 | 0.399 (0.162) | 0.015 | -0.135 (0.229) | 0.556 | 0.170 | 121 |
| Dec. 2001 | 0.516 (0.261) | 0.050 | -0.554 (0.464) | 0.235 | 0.009 | 113 |
| Dec. 2000 | 0.278 (0.137) | 0.045 | 2.826 (0.577) | 0.000* | 0.286 | 96 |
| Dec. 1999 | -0.133 (0.115) | 0.252 | 0.748 (0.515) | 0.150 | -0.001 | 92 |
| Mean | | | 0.207 | | 0.070 | |

This table shows results from cross-sectional regressions of standardized price-to-book on quality and quality interacted with a qvol dummy. $D_1$ is a dummy coded one if the observation is in the lowest qvol quintile and coded zero for all other observations. The 1% most extreme observations in price-to-book are excluded from each cross-section.

# 8 Appendix 3: AR (1) process

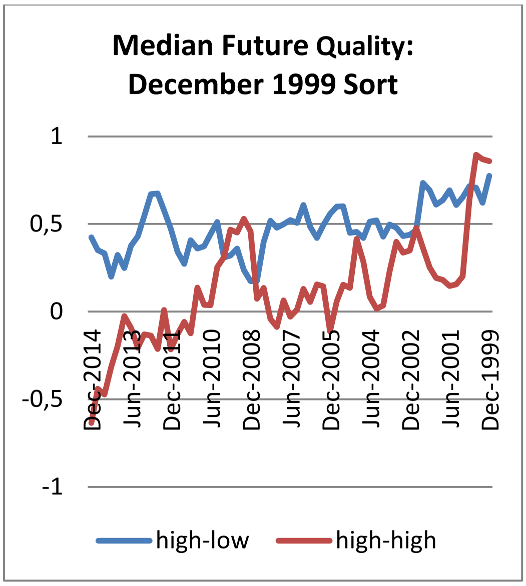


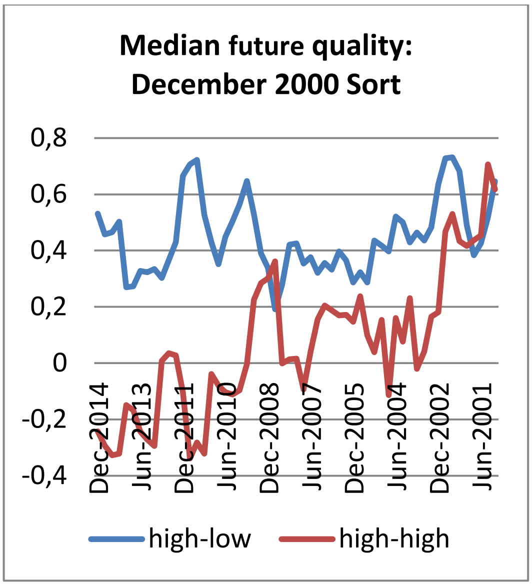

This graph shows a stylized example of two AR(1) processes A and B. Both have an unconditional expectation of 0.1. process A have an AR(1) coefficient of 0.8 while process B have an AR(1) coefficient of 0.3.

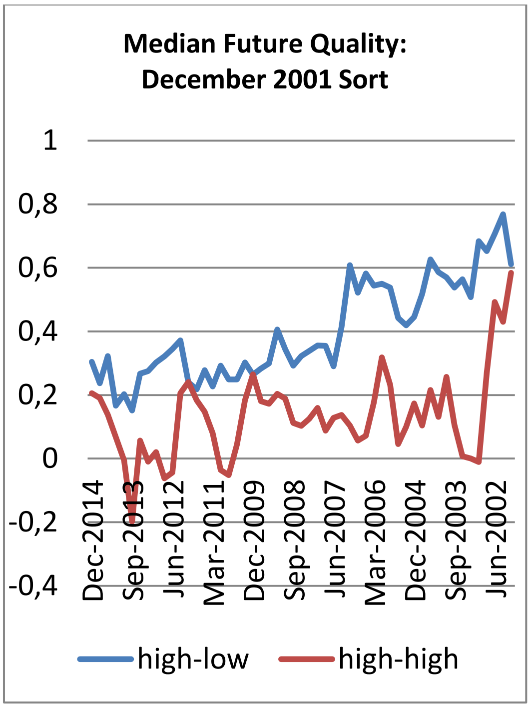
$$Y_t = \mu + \varphi_1 Y_{t-1} + u_t$$

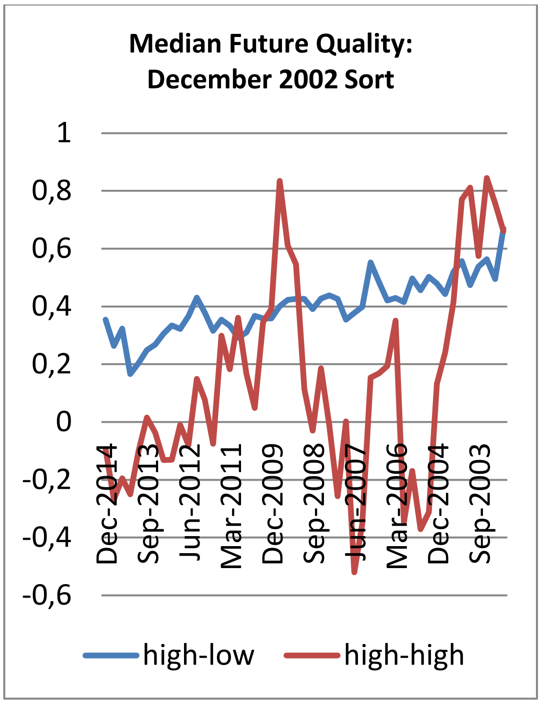
$$E[Y_t] = \frac{\mu}{1-\varphi} = 0.1$$

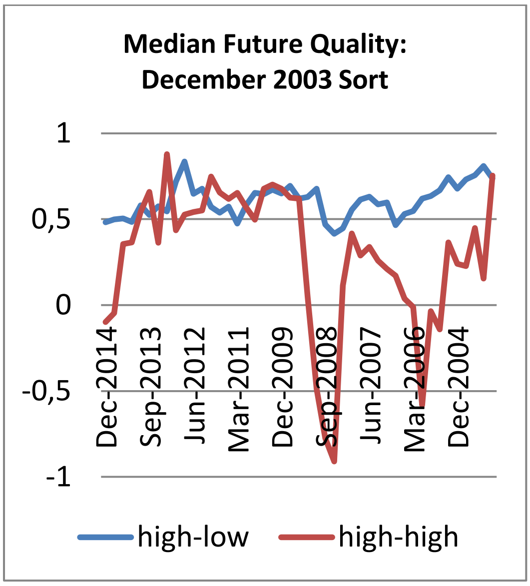
# 9 Appendix 4: Median Future Quality Annual Sorts.

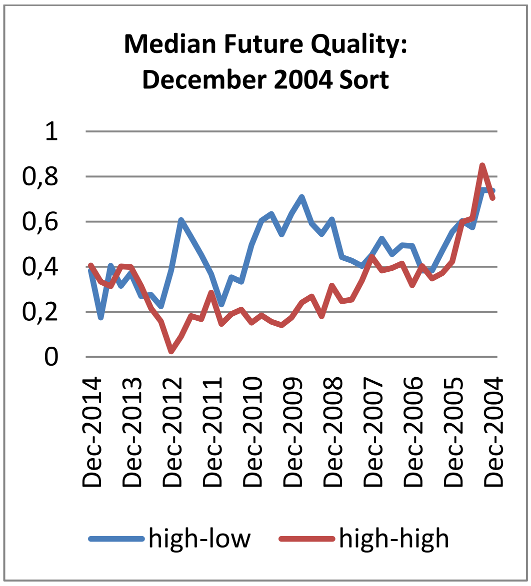



Median Future Quality: December 2003 Sort
1
0,5
0
-0,5
-1
Dec-2014
Sep-2013
Jun-2012
Mar-2011
Dec-2009
Sep-2008
Jun-2007
Mar-2006
Dec-2004
high-low
high-high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Dec-2011
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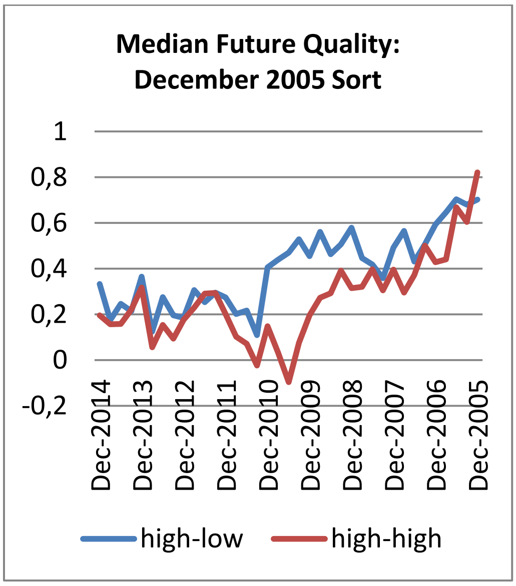
Dec-2009
Dec-2008
Dec-2007
Dec-2006
Dec-2005
Dec-2004
high-low
high-high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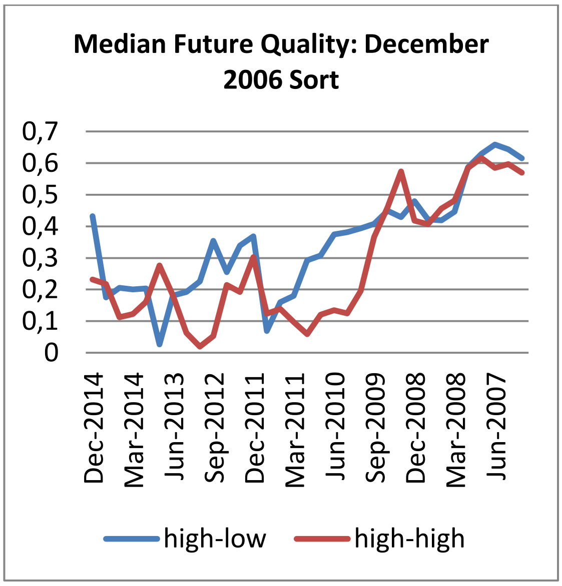
Dec-2010
Dec-2009
Dec-2008
Dec-2007
Dec-2006
Dec-2005
high-low
high-high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Jun-2013
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Dec-2011
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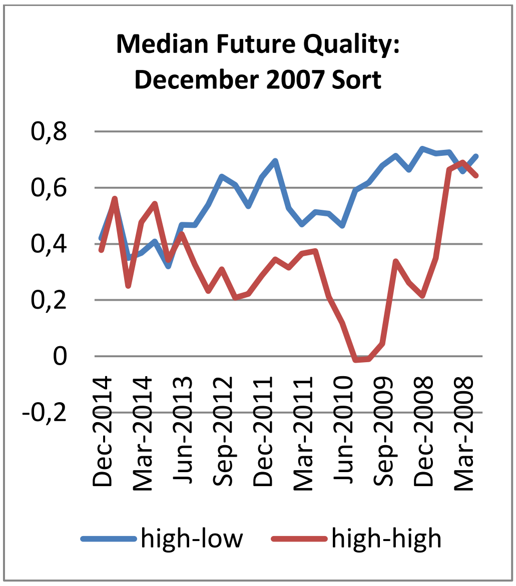
Mar-2008
Jun-2007
high-low
high-high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Mar-2008
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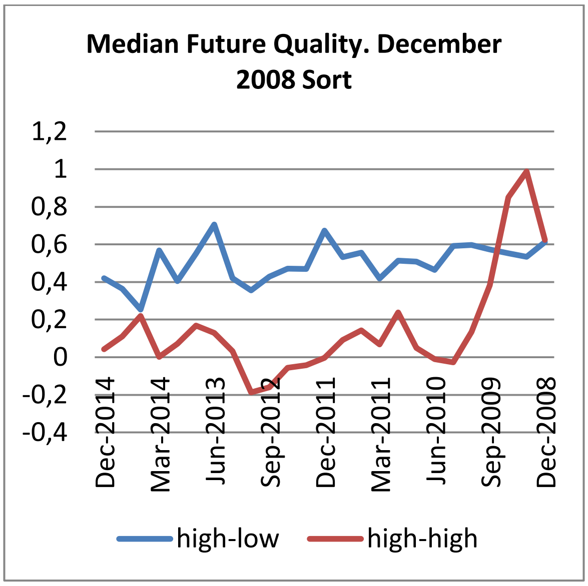
high-high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0
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-0,4
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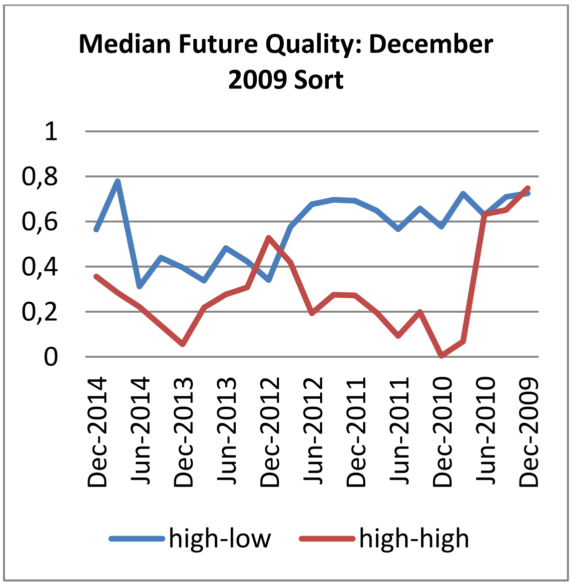
Dec-2011
Mar-2011
Jun-2010
Sep-2009
Dec-2008
high-low
high-high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0,2
0
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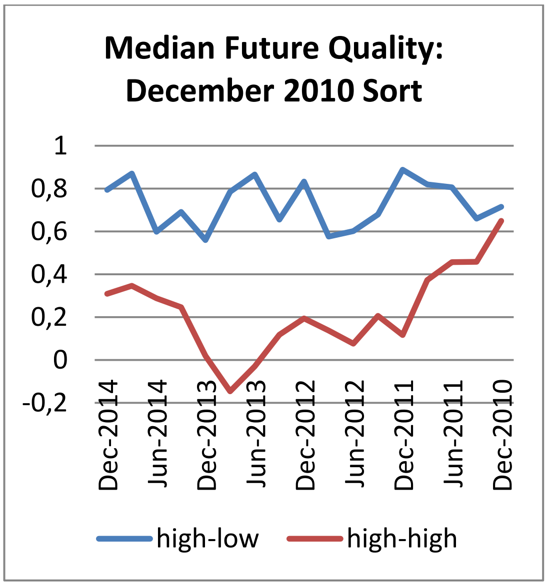
Jun-2014
Dec-2013
Jun-2013
Dec-2012
Jun-2012
Dec-2011
Jun-2011
Dec-2010
Jun-2010
Dec-2009
high-low
high-high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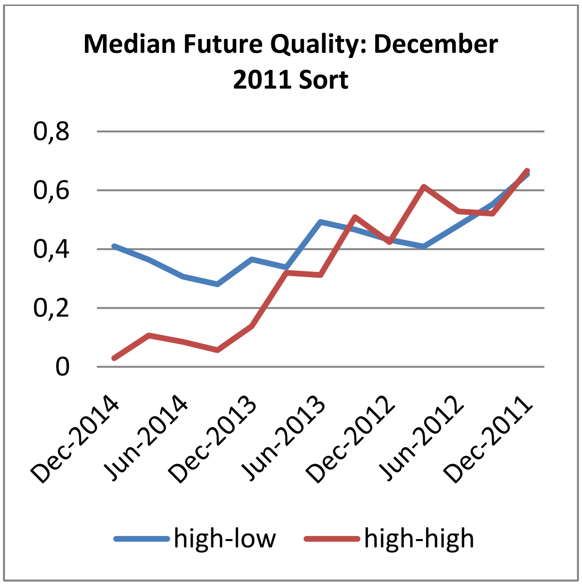
Dec-2010
high-low
high-high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Dec-2013
Jun-2013
Dec-2012
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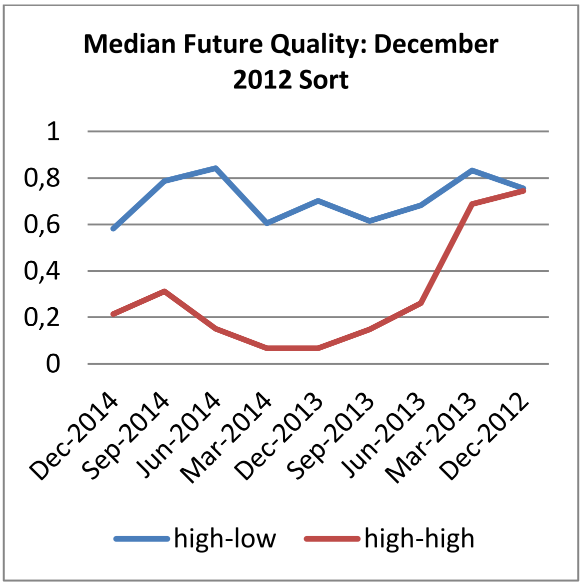
Dec-2011
high-low
high-high


Median Future Quality: December 2012 Sort
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0,4
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Jun-2014
Mar-2014
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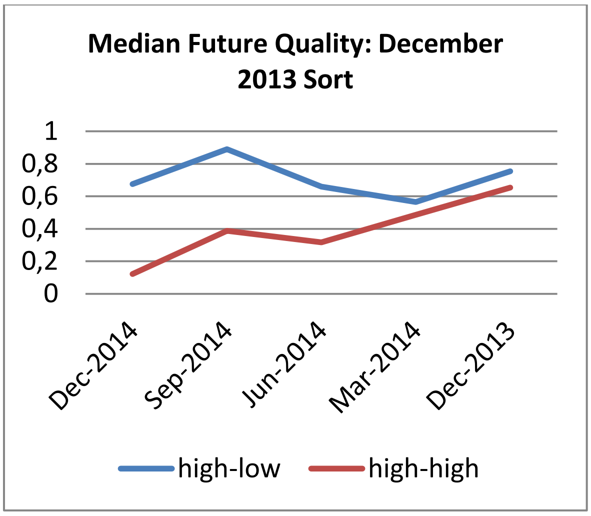
Jun-2013
Mar-2013
Dec-2012
high-low
high-high


Median Future Quality: December 2013 Sort
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0,6
0,4
0,2
0
Dec-2014
Sep-2014
Jun-2014
Mar-2014
Dec-2013
high-low
high-high

# 10 Appendix 4: Gordon's Growth Formula

Assuming a constant growth and discount rate the present value of a common stock can be expressed with Gordon's growth formula.

$$P = \frac{D}{r_e - g}$$

Where D is the expected dividend one year ahead. $r_e$ is the required rate of return p.a. and g is the growth rate of D p.a.

First. $D = E * \frac{D}{E}$ or D = E * Payout ratio. where E is earnings.

Thus $P = \frac{E * payout\ ratio}{r_e - g}$

If we divide both sides on book equity (B) we get the theoretical model for the price-to-book relationship under the assumption of constant return on incremental equity. a constant reinvestment rate and discount rate. These assumptions imply a constant growth rate as.

g = ROE*(1 – payout ratio).

$$\frac{P}{B} = \frac{ROE * payout\ ratio}{r_e - g}$$

# 11 Appendix 5: Effect of ROE Persistence on the Price-to-Book Ratio

$$\frac{P}{B} = \frac{ROE * Payout\ ratio}{r_e - g}$$

Or

$$\frac{P}{B} = \frac{PV}{B} = \frac{\sum_{t=1}^{\infty} \frac{D_t}{(1 + r_e)^t}}{B}$$

Where B represents book equity. P the market price. $r_e$ the discount rate. g the growth rate and D the dividend

Assumptions: $r_e$=10% p.a.. Temporary change in ROE from 10% p.a. to 17% p.a.. payout =1. growth (g) = 0 and B = 100.

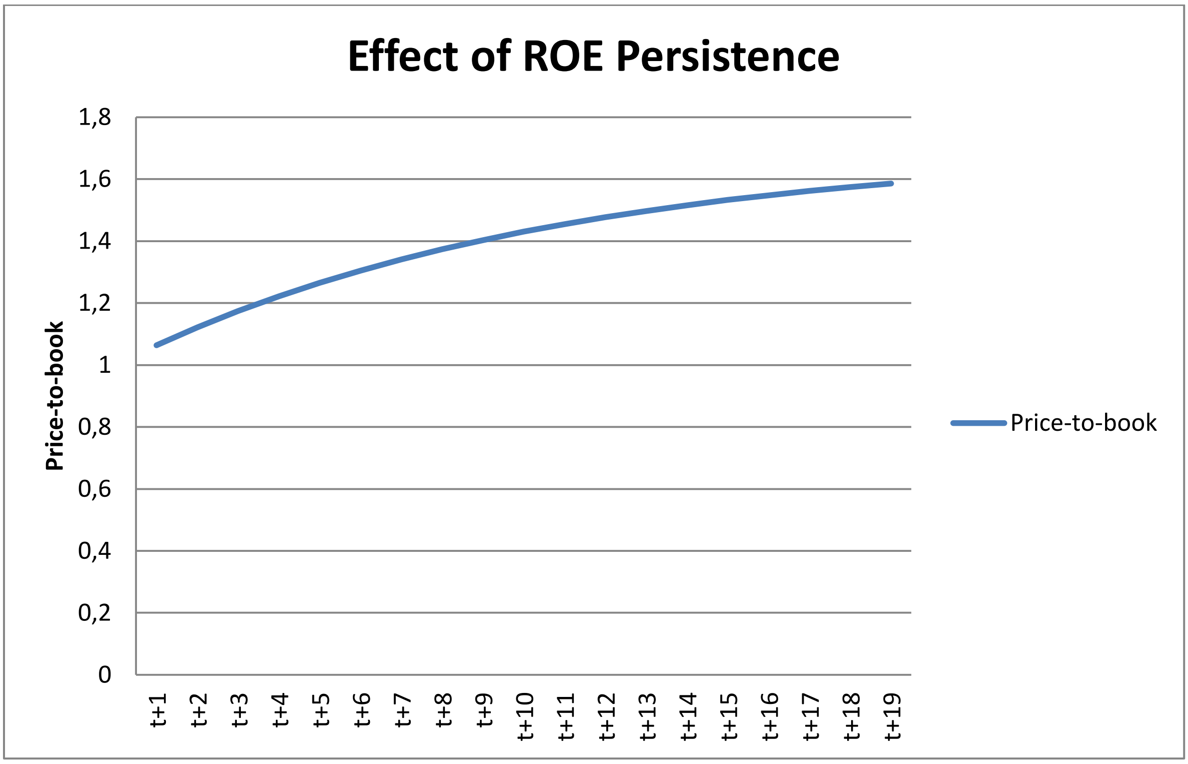
This example show a case where a perpetual ROE of 10% is temporarily increased by 7% to 17%. with the increase in earnings paid as dividends. The PV may in this case be split in two parts.

Since. $PV_{ROE\,=\,10\%} = \frac{D_1}{r_e - g} = \frac{10}{0.1 - 0} = B$

PV with temporary elevated ROE is.

$PV = B + \sum_{t=1}^{q} \frac{B(ROE - r_e)}{(1 + r_e)^t}$ and $\frac{P}{B} = 1 + \frac{\sum_{t=1}^{q} \frac{B(ROE - r_e)}{(1 + r_e)^t}}{B}$

Where q is the number of periods ROE is elevated.




The graph shows how current price-to-book. y-axis. will change as the period with abnormally high ROE persists (q increase). T+1 imply ROE stay elevated for one year. T+2 means ROE stay elevated for two years. and so forth.

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