Norwegian School of Economics

Bergen, Spring 2017

Fundamental Volatility and Stock Returns

Does fundamental volatility explain stock returns?

Selboe & Virdee

Supervisor: Francisco Santos

Master thesis in Financial Economics (FIE)

NORWEGIAN SCHOOL OF ECONOMICS

Abstract

In this thesis, we investigate whether the fundamental uncertainty can explain the cross-section of stock returns. To measure the fundamental uncertainty, we estimate rolling standard deviations and accounting betas of four different fundamentals: revenues, gross profit, earnings and cash flows. The standard deviation and the beta of revenues significantly explain returns in the Fama-Macbeth procedure, but only appears significant among smaller stocks in the portfolio formation procedure. The beta of gross profit is the only measure that we found to be significantly explaining stock returns in both procedures across sizes, when we exclude penny stocks. Interestingly, firms with low fundamental volatility appear to earn higher returns compared to firms with high fundamental volatility. We also find that investing in firms with low fundamental volatility effectively reduces the exposure to idiosyncratic risk.

Table of Content

1. Introduction

Applying Frank Knights (1921) distinction between risk and uncertainty to stocks, one could argue risk describes the various states that a firm's cash flows can be in with known probabilities, while uncertainty is describing the states with unknown probabilities. Firms with uncertain cash flows might therefore be considered inferior, as the probabilities of the outcomes remain unknown and speculative. The required rate of return for these firms could therefore be expected to be higher, depending on the level of risk aversion among the marginal investors. The source of this uncertainty could be information uncertainty around the future fundamentals, but also information asymmetry where only sophisticated investors or insiders are able to predict the highly volatile fundamentals and correctly determine the value of the company.

In this thesis, we investigate whether high uncertainty around the firm's fundamentals could be considered a key characteristic in explaining the cross-section of stock returns. To measure this uncertainty, we estimate the volatility of the following four fundamentals: revenues, gross profit, earnings and cash flows. From a risk perspective, only systematic risk should be compensated for. If the fundamental volatility proxies for risk, it will not be compensated for unless parts of the volatility cannot be diversified away. This led us in the direction of estimating accounting betas. The standard deviation of the various fundamentals measures the fundamental volatility, while the accounting betas provide an estimate of the systematic fundamental volatility[1].

We apply two common asset pricing tests: the Fama-Macbeth and portfolio formation procedure. The asset pricing tests show mixed evidence. We find that the standard deviation and the beta of revenue significantly explain returns in the Fama-Macbeth procedure, but only appear significant among smaller stocks in the portfolio formation procedure. The beta of gross profit is the only measure that we found to be significantly explaining stock returns in both the procedures across sizes, when we exclude penny-stocks. Interestingly, firms with low fundamental volatility appear to earn higher returns compared to firms with high fundamental volatility. The standard deviation and beta of revenues load negatively in both the Fama-Macbeth and portfolio formation procedure among smaller stocks. Similarly, the beta of gross

[1] At times we refer to the *fundamental volatility* as an umbrella term for both the standard deviations and accounting betas, unless otherwise specified in the beginning of the section.

profit also loads negatively in both the procedures.

Even though we do not find the volatility of cash flows to be significant, our findings are in line with Zhang (2006) and Huang (2009) who find that firms with low cash flow volatility tend to earn higher stock returns. On the other end, our findings contradict studies as Beaver, Kettler and Scholes (1970) and Rosenberg and Guy (1976) who find that firms with higher earnings volatility tend to be riskier. To a large extent we provide a robustness test of Huang's (2009) findings. Further, we investigate investment strategies formed independently on the fundamental volatility. This differs from Zhang (2006) who specifically considers the impact cash flow volatility has on price-continuation strategies[2]. To test whether the volatility of fundamentals explains stock returns, we apply a significantly different methodology compared to Beaver et al. (1970) and Rosenberg and Guy (1976).

We also provide additional insight into how fundamental volatility fits into quality investing. Novy-Marx (2013) argues for a simple proxy of quality, the gross profitability. Yet, Novy-Marx (2014) fails to explain the abnormal returns of Grantham's quality strategy using the gross profitability. Grantham (2004) finds that profitable and low-levered firms with stable earnings tend to earn abnormal returns. There is a likelihood that the gross profitability poorly captures the stability aspect of quality stocks. Investigating fundamental volatility, controlling for the gross profitability, therefore appears to be an attractive way to investigate how the fundamental stability improves quality strategies. From the quality narrative, we find that firms that tend to be the most resilient to recessions, with low accounting betas, tend to earn higher stock returns. Most interestingly, we also find that investing in firms with low fundamental volatility effectively reduces the exposure to idiosyncratic risk.

The remainder of our master thesis is organized as follows. The next section discusses related literature and some of our main findings. Section 3 describes our sample data and variable construction. Section 4 provides the descriptive statistics of the sample data. In Section 5, we present the results from the Fama-Macbeth and portfolio formation procedure. In Section 6 we discuss the impact fundamental volatility has on idiosyncratic risk. Section 7 presents our robustness tests and discusses related topics, while Section 8 provides our conclusion.

[2] As momentum, post-earnings announcement stock price drift in the direction indicated by the earnings surprise, and post-event return drift in the direction of the announcement date return.

2. Related studies

Our master thesis contributes by taking a deeper dive into the stability aspect of quality investing. We believe that the quality dimension often is hard to quantify and measure exactly, since there are a lot of "rule of thumb" applied by investors when determining quality. In contrary to most papers on quality investing, we therefore assess the stability of fundamentals through not only various measures, but also by explicitly testing the measures using the traditional asset pricing tests.

High profitability combined with stable fundamentals is surely pointing in the direction of a durable competitive advantage, which often is associated with quality[3]. Most academic papers so far assess the stability mostly by looking at historical growth rates, profitability expansions and constant positive returns on equity/assets over varying time spans. A few papers assess the volatility of earnings as a part of the safety aspect of stocks, as Asness, Frazzini and Pedersen (2014) and Grantham (2004). It is rather puzzling that the volatility of earnings has gotten this much attention in quality investing studies, considering the widely-known practice among firms to smoothen earnings by manipulating accounting numbers. Any measure that is easy to manipulate by the firms, is less likely to proxy for risk, considering the firm's incentives to be perceived as less risky. Further, none of the papers we have viewed so far have presented traditional asset pricing tests where the volatility has been directly tested, particularly the volatility of revenues and gross profits. Asness et al. (2014) even explain that their choice of stability-metrics simply was determined by applying "common sense" since the literature on what should be included to determine the required returns still is "very contentious".

Interestingly when Novy-Marx (2014) conducts a spanning-test including several quality factors, gross profitability seemed less able to explain Grantham's quality strategy. Since Grantham's strategy is the only one that considers earnings volatility it could indicate that gross profitability to a larger extent is able to capture the profitability and growth aspect of quality, rather than for example the stability aspect. Investigating fundamental volatility, as an

[3] Warren Buffett refers to the competitive advantage as the "moat" in several interviews: *"I don't want a business that's easy for competitors. I want a business with a moat around it with a very valuable castle in the middle. And then I want the duke who's in charge of that castle to be honest and hard-working and able. And then I want a big moat around the castle, and that moat can be various things."*
http://www.nasdaq.com/article/warren-buffett-on-the-importance-of-moats-cm767018#ixzz4iy1ril00

extension of Novy-Marx's profitability factor, therefore appears to be an interesting way to investigate how the fundamental stability improves quality strategies.

Our findings suggest that investing in firms with low fundamental volatility does yield higher stock returns, particularly in the Fama-Macbeth regressions. We find similar findings in the portfolio formation procedure, but only among smaller stocks. We also find that firms that tend to have the most recession-resilient fundamentals, with low accounting betas, tend to outperform firms that are highly exposed to the economy. These findings support Grantham's (2004) proposition that firms with high and stable profits, tend to provide an "insurance against economic downturns" which tends to be underpriced in the market.

Among quality-investing papers the fundamental volatility is not explicitly treated as a proxy for information uncertainty. Grantham (2004) for instance states that stable profits indicate low risk, without referring to a specific type of risk[4]. Asness et al. (2014) also do not specify what risk is being minimized by investing in firms with low earnings volatility. Fundamental volatility could for instance proxy for information uncertainty as proposed by Zhang (2006).

In contrast to Zhang (2006), we do not solely study the impact that cash flow volatility has on price-continuation strategies, through the information uncertainty narrative. We investigate the independent explanatory power of fundamental volatility. Zhang (2006) tests the hypothesis that more information uncertainty will lead to a slower price response caused by larger psychological biases such as over- and underconfidence. Using six proxies for information uncertainty[5], he finds that stocks with greater information uncertainty have relatively lower returns when there is bad news, and relatively higher returns when there is good news. One of the proxies for information uncertainty is the cash flow volatility. This indicates that when there is more information uncertainty, new information is incorporated slower into stock prices and investors tend to either underreact or overreact.[6] These results are inconsistent with the idea that information uncertainty is a cross-sectional risk-factor and requires a higher cost of capital[7], and does instead point towards a behavioural story[8].

[4] "Most high quality companies tend to be stable profit generators and as a result are less risky" - Grantham (2004)
[5] Firm size, firm age, analyst coverage, dispersion in analyst forecasts, return volatility, and cash flow volatility
[6] This has consequences regarding the momentum strategy which should work particularly well in high-uncertainty stocks.
[7] Easley and O'Hara (2005) do indeed find that more information uncertainty in the form of more private information and subsequently less public information (information asymmetry) is compensated by higher returns. Later studies find that information asymmetry is only compensated in markets which are not large and where you cannot fully diversify (Hughes et al. 2007), or in imperfect markets (Lambert et al. 2012).

We do not find the cash flow volatility to be significantly explaining stock returns across sizes. Still, our findings do not contradict the results found by Zhang (2006). Particularly among smaller stocks, we find a positive alpha by going long in firms with low revenues volatility and shorting firms with high revenues volatility. Similar results were found in the Fama-Macbeth procedure. Our findings support the proposition that low information uncertainty, proxied by low fundamental volatility, is positively related to returns. Zhang (2006) finds similar evidence for momentum strategies. Interestingly, the findings that more information uncertainty represented by proxies such as analyst dispersion, accrual quality and cash flow volatility often is associated with lower returns[9] breaks with one of the fundamentals in classic asset pricing; that risk is compensated by returns. This is also more in line with our study.

We provide an interesting robustness test of Huang's (2009) findings, using annual fundamentals and four different measures of fundamental volatility. Our tests differ primarily since we choose to estimate the fundamental volatility using annual data as Zhang (2006) and less frequent rebalancing in the portfolio formation procedure. The monthly rebalancing that Huang (2009) applies in his tests is associated with significantly higher transaction costs, the alphas could therefore be a result of limits to arbitrage rather than being driven by risk.

So far Huang (2009) is the only study to our knowledge that tests if fundamental volatility, proxied by cash flow volatility, can explain cross-sectional returns. His study stems from the notion that since there is a negative relationship between total return volatility and future stock returns as documented by Ang, Hodrick, Xing, & Zhang (2006) there should be a similar relationship between cash flow volatility and future returns, if the total return volatility is related to earnings and cash flows volatility. Huang finds that there is a negative relationship between historical cash flow volatility and future returns. He also finds that both the systematic and idiosyncratic part of cash flow volatility matters. The idiosyncratic return volatility of Ang et al. (2006) does not drive out the cash flow volatility effect in the asset

[8] Lakonishok, Shleifer and Vishny (1995) argue that naive investors overprice firms with recent good performance and undervalue firms with recent bad performance; they extrapolate past performance too far into the future. Further Daniel et al. (1998, 2001) argue that investors are more overconfident when there are greater uncertainty regarding fundamentals of a company. Hirshleifer (2001) makes the point that there are more psychological biases when greater information uncertainty regarding fundamentals are present.

[9] Francis, LaFond, Olsson and Schipper (2004, 2005) find that accrual quality is a priced risk factor, and is indeed compensated by higher returns. Core et al. (2008) points to the fact that accruals quality fails to explain the cross section of returns on several portfolios such as Fama and French 25 size/book-to-market portfolios. Brousseau and Gu (2013) finds that the negative relationship between accrual quality and returns are driven by the smallest firms, and that the opposite relationship holds when these are not accounted for. Bandyopadhyay et al. (2017) finds that the opposite relationship holds regardless of size. Diether et al. (2002) shows that stocks with higher analyst dispersion earns lower future returns when compared to similar stocks.

pricing tests. In our Fama-Macbeth regressions we do find that the revenue volatility drives stock returns. We also find some supporting evidence that volatility of revenues and earnings are driving stock returns among smaller stocks in the portfolio formation procedure, as Huang (2009) finds for cash flow volatility across sizes. We further find that the systematic fundamental volatility, measured by the gross profit beta, significantly explains stock returns. Huang finds similar results for the cash flow beta.

Our approach to determine whether firms with high fundamental volatility tend to be riskier, is by determining the predictive power fundamental volatility directly has on stock returns, not on the market beta. From the time before the publications of Fama and French in the 1990s, Beaver et al. (1970) and Rosenberg and Guy (1976) found that earnings variability and accounting betas predicted the market beta. The primary issue with these studies, is that most of them have tried to explain the market beta of a single-index or capital asset pricing model. The market beta has more or less been "declared dead" since the 1990s, when Fama and French presented the size and value factors. The market beta alone has a poor track record when it comes to predicting returns[10]. Even if earnings volatility can explain the market beta, it is of little value since the market beta is a less useful predictor of returns. Our findings contradict the findings of Beaver et al. (1970) and Rosenberg and Guy (1976) to a large extent, particularly since we find evidence which indicates that higher fundamental volatility is associated with lower stock returns, not higher stock returns. Any risk-based explanation therefore appears to have rather low empirical support.

[10] Fama and French (2003): "empirical work on the model consistently finds that the relation between average return and market beta is flatter (the risk premium per unit of market beta is lower) than predicted by the model"

3. Data and variable construction

For our analysis we gather monthly stock return data from Center for Research in Security Prices (CRSP) and fundamental data from the CRSP-COMPUSTAT merged database. Following Fama and French (1992) we exclude financial firms with Standard Industrial Classification (SIC) codes 6000-6999.

The CRSP and COMPUSTAT sample ranges from 1968 to 2016 and includes stocks from the New York Stock Exchange (NYSE), National Association of Securities Dealers Automated Quotations (NASDAQ) and NYSE MKT (form. American Stock Exchange). Annual fundamentals for all fiscal yearends in calendar year t - 1 are aligned with stock returns from July in calendar year t to June year t + 1. Put differently, the fundamentals of firms ending their fiscal year in any of the months in calendar year t - 1 are matched with stock returns from July year t to June year t + 1. The 6-month gap (minimum) between the fiscal yearend and returns, is to ensure that the fundamentals are known before they are used to explain stock returns.

Size, Value, Profitability and Momentum

To measure the size of the firm, the market value at the end of June is used, and aligned with stock returns starting from July calendar year t to June year t + 1. For the book-to-market ratio the market value at the end of December in calendar year t - 1 is divided by the book equity in calendar year t - 1 regardless of fiscal yearend. The deferred taxes on the balance-sheet are added to the common/ordinary book equity, before it is used in the book-to-market calculation. This book-to-market estimate is aligned with stock returns starting from July calendar year t to June year t + 1.

Fama and French (1992) argue that their construction of the book-to-market ratio is the best practice to tackle possible timing issues in the stock prices, even though there is a time mismatch between the book and market value. A time consistent match would be to align the market value at the fiscal yearend to the book value in the same year. This however might, lead to some problems. Consider if the market value throughout the year falls due to a sudden shock, a book-to-market using earlier market values will end up with a lower book-to-market than the one using a later market value. The latter will most likely contain the relevant information. This argument should be just as valid for book-to-market ratios constructed with market values from a later point in time compared to the book-value. Asness, Moskowitz and Pedersen (2013) for instance uses the market value at the end of June in year *t* divided by the 6-month lagged book values when they estimate the book-to-market. Novy-Marx's (2013) construction of the book-to-market is somewhat unclear, but it appears to be constructed similarly as Asness et al. (2013). This is to "avoid taking unwanted positions in momentum" and make the momentum effect clearer [11].

The market betas are estimated by regressing the individual stock returns on the value-weighted market returns, using the previous 24 to 60 monthly stock returns (as available) prior to July for each calendar year. The derived beta is called the pre-ranking beta. In the end of June each year, all the stocks are sorted into size-deciles using NYSE breakpoints. For each of the size-deciles, the pre-ranking betas are subdivided into beta-deciles using NYSE breakpoints. In total we end up with 100 portfolios sorted on the size and pre-ranking betas. The monthly equal-weighted returns are estimated for all 100 portfolios and regressed as time-series on the current and one month lagged market returns, across the whole sample. The resulting sum of coefficient is called the post-ranking beta. These betas are assigned to all the stocks in each of the 100 portfolios. This estimation process is identical to Fama and French (1992). The post-ranking betas are primarily used since the pre-ranking betas of individual stocks tend to be noisy, caused by the strong correlation between size and pre-ranking betas and an error-in-variable problem. This mostly affects the results in the Fama-Macbeth regressions, since the market beta is an unobserved explanatory variable in these regressions. Using portfolios and post-ranking betas effectively reduce this noise. One downside related to using post-ranking betas is that they are estimated on data that is unavailable at the time of portfolio formation.

Profitability is estimated using the same metric as Novy-Marx (2013). The profitability is calculated as revenues minus cost of goods sold, scaled to assets. The profitability estimate for all fiscal yearends in calendar year t - 1 is aligned with stock returns from July year t to June year t + 1. Momentum is also estimated as in Novy-Marx (2013), controlling both for the lagged returns of the previous month and the lagged returns from the past twelve months up to

[11] We tried multiple specification of the book-to-market. The various specifications did not significantly change the results. We therefore choose to define our book-to-market in a similar manner as Fama and French (1992)

the previous month. Momentum is known to underperform in the first month following the signal period[12], including the lagged returns of the previous month is therefore only an attempt to make the momentum signal clearer in the Fama-Macbeth regressions.

Fundamental volatility

To measure the fundamental uncertainty, we estimate the total fundamental volatility and systematic fundamental volatility. The total fundamental volatility is estimated for each stock by calculating rolling standard deviations of various fundamentals. The systematic fundamental volatility is calculated as rolling accounting betas, which are derived by regressing the firm-specific fundamentals on a market benchmark[13]. We look at the following four fundamentals: revenues, gross profit, earnings and cash flows.

The fundamentals are scaled to make them comparable across stocks, before they are used to estimate the volatility. Various studies employ various scalars, but the ones that are commonly used are assets, book equity and sales. Huang (2009), who found that the cash flow volatility significantly explains stock returns, scaled the cash flows to both assets and sales. The intuition behind using sales as scalar is that it would control for the seasonality in his quarterly cash flow estimates. In contrast to Huang (2009), Novy-Marx (2013) argues that earnings and cash flows are equity level measures of profitability, while the gross profitability is an asset level measure of profitability. The reasoning behind this is probably that neither revenues nor gross profit includes payments to creditors. We applied the same intuition as Novy-Marx (2013), when choosing the scalars for the fundamentals. Further, since we use annual estimates seasonality is less likely to be an issue [14].

The standard deviation of the revenues is derived by scaling revenues to assets, and estimating the rolling standard deviation of the scaled revenues. The rolling standard deviation is estimated using the previous 5 years of accounting data, allowing no values to be missing. The accounting beta of revenues is estimated by running rolling regressions for each stock, where the dependent variable is the scaled revenues of the firm and the explanatory variable is the scaled revenues of the market. The scaled revenues of the market are estimated by

[12] See Jagadeesh and Titman (1993)
[13] $SD(x_i) = \sqrt{\beta_i^2 VAR(x_m) + VAR(\varepsilon_i)}$, where x_i refers to the scaled fundamentals of the firm, and x_m refers to the scaled fundamentals of the market. $SD(x_i)$ is a estimate of the (total) fundamental volatility, $\beta_i^2 VAR(x_m)$ refers to the systematic fundamental volatility. β_i refers to the accounting betas.
[14] We also tested changing the scalars, without any significant changes to our end results.

accumulating the revenues and assets of all the firms for each calendar year, and thereafter dividing the accumulated revenues on the accumulated assets. As with the standard deviations, we estimate the accounting beta using the previous 5 years of accounting data, allowing for no missing values. The standard deviation and beta of gross profit is estimated similarly.

Earnings are defined as the income to the common shareholders, before extraordinary items, added income-statement deferred taxes. Cash flows are defined as the income to the common shareholders, before extraordinary items, added income-statement deferred taxes, depreciation and subtracting changes to working capital and capital expenditure. Both the earnings and the cash flows are scaled to the common equity added deferred taxes. The rolling standard deviation of earnings and cash flows are estimated on the previous 5 years of scaled fundamentals, without allowing for any missing values. The accounting betas are also estimated on the previous 5 years of scaled fundamentals, requiring no missing values. The market benchmark is constructed identically for the earnings and cash flows as for the revenues and gross profit.

We believe that requiring no non-missing observations is the conservative approach, since it increases the precision of the fundamental volatility estimates. We therefore estimate the fundamental volatility identically as Asness et al. (2014). They estimate the standard deviation of earnings for their annual data, by requiring 5 non-missing observations.

We use a similar cash flow definition as Novy-Marx (2013), which includes changes in fixed assets[15]. Other studies as Huang (2009), define the cash flows without considering the non-current investments, without providing any intuition for doing so. There is a possibility that this is to tackle the firms smoothing practice by adjusting capital expenditures, as observed by Minton and Schrand (1999). We choose to include changes in the fixed assets, since we believe it contains signals about future growth and profitability[16]. Note that neither Novy-Marx (2013) nor Huang (2009) consider changes in non-current debt, which is a key component of the cash flows. For profitability, it is hard to argue that changes in the leverage should be considered. A consequence of this would be that a firm that annually keeps levering

[15] Net Income + Depreciation - Changes to Working Capital - Capital Expenditure. We do not use Net Income, but rather the income to the common equity holders added income-statement deferred taxes as Fama-French (1992)
[16] We tested the standard deviation and beta of cash flows excluding capital expenditures, and found no significant changes to the end results.

up would be considered more profitable. This does not necessarily mean that leveraging should be ignored when we estimate the standard deviation or beta of cash flows. Our thesis motivation is partly to investigate whether the fundamental volatility can be used as a proxy for risk or as a quality signal. There is a possibility that the cash flow volatility could be smoothed out if we account for leverage. In bad states the firm would lever up to cover its losses and in good states the firm would lever down. This could dilute the power fundamental volatility potentially has as a risk proxy or as a trading signal. The leveraging is therefore not included when we estimate the standard deviations and the betas of the cash flows.

Compared to Huang (2009) we estimate the accounting betas slightly differently. He estimates the betas by regressing the firms scaled cash flows on the scaled cash flows of industries, not the market. We chose to use a market-level benchmark, to ensure that the benchmark is well diversified and reflects market-wide fluctuations.

Since true accounting betas are unobservable and estimated on relatively few observations, there is reason to believe that the estimates contain noise. For instance, when we sort the average profitability on the beta of gross profit in Table 1, it appears that the raw accounting beta does a poor job predicting the profitability. We therefore choose to estimate post-ranking accounting betas for the Fama-Macbeth regressions. We do not find a particularly strong correlation between size and the pre-ranking accounting betas, the post-ranking accounting betas are therefore not estimated by size as the post-ranking market beta[17]. We start by sorting each stock into deciles based on their raw accounting beta, for each portfolio we annually estimate the equal-weighted average of scaled fundamentals. These estimates are then regressed on the market equivalent across the entire sample. We therefore get 10 accounting betas, one for each portfolio. These betas are assigned to each of the stocks in each of the portfolios and used in the Fama-Macbeth regressions.

Table 1: Sorting the raw accounting beta of GP/AT

The table below rapports the average raw accounting beta of gross profit (BETA of GP/AT) and profitability (GP/AT) by quintiles formed on the raw accounting beta of gross profit, using NYSE breaks.

Quintiles formed on BETA of GP/AT	1	2	3	4	5
BETA of GP/AT	-3,88	0,54	0,43	1,56	5,02
GP/AT	43 %	32 %	30 %	35 %	39 %

[17] Fama and French (1992) estimated the post-ranking betas on size and pre-ranking betas, due to the -98% correlation Chan and Chen found between the pre-ranking beta and size. We only find correlations ranging between 2%-4% between the accounting betas.

Treatment missing values and outliers

Firms with missing market value for June in the year *t* or December in year *t* - 1 are excluded from the regression where we use the returns from July in year *t*. Further stocks with negative market value, book-equity and/or assets are excluded from the sample. The stocks also need fundamental data for any fiscal yearend in calendar year *t* - 1. Since we estimate rolling standard deviations and betas of the fundamentals, the firms need at least four years of accounting data prior to the previous calendar year *t* - 1. The choice of number of years is somewhat arbitrary, since neither Zhang (2006) nor Asness et al. (2014) justify their choices. In the robustness section we discuss the various look-back periods for the estimation of the fundamental volatility.

Missing returns are set to zero and delisted returns are included in our regressions. Delisting of firms means that money would be returned to the investor before the time of rebalancing in the portfolio formation procedure. Where this money is then being placed, till the next rebalancing, requires assumptions. By setting the returns to zero we assume that the returned amount does not get reinvested before portfolio rebalancing in June of year *t* + 1. This is a conservative assumption. Under alternative assumptions there is a possibility that some of our fundamental volatility measures might show significance, we have not tested for that. If this is the case, the long-short investment strategies do not appear robust.

We choose to winsorize all of the variables at the 0.5% and 99.5% level as Fama and French (1993). The scaled fundamentals were winsorized both before and after we estimated the volatility, since we found extreme maximum and minimum values in the fifth and first quintile. The benefit of winsorizing, instead of trimming the variables as Novy-Marx (2013), is that as many observations as possible are preserved. Trimming results in more missing values, thus fewer observations for the asset pricing tests.

Table 2: Overview of variables (excl. the market betas), t = calendar year, i = firm, m = market

Variable	Details	Construction*	Alignment with returns
Size	Monthly closing price, if not available Bid-Ask average (PRC), Shares outstanding (SHROUT)	$PRC_t * SHROUT_t$	The size estimate of the 6th month in year t is aligned with stock returns from July year t to June year t+1.
Book-to-market	Size (in 1000s) Common/Ordinary Equity (CEQ), Deferred Taxes Balance Sheet (TXDB).	$\frac{(CEQ_t + TXDB_t) * 1000}{Size_{12th\ month,\ t}}$	The adjusted book-equity from year t-1 is divided by the size estimate of the 12th month in year t-1. This estimate is aligned with stock returns from July year t to June year t+1
Profitability	Gross profit (GP), Assets (AT)	$\frac{GP_t}{AT_t}$	For all fiscal yearends the profitability estimate from calendar year t-1 is aligned with stock returns from July year t to June year t+1.
Momentum (0, 1)	Returns (RET)	Lag (Returns)	The returns of the previous month are lagged and aligned with the current stock returns
Momentum (2,12)	Returns (RET)	Lag (Cumulative returns)	The lagged returns from the past twelve months up to the previous month (2,12) are aligned with the current stock returns.
Earnings	Income to the common equity holders before extraordinary items (IBCOM) Deferred taxes (TXDI),	$IBCOM_{i,t}$+$TXDI_{i,t}$	--
Cash flows	Income to the common equity holders before extraordinary items (IBCOM), Deferred taxes (TXDI), Depreciation (DP), Changes to Working Capital (WCAPCH), Capital Expenditure (CAPX)	$IBCOM_{i,t} + TXDI_{i,t} + DP_{i,t} - WCAPCH_{i,t} - CAPX_{i,t}$	--
Adjusted book-equity	Common/Ordinary Equity (CEQ), Deferred Taxes Balance Sheet (TXDB).	$CEQ_t + TXDB_t$	--
Scaled eevenues	Revenues (REVT), Assets (AT),	For the firm: $\frac{REVT_{i,t}}{AT_{i,t}}$, For the market: $\frac{(\sum_i REVT_i)_t}{(\sum_i AT_i)_t}$	--
Scaled gross profit	Gross Profit (GP), Assets (AT),	For the firm: $\frac{GP_{i,t}}{AT_{i,t}}$, For the market: $\frac{(\sum_i GP_i)_t}{(\sum_i AT_i)_t}$	--
Scaled earnings	Earnings, Adjusted book-equity	For the firm: $\frac{Earnings_{i,t}}{\text{Adjusted book-equity}_{i,t}}$, For the market: $\frac{(\sum_i Earnings_i)_t}{(\sum_i \text{Adjusted book-equity}_i)_t}$	--
Scaled cash flows	Cash flows, Adjusted book-equity	For the firm: $\frac{Cash-flows_{i,t}}{\text{Adjusted book-equity}_{i,t}}$, For the market: $\frac{(\sum_i Cash-flows_i)_t}{(\sum_i \text{Adjusted book-equity}_i)_t}$	--
Standard deviation of fundamentals (X), also referred to as the fundamental volatility	X = Scaled revenues, scaled gross profit, scaled earnings or scaled cash flows	STD (X),	Estimated using previous 5 years of annual fundamentals (allowing for no missing values). The estimated standard deviation in calendar year t-1 for any fiscal yearend, is aligned with stock returns from July year t to June year t+1.
Beta of fundamentals (X), also referred to as accounting betas or systematic fundamental volatility	X = Scaled revenues, scaled gross profit, scaled earnings or scaled cash-fl	Beta (Xi, Xm)	Estimated using previous 5 years of annual fundamentals (allowing for no missing values). The estimated beta in calendar year t-1 for any fiscal yearend, is aligned with stock returns from July year t to June year t+1.

4. Descriptive data and sorts

Sorts on fundamental volatility

Table 3 below shows both the univariate and double-sorted returns of the fundamental volatility, estimated by 5-year rolling standard deviations. The sample used to estimate these returns start from July 1973 and ends in June 2016. Our data sample starts in 1968, but we lose 5 years due to the estimation of fundamental volatilities and betas. Panel A reports equal-weighted monthly returns, while Panel B reports value-weighted monthly returns using the lagged market value of the previous month as weight. We chose to include both value- and equal-weighted sorts because where value-weighting puts a larger emphasis on the large caps, the equal-weighting puts emphasis on the small caps. We are interested in finding a return pattern for the fundamental volatility that is representative across size, in addition to other factors as profitability and value. Looking at just equal or value-weighted sorts can give us a skewed picture of reality. Panel C shows the key characteristics of the stocks sorted on the various measures of fundamental volatility.

The univariate sorts in Table 3A show that as fundamental volatility increases, returns increase as well, except for the quintiles formed on cash flow volatility. The fifth quintile sorted on the standard deviation of revenues has an average return of 1.46% compared to 1.26% in the first quintile in the univariate sort. Similar patterns are found in the univariate sorts of the standard deviation of gross profit and earnings. The returns are not rising monotonically, indicating that the relationship between fundamental volatility and returns is not clear cut.

Interestingly, the return patterns appear to reverse when sorted on size. Ignoring the first size-portfolio, the returns fall as the fundamental volatility increases across the various measures. In the first size quintile, the firms with the highest standard deviation of revenues have average returns of 1.60% compared to returns of 1.41% among the firms with the lowest standard deviation of revenues. In the second size quintile, the firms with the highest standard deviation of revenues have average returns of 1.11% compared to returns of 1.28% among the firms with the lowest standard deviation of revenues. This pattern is found for all the volatility measures, except for the cash flow volatility.

The double sorts of fundamental volatility on profitability show the same return pattern as the univariate sorts only among the more profitable firms. Among the least profitable firms, the firms with the lowest standard deviation of revenues earn average returns of 1.05%, while firms with the highest standard deviation of revenues earn average returns of 0.98%. Among the most profitable firms, the firms with the lowest standard deviation of revenues earn average returns of 1.61%, while firms with the highest standard deviation of revenues earn average returns of 1.70%. This return pattern is found across all the volatility measures.

Turning to the double sorts on value, the return pattern is similar as for profitability for all of the volatility measures. Among the least valuable firms, the firms with the lowest standard deviation of revenues earn average returns of 0.96%, while firms with the highest standard deviation of revenues earn average returns of 0.82%. Among the most valuable firms, the firms with the lowest standard deviation of revenues earn average returns of 1.58%, while firms with the highest standard deviation of revenues earn average returns of 2.05%. This pattern is found among all of the volatility measures. Note that the double sorts may be influenced by other variables, for instance size. The impact of size becomes clearer when we look at the value-weighted returns instead.

In Table 3B, the univariate sorts show that value-weighted returns decrease as fundamental volatility increases, opposite of what we found in Table 3A. This can look puzzling at first, but a similar pattern was found in the upper size quintiles in Table 3A. This indicates that a lot of small caps seem to influence the equal-weighted returns of the high fundamental volatility portfolios. Smaller stocks are associated with higher return variance, as highlighted by Fama and French (1993), which could be driving the higher stock returns. The value-weighting is primarily an attempt to minimize the variance of the constructed quintiles, by putting less weight on these smaller stocks. In Table 3B most of the sorts appear to show a weak pattern where the returns fall as the fundamental increases. For all the fundamental volatility measures, the fifth quintile appears to often show lower value-weighted returns than the first quintile when sorted on size, profitability and value.

Both in Table 3A and Table 3B it appears that profitable and low volatility firms tend to earn a premium when compared to unprofitable firms with high volatility. Consider the standard deviation of gross profit sorted on profitability, in Table 3B. The profitable, low-volatility firms earn 0.81% compared to unprofitable, high-volatility firms earning 0.35%. This appears to be a consistent pattern for all the four fundamental volatility measures when sorted on profitability. This supports Grantham's (2004) proposition that firms that tend to be both profitable and stable tend to outperform stocks that are unprofitable and unstable.

Table 3A and 3B: Returns sorted on size, profitability and value

Panel A presents the average equal-weighted monthly stock returns in percent sorted on the various measures of fundamental volatility, size, profitability and value. The sample used to compute the time-series averages spans from July 1973 to June 2016. All quintiles are formed annually using the NYSE breakpoints. Panel B presents the average value-weighted monthly stock returns in percent sorted using the various measures of fundamental volatility, size, profitability and value. The value-weighted returns are estimated using the previous month's market value as weight. Along the horizontal axis we align the size, profitability and value quintiles. The size quintiles are formed in the end of June each year, using the market value (ME) in June in calendar year *t*. The profitability quintiles are formed in the end of June in calendar year *t* using the gross profitability for any fiscal yearend in calendar year *t* - 1. The value quintiles are formed in the end of June each year, using the BE/ME estimate from calendar year *t* - 1. Book-equity (BE) refers to balance-sheet deferred taxes added to the common equity. The book-equity for any fiscal yearend in calendar year *t* - 1 is divided by the December market value in calendar year *t* - 1, this is the estimated book-to-market per calendar year *t* - 1. Along the vertical axis we have align the fundamental volatility quintiles. The fundamental volatility here is measured using the standard deviation (SD) of various fundamentals. The SD is estimated using 5 years of previous fundamentals, allowing for no missing values The fundamentals referred to are revenues-to-assets (REV), Gross profit-to-assets (GP), Earnings-to-book equity (E) and Cash flows-to-book equity (CF). Earnings refers to the income to common shareholders, before extraordinary items, added income-statement deferred taxes. Cash flows refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. The fundamental volatility estimates for any fiscal yearend in calendar year *t* - 1 is used to form quintiles in the end of June *t*.

Panel A: Equal-weighted returns

		Uni. sorts	*Size quintiles*					*Profitability quintiles*					*Value quintiles*				
			Small				Big	Unprof.				Prof.	Growth				Value
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Quintiles formed on SD of REV	1 - Low	1,26	1,41	1,28	1,29	1,19	1,06	1,05	1,22	1,50	1,37	1,61	0,96	1,27	1,19	1,23	1,58
	2	1,39	1,57	1,41	1,38	1,29	1,08	1,14	1,37	1,41	1,46	1,51	1,07	1,32	1,45	1,38	1,72
	3	1,44	1,61	1,40	1,34	1,32	1,02	1,14	1,32	1,47	1,52	1,56	1,06	1,24	1,45	1,58	1,81
	4	1,50	1,67	1,37	1,32	1,21	1,01	1,23	1,31	1,53	1,56	1,64	1,06	1,29	1,47	1,61	1,96
	5 - High	1,46	1,60	1,11	1,12	1,16	1,01	0,98	1,26	1,43	1,54	1,70	0,82	1,34	1,55	1,63	2,05
Quintiles formed on SD of GP	1 - Low	1,31	1,59	1,39	1,32	1,13	1,07	1,23	1,28	1,42	1,45	1,41	1,05	1,16	1,26	1,19	1,65
	2	1,42	1,59	1,39	1,50	1,30	1,09	1,14	1,48	1,45	1,38	1,60	1,15	1,39	1,33	1,41	1,69
	3	1,44	1,64	1,42	1,31	1,24	1,07	1,20	1,33	1,52	1,48	1,53	1,01	1,25	1,43	1,56	1,82
	4	1,42	1,58	1,28	1,24	1,31	1,01	0,89	1,20	1,46	1,59	1,56	1,00	1,24	1,50	1,51	1,78
	5 - High	1,47	1,60	1,18	1,13	1,23	0,94	0,95	1,22	1,46	1,55	1,71	0,89	1,35	1,55	1,74	2,17
Quintiles formed on SD of E	1 - Low	1,30	1,46	1,35	1,32	1,23	1,08	1,15	1,25	1,31	1,34	1,42	1,18	1,28	1,22	1,28	1,55
	2	1,42	1,64	1,39	1,32	1,27	1,09	1,22	1,38	1,43	1,40	1,54	1,14	1,32	1,45	1,44	1,66
	3	1,49	1,77	1,33	1,32	1,32	1,03	1,20	1,34	1,50	1,55	1,65	1,14	1,32	1,48	1,51	1,86
	4	1,47	1,61	1,45	1,35	1,30	0,97	1,21	1,21	1,48	1,62	1,64	0,99	1,32	1,49	1,60	1,78
	5 - High	1,42	1,55	1,06	1,15	1,04	1,02	0,92	1,31	1,51	1,57	1,76	0,80	1,26	1,53	1,66	2,17
Quintiles formed on SD of CF	1 - Low	1,38	1,67	1,37	1,31	1,23	1,09	1,05	1,30	1,44	1,40	1,53	1,16	1,37	1,36	1,40	1,59
	2	1,44	1,72	1,37	1,31	1,28	1,09	1,36	1,43	1,41	1,43	1,51	1,21	1,22	1,42	1,43	1,81
	3	1,49	1,69	1,40	1,42	1,36	1,04	1,22	1,39	1,52	1,55	1,62	1,13	1,40	1,41	1,57	1,77
	4	1,48	1,67	1,39	1,26	1,18	0,99	1,22	1,35	1,48	1,62	1,63	0,95	1,26	1,46	1,61	1,89
	5 - High	1,37	1,48	1,08	1,16	1,11	0,92	0,90	1,14	1,47	1,54	1,76	0,81	1,26	1,53	1,52	2,10
Uni. sort			1,46	1,15	1,15	1,13	0,99	0,89	1,13	1,29	1,43	1,55	0,73	1,20	1,37	1,48	1,86

Panel B: Value-weighted returns

		Uni. sorts	*Size quintiles*					*Profitability quintiles*					*Value quintiles*				
			Small				Big	Unprof.				Prof.	Growth				Value
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Quintiles formed on SD of REV	1 - Low	0,83	0,72	0,86	0,97	1,02	0,81	0,72	0,76	0,90	0,81	1,05	0,78	0,73	0,90	0,97	0,99
	2	0,84	1,11	1,03	1,03	0,93	0,80	0,89	0,75	0,85	0,72	0,96	0,63	1,10	1,01	0,91	0,92
	3	0,78	1,01	1,06	1,06	1,04	0,71	0,22	0,67	0,80	0,89	0,83	0,71	0,82	0,73	1,08	0,86
	4	0,61	1,11	0,95	0,93	0,79	0,52	0,45	0,61	0,95	0,58	0,50	0,47	0,52	0,88	1,05	0,71
	5 - High	0,65	0,86	0,77	0,73	0,91	0,57	0,19	0,45	0,75	0,76	0,87	0,38	0,77	0,81	0,70	1,10
Quintiles formed on SD of GP	1 - Low	0,83	0,94	1,03	1,05	0,93	0,81	0,89	0,89	0,81	0,67	0,81	0,58	0,79	0,98	1,00	1,00
	2	0,78	1,17	0,97	1,22	0,97	0,73	0,34	0,83	0,89	0,67	1,01	0,76	0,84	0,60	0,97	0,97
	3	0,78	1,15	1,06	0,97	1,00	0,72	0,13	0,60	1,01	0,70	0,97	0,59	0,96	1,10	0,74	1,00
	4	0,84	0,90	0,84	0,84	0,88	0,82	0,41	0,58	0,94	0,98	0,85	0,75	0,79	1,12	0,98	0,85
	5 - High	0,56	0,87	0,86	0,74	0,92	0,45	0,35	0,03	0,54	0,73	0,63	0,47	0,59	0,59	0,96	0,85
Quintiles formed on SD of E	1 - Low	0,85	0,97	1,00	1,08	1,03	0,81	0,81	0,79	0,77	0,95	0,87	0,77	0,84	0,93	0,91	0,98
	2	0,76	1,27	0,93	0,98	0,87	0,73	0,54	0,64	0,94	0,87	0,67	0,53	0,98	0,87	0,97	0,77
	3	0,78	1,23	0,92	0,93	1,02	0,73	0,63	0,63	1,05	0,40	1,11	0,72	0,72	0,91	0,81	1,21
	4	0,73	0,98	1,08	0,92	0,95	0,67	0,55	0,69	0,64	0,83	0,79	0,54	0,74	0,96	1,12	0,91
	5 - High	0,62	0,72	0,76	0,79	0,79	0,55	0,27	0,51	0,71	0,77	0,74	0,58	0,55	0,55	0,92	0,89
Quintiles formed on SD of CF	1 - Low	0,73	1,17	0,90	0,98	1,00	0,68	0,72	0,71	0,98	0,71	0,63	0,43	0,83	1,02	0,91	1,01
	2	0,78	1,24	0,94	0,94	0,87	0,75	0,74	0,69	0,66	0,73	0,96	0,70	0,84	0,84	0,81	0,84
	3	0,93	1,11	1,02	1,06	1,02	0,90	0,77	0,63	1,11	0,89	1,05	0,91	0,95	0,75	1,27	0,84
	4	0,69	1,06	1,06	0,93	0,90	0,61	0,33	0,64	0,74	0,60	0,92	0,55	0,58	0,90	0,98	1,10
	5 - High	0,65	0,67	0,77	0,81	0,89	0,56	0,35	0,60	0,64	0,94	0,67	0,57	0,68	0,74	0,72	0,92
Uni. sort			0,87	0,86	0,85	0,90	0,70	0,53	0,61	0,85	0,74	0,84	0,58	0,79	0,87	0,95	0,94

In general, most asset pricing models assume that the returns are normally distributed. The normal distribution allows us to model risk by simply estimating the mean, standard deviation and covariance of returns. If the normality cannot be assumed the risk will either be over- or understated by the asset pricing models. Since we are trying to determine how uncertainty around the firm fundamentals impact stock returns, it is interesting to look into the normal distribution of the stocks with high fundamental volatility. Stocks with highly volatile fundamentals could be expected to have risk that is difficult to model out.

The stated kurtosis and skewness in Table 3C are estimated on the returns of the individual stocks in the portfolios and simply averaged for each fundamental volatility quintile. The kurtosis measures to what extent the distribution of returns is fat-tailed, while the skewness measures to what extent the distribution of returns is tilted to one side. The high kurtosis indicates that the probability for extreme observations is present, while the positive skew indicates a higher probability for positive returns. The positive skew in other words could indicate that the standard deviation of the returns overstates the actual risk (Bodie et al. 2014).

For investors wanting to reduce the probability for extreme returns, it could be appealing to invest in firms with low fundamental volatility. In Table 3C we observe that the largest values for skewness and kurtosis are found among stocks with the highest fundamental volatility. The smallest stocks also appear in the quintile with highest fundamental volatility. Put differently, firms with low fundamental volatility also tends to be large firms. The reduction in the skewness and kurtosis might therefore be coming from investing in bigger firms, and not necessarily by investing in low fundamental volatility firms.

Profitability has a less consistent interpretation across the various volatility measures. For the portfolios formed on the standard deviation of revenues and gross profitability, the profitability, here measured as gross profitability, appears to increase with the fundamental volatility. For portfolios formed on the standard deviation of earnings and cash flows, the profitability shows a less clear pattern. Value does not seem to change much across the fundamental volatility quintiles.

Table 3C: Key descriptives

The table below presents the key descriptive of the quintiles formed on the various measures of fundamental volatility. The sample used to compute the time-series averages spans from July 1973 to June 2016. All quintiles are formed annually using the NYSE breakpoints. Horizontally we align the fundamental volatility quintiles. The fundamental volatility here is estimated using the standard deviation (SD) of various fundamentals. The SD is estimated using 5 years of previous fundamentals, allowing for no missing values. The fundamentals refere to: revenues-to-assets (REV/AT), Gross profit-to-assets (GP/AT), Earnings-to-book equity (E/BE) and Cash flows-to-book equity (CF/BE). Earnings (E) refers to the income to common shareholders, before extraordinary items added income-statement deferred taxes. Cash flows (CF) refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. Book equity (BE) refers to the common equity added deferred taxes. The fundamental volatility estimates for any fiscal yearend in calendar year $t - 1$ is used to form quintiles in the end of June t. The stated kurtosis and skewness is estimated on the returns of the individual stocks in the portfolios and simply averaged for each fundamental volatility quintile. Number of firms refers to the number of firms in each of the quintiles each month. The Average MCAP refers to the average monthly market value of the firms in each of the quintiles. % of micro stocks refer to the average portion of micro stocks (market value < $300 mill.) in each quintile. Gross Profitability is the average profitability estimated for each portfolio over time. The BE/ME is the average book-to-market of the stocks by quintile over time. BE/ME is constructed by dividing the book-equity for any fiscal yearend in year t - 1 by the December market value of calendar year t - 1. Beta of REV/AT, GP/AT, E/BE and CF/BE refers to the accounting betas estimated by regressing the previous 5 years of firm-specific fundamentals on a corresponding market benchmark.

Portfolio	**SD of REV/AT**					**SD of GP/AT**					**SD of E/BE**					**SD of CF/BE**				
	1 (L)	2	3	4	5 (H)	1 (L)	2	3	4	5 (H)	1 (L)	2	3	4	5 (H)	1 (L)	2	3	4	5 (H)
Kurtosis of returns	2,23	1,99	2,07	2,47	3,43	2,14	1,84	2,15	2,34	3,63	1,95	1,93	2,04	2,40	3,94	2,02	1,99	2,05	2,43	3,78
Skewness of returns	0,54	0,55	0,57	0,67	0,84	0,48	0,48	0,58	0,64	0,88	0,43	0,49	0,54	0,63	0,96	0,46	0,53	0,55	0,65	0,92
Number of firms	339	384	452	558	752	295	349	425	524	892	348	392	436	512	797	376	387	431	516	775
Average MCAP (Bill.)	4,7	3,6	2,6	1,8	1,0	4,0	3,5	2,8	2,3	1,2	4,0	3,5	2,9	2,2	0,9	4,3	3,7	2,6	2,0	0,9
% of micro stocks	40 %	48 %	57 %	65 %	76 %	38 %	47 %	56 %	63 %	74 %	37 %	49 %	56 %	64 %	77 %	42 %	48 %	55 %	64 %	77 %
Gross Profitability	24 %	35 %	38 %	40 %	44 %	23 %	34 %	38 %	40 %	43 %	38 %	40 %	41 %	39 %	35 %	41 %	40 %	40 %	38 %	34 %
BE/ME	0,92	0,91	0,93	0,95	0,93	1,03	0,99	0,99	0,97	0,82	0,83	0,91	0,96	1,03	0,91	0,91	0,95	0,99	1,01	0,85
SD of Rev/AT	3 %	7 %	10 %	16 %	37 %	7 %	10 %	13 %	17 %	28 %	10 %	13 %	16 %	18 %	25 %	12 %	14 %	15 %	18 %	25 %
SD of GP/AT	3 %	4 %	5 %	7 %	12 %	1 %	2 %	4 %	6 %	14 %	3 %	4 %	6 %	7 %	12 %	4 %	5 %	6 %	7 %	12 %
SD of E/BE	14 %	14 %	16 %	20 %	37 %	7 %	10 %	12 %	17 %	41 %	2 %	3 %	5 %	10 %	58 %	3 %	4 %	7 %	11 %	57 %
SD of CF/BE	18 %	17 %	19 %	24 %	41 %	12 %	14 %	16 %	21 %	44 %	6 %	7 %	10 %	14 %	61 %	3 %	5 %	8 %	14 %	66 %
Beta of Rev/AT	0,09	0,23	0,30	0,44	0,46	0,28	0,39	0,37	0,42	0,28	0,39	0,47	0,49	0,42	0,12	0,54	0,54	0,49	0,40	0,03
Beta of GP/AT	0,12	0,32	0,45	0,45	0,35	0,07	0,24	0,39	0,51	0,38	0,18	0,35	0,58	0,62	0,14	0,55	0,53	0,56	0,45	0,00
Beta of E/BE	0,87	1,13	1,44	1,46	1,85	0,35	0,90	0,94	1,23	2,37	0,06	0,18	0,40	0,76	3,62	0,30	0,41	0,51	0,77	3,43
Beta of CF/BE	0,96	0,76	0,84	0,81	1,14	0,53	0,66	0,52	0,66	1,51	0,19	0,19	0,20	0,47	2,27	0,03	0,10	0,25	0,43	2,44

Sorts on the accounting betas

Table 4 below shows both the univariate and double-sorted returns of the systematic fundamental volatility, estimated by 5-year rolling accounting betas. We use a sample starting in July 1973 and ends in June 2016. Our data sample starts in 1968, but we lose 5 years due to the estimation of the fundamental volatilities and betas. Table 4A reports equal-weighted monthly returns, while Table 4B reports value-weighted monthly returns using the lagged market value of the previous month as weight.

The univariate sorts in Table 4A show decreasing returns as the accounting betas increases from the first to the fifth quintile. For example, the monthly returns of quintiles sorted on the revenue beta decrease from 1.60% to 1.35%, while for the beta of gross profitability the monthly returns decrease from 1.56% to 1.33%. The only exception appears to be for the cash flow beta, which show a flat return pattern across the quintiles in the univariate sort. The first quintile has monthly return of 1.42%, while the fifth quintile has a monthly return of 1.40%.

Turning to the double-sorts, we see that the quintiles formed on revenues, gross profit and earnings betas show a decreasing pattern regardless of size quintile, especially when we compare the first and the fifth beta quintile. For example, the average returns of the quintiles formed on the revenue beta decrease from 1.77% to 1.51% in the first size quintile and from 1.12% to 0.92% in the fifth size quintile. The same pattern is found when betas of revenues, gross profits and earnings are sorted on profitability and value.

The value-weighted returns in Table 4B show the same decreasing return pattern, although not as strong as in Table 4A. In the univariate sort, only the beta of revenues and gross profitability show a decreasing return pattern when we compare the first and fifth quintile. The average returns of the quintiles formed on the revenue beta decrease from 0.85% to 0.56%, while average returns of the quintiles formed on the gross profit beta decreases from 0.95% to 0.47%. The quintiles formed on the beta of earnings and cash flows do not show the same persistent decreasing pattern as the other two measures.

When sorted on size, the quintiles formed on the beta of revenues and gross profit show a decreasing return pattern when we compare the first beta quintile to the fifth quintile. The same pattern is found when the beta of revenues and gross profit are sorted on profitability.

For some reason, the third profitability quintile shows a opposite return pattern for both revenues and gross profitability. For instance, the average returns increase from 0.79% to 0.88% in the third profitability quintile when we compared the first and fifth quintile formed on the revenue beta.

When the beta of revenues and gross profit are sorted on value, we find the same decreasing return pattern when we compare the first and fifth beta quintile, but the pattern is somewhat weaker. In both the third and fifth value quintile, the average returns of the quintiles formed on revenue betas show average returns going from 0.64% to 0.72% and 0.72% to 0.95% as we respectively compare the first and fifth beta quintile. The average returns of the quintiles formed on the gross profit beta increase from 0.48% to 1.16%, when we compare the first and fifth beta quintile in the third value quintile. Overall it seems like the decreasing monthly return pattern for the beta of revenues and gross profit still exists when sorted on size and profitability, but maybe somewhat weaker in the value sort.

Table 4A and 4B: Equal-weighted returns sorted on size, profitability and value. (Betas)

Panel A presents the average equal-weighted monthly stock returns in percent sorted on the various measures of accounting betas, size, profitability and value. The sample used to compute the time-series averages spans from July 1973 to June 2016. All quintiles are formed annually using the NYSE breakpoints. Panel B below presents the average value-weighted monthly stock returns in percent sorted using the various measures of accounting betas, size, profitability and value. The value-weighted returns are estimated using the previous month's market value as weight. Along the horizontal axis we align the size, profitability and value quintiles. The size quintiles are formed in the end of June each year, using the market value (ME) in June in calendar year *t*. The profitability quintiles are formed in the end of June in calendar year *t* using the gross profitability for any fiscal yearend in calendar year *t - 1*. The value quintiles are formed in the end of June each year, using the BE/ME estimate from calendar year *t - 1*. Book-equity (BE) refers to balance-sheet deferred taxes added to the common equity. The book-equity for any fiscal yearend in calendar year *t - 1* is divided by the December market value in calendar year *t - 1*, this is the estimated book-to-market per calendar year *t - 1*. Along the vertical axis we have align the accounting beta quintiles. The accounting betas are estimated by running rolling regressions for each stock, where the dependent variable is the scaled fundamentals of the firm, while the explanatory variable is the scaled fundamentals of the market. The scaled fundamentals of the market are estimated by accumulating the scaled fundamentals of all the firms for each calendar year. As with the standard deviations, we estimate the accounting betas using the previous 5 years of accounting data, allowing for no missing values. The scaled fundamentals referred to are revenues-to-assets (REV), Gross profit-to-assets (GP), Earnings-to-book equity (E) and Cash flows-to-book equity (CF). Earnings refers to the income to common shareholders, before extraordinary items, added income-statement deferred taxes. Cash flows refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. The accounting beta estimates for any fiscal yearend in calendar year *t - 1* is used to form quintiles in the end of June *t*.

Panel A: Equal-weighted returns

		Uni. sorts	*Size quintiles*					*Profitability quintiles*					*Value quintiles*				
			Small				Big	Unprof.				Prof.	Growth				Value
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Quintiles formed on Beta of REV	1 - Low	1,60	1,77	1,45	1,29	1,22	1,12	1,33	1,41	1,59	1,61	1,77	1,06	1,44	1,69	1,71	2,20
	2	1,38	1,56	1,24	1,38	1,28	1,02	0,99	1,33	1,52	1,51	1,56	0,92	1,30	1,40	1,44	1,80
	3	1,35	1,52	1,33	1,30	1,28	1,06	1,17	1,15	1,47	1,49	1,55	1,02	1,26	1,36	1,32	1,72
	4	1,38	1,50	1,37	1,34	1,26	1,09	1,05	1,31	1,38	1,45	1,57	1,05	1,27	1,34	1,50	1,67
	5 - High	1,35	1,51	1,13	1,15	1,15	0,92	0,91	1,25	1,37	1,47	1,55	0,79	1,16	1,36	1,52	1,82
Quintiles formed on Beta of GP	1 - Low	1,56	1,71	1,34	1,26	1,36	1,19	1,20	1,28	1,48	1,62	1,79	0,95	1,43	1,65	1,76	2,20
	2	1,34	1,52	1,29	1,28	1,15	1,08	1,12	1,27	1,54	1,36	1,46	0,94	1,12	1,38	1,34	1,74
	3	1,44	1,70	1,37	1,43	1,28	1,01	1,25	1,38	1,54	1,56	1,61	1,10	1,34	1,40	1,35	1,82
	4	1,42	1,59	1,33	1,40	1,27	1,09	1,03	1,33	1,44	1,58	1,55	1,09	1,32	1,38	1,52	1,70
	5 - High	1,33	1,48	1,21	1,11	1,16	0,87	0,79	1,24	1,39	1,43	1,53	0,89	1,21	1,35	1,52	1,77
Quintiles formed on BETA of E	1 - Low	1,51	1,63	1,36	1,43	1,30	1,04	1,14	1,50	1,55	1,64	1,66	0,94	1,37	1,70	1,62	2,09
	2	1,40	1,59	1,37	1,36	1,26	1,07	1,20	1,28	1,47	1,39	1,56	1,09	1,37	1,36	1,43	1,67
	3	1,34	1,50	1,29	1,31	1,27	1,10	1,08	1,27	1,37	1,46	1,45	1,13	1,22	1,35	1,39	1,57
	4	1,45	1,69	1,33	1,31	1,29	1,02	1,13	1,27	1,48	1,49	1,66	1,09	1,25	1,38	1,51	1,89
	5 - High	1,39	1,57	1,19	1,05	1,03	0,95	0,94	1,14	1,44	1,53	1,75	0,81	1,25	1,40	1,58	1,96
Quintiles formed on Beta of CF	1 - Low	1,42	1,52	1,30	1,32	1,21	0,96	0,99	1,29	1,49	1,58	1,63	0,90	1,32	1,50	1,50	1,96
	2	1,46	1,71	1,45	1,33	1,21	1,00	1,14	1,47	1,47	1,54	1,55	1,19	1,34	1,42	1,41	1,84
	3	1,44	1,67	1,39	1,37	1,28	1,09	1,18	1,27	1,47	1,49	1,63	1,08	1,39	1,44	1,49	1,72
	4	1,42	1,65	1,34	1,26	1,31	1,01	1,22	1,27	1,43	1,43	1,63	1,06	1,22	1,34	1,58	1,79
	5 - High	1,40	1,57	1,09	1,17	1,18	1,13	1,04	1,22	1,46	1,51	1,70	0,83	1,22	1,51	1,58	1,99
Uni. sort			1,46	1,15	1,15	1,13	0,99	0,89	1,13	1,29	1,43	1,55	0,73	1,20	1,37	1,48	1,86

Panel B: Value-weighted returns

		Uni. sorts	*Size quintiles*					*Profitability quintiles*					*Value quintiles*				
			Small				Big	Unprof.				Prof.	Growth				Value
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Quintiles formed on Beta of REV	1 - Low	0,85	1,13	0,99	0,91	0,90	0,81	0,57	0,81	0,79	1,03	0,82	0,89	0,74	0,64	1,21	0,72
	2	0,83	1,06	0,82	1,00	0,96	0,79	0,88	0,78	0,78	0,59	1,03	0,70	0,84	1,02	0,89	1,01
	3	0,76	0,87	0,94	1,03	1,01	0,72	0,48	0,61	0,90	0,82	0,97	0,67	0,70	0,89	0,89	1,06
	4	0,81	0,90	1,04	1,05	0,94	0,78	0,80	0,72	0,85	0,88	0,76	0,60	1,08	0,96	0,92	0,86
	5 - High	0,56	0,79	0,86	0,75	0,89	0,48	0,21	0,48	0,88	0,40	0,62	0,30	0,61	0,72	0,93	0,95
Quintiles formed on Beta of GP	1 - Low	0,95	1,00	0,91	0,84	1,09	0,93	0,80	0,56	0,75	1,12	1,05	1,05	0,74	0,93	1,02	0,48
	2	0,78	1,03	0,91	0,96	0,93	0,73	0,54	0,90	0,99	0,60	0,89	0,48	0,90	1,04	0,99	1,30
	3	0,80	1,11	0,94	1,16	1,00	0,74	0,96	0,77	0,74	0,89	0,58	0,60	0,84	0,93	0,92	0,93
	4	0,89	1,12	1,00	1,14	0,92	0,87	0,57	0,73	0,95	0,77	1,33	0,91	0,96	0,71	1,03	0,66
	5 - High	0,47	0,73	0,91	0,67	0,76	0,41	-0,16	0,34	0,79	0,58	0,39	0,16	0,60	0,84	0,81	1,16
Quintiles formed on Beta of E	1 - Low	0,77	0,83	0,98	1,05	1,04	0,70	0,45	0,86	0,67	0,80	0,89	0,68	0,90	0,83	1,04	0,58
	2	0,79	1,05	0,99	1,05	1,06	0,73	0,51	0,53	0,92	0,84	0,96	0,64	0,78	1,00	0,96	1,03
	3	0,87	0,95	0,83	0,98	0,94	0,86	0,86	0,72	0,97	0,84	0,93	0,77	1,06	0,79	1,00	0,77
	4	0,57	1,17	0,99	0,96	0,92	0,46	0,59	0,55	0,86	0,41	0,51	0,34	0,60	0,87	0,61	1,09
	5 - High	0,80	0,93	0,86	0,68	0,72	0,81	0,53	0,68	0,78	0,94	0,91	0,68	0,60	0,91	1,24	1,15
Quintiles formed on Beta of CF	1 - Low	0,75	0,76	0,91	1,00	0,97	0,69	0,16	0,42	0,86	0,94	0,82	0,75	0,90	0,50	0,96	0,57
	2	0,67	1,26	1,00	1,00	0,95	0,59	0,75	0,89	0,90	0,29	0,74	0,29	0,85	1,02	1,05	0,84
	3	0,90	1,08	1,02	1,02	0,96	0,87	0,68	0,62	0,91	1,03	1,05	0,77	1,01	0,96	0,82	1,13
	4	0,62	1,11	0,95	0,86	0,94	0,55	0,64	0,48	0,67	0,70	0,58	0,49	0,58	0,87	0,75	0,83
	5 - High	0,90	0,86	0,80	0,84	0,89	0,91	0,59	0,77	0,86	1,02	1,17	0,90	0,58	0,92	1,21	1,18
Uni. sort			0,87	0,86	0,85	0,90	0,70	0,53	0,61	0,85	0,74	0,84	0,58	0,79	0,87	0,95	0,94

As highlighted earlier, the normal distribution is key to model risk. The return distributions that are not normal can potentially overstate or understate risk. We therefore investigate the kurtosis and skewness of the quintiles formed on the accounting betas as well. Table 4C shows that the highest values of kurtosis and skewness are found in the first and fifth quintile when sorted on the various accounting betas. It appears that these firms also tend to be small firms with extreme accounting betas. As Table 4C states, the bigger stocks are found in the mid-portfolios while the small ones are distributed to the first and fifth quintiles. Intuitively, the biggest stocks are expected to have the most resilient earnings when it comes to for instance recessions. Therefore, when we estimate the accounting betas of these firms, they tend to be closer to zero. The highest valued firms also appear to be in the first and fifth quintile when we look at the portfolios formed on the beta of gross profit.

Table 4C: Key descriptives (Betas)

Table 4C presents the key descriptive of the quintiles formed on the various measures of accounting betas. The sample used to compute the time-series averages spans from July 1973 to June 2016. All quintiles are formed annually using the NYSE breakpoints. Horizontally we align the accounting beta quintiles. The accounting betas are estimated by running rolling regressions for each stock, where the dependent variable is the fundamentals of the firm, while the explanatory variable is the the scaled fundamentals of the market. The scaled fundamentals of the market are estimated by accumulating the scaled fundamentals of all the firms for each calendar year. As with the standard deviations, we estimate the accounting betas using the previous 5 years of accounting data, allowing for no missing values. The fundamentals previously referred to are revenues-to-assets (REV/AT), Gross profit-to-assets (GP/AT), Earnings-to-book equity (E/BE) and Cash flows-to-book equity (CF/BE). Earnings (E) refers to the income to common shareholders, before extraordinary items added income-statement deferred taxes. Cash flows (CF) refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. The fundamental volatility estimates for any fiscal yearend in calendar year *t - 1* is used to form quintiles in the end of June *t.* Book equity (BE) refers to the common equity added deferred taxes. The fundamental volatility estimates for any fiscal yearend in calendar year *t - 1* is used to form quintiles in the end of June *t.* The stated kurtosis and skewness is estimated on the returns of the individual stocks in the portfolios and simply averaged for each fundamental volatility quintile. Number of firms refers to the number of firms in each of the quintiles each month. The Average MCAP refers to the average monthly market value of the firms in each of the quintiles. % of micro stocks refer to the average portion of micro stocks (market value < $300 mill.) in each quintile. Gross Profitability is the average profitability estimated for each portfolio over time. The BE/ME is the average book-to-market of the stocks by quintile over time. BE/ME is constructed by dividing the book-equity for any fiscal yearend in year *t* - 1 by the December market value of calendar year *t* - 1. STD of REV/AT, GP/AT, E/BE and CF/BE refers to the standard deviation estimated using the previous 5 years of fundamentals.

Portfolio	**Beta of REV/AT**					**Beta of GP/AT**					**Beta of E/BE**					**Beta of CF/BE**				
	1 (L)	2	3	4	5 (H)	1 (L)	2	3	4	5 (H)	1 (L)	2	3	4	5 (H)	1 (L)	2	3	4	5 (H)
Kurtosis of returns	2,83	2,06	1,86	1,88	2,70	2,80	1,88	1,89	1,85	2,74	2,83	1,88	1,86	1,90	2,92	2,78	1,91	1,87	1,91	2,93
Skewness of returns	0,74	0,58	0,54	0,55	0,69	0,74	0,53	0,54	0,55	0,72	0,73	0,51	0,48	0,56	0,78	0,72	0,53	0,52	0,55	0,76
Number of firms	661	432	397	419	575	686	397	370	413	618	625	400	396	446	618	627	433	405	428	592
Average MCAP (Bill.)	1,3	2,7	3,6	3,2	1,9	1,4	2,7	2,9	3,2	2,3	1,7	3,2	3,5	2,6	1,6	1,5	3,1	3,4	2,9	1,7
% of micro stocks	71 %	54 %	51 %	54 %	66 %	70 %	53 %	50 %	55 %	66 %	70 %	49 %	49 %	56 %	70 %	71 %	54 %	50 %	54 %	67 %
Gross Profitability	44 %	33 %	33 %	36 %	39 %	43 %	34 %	32 %	36 %	39 %	38 %	39 %	39 %	40 %	36 %	37 %	40 %	41 %	39 %	35 %
BE/ME	0,90	0,91	0,95	0,93	0,97	0,87	0,97	1,01	0,97	0,89	0,91	0,91	0,91	0,96	0,96	0,90	0,95	0,95	0,98	0,90
SD of Rev/AT	24 %	9 %	9 %	12 %	28 %	22 %	13 %	12 %	14 %	23 %	21 %	14 %	13 %	16 %	22 %	21 %	15 %	14 %	16 %	21 %
SD of GP/AT	10 %	5 %	5 %	6 %	10 %	10 %	4 %	3 %	5 %	11 %	9 %	5 %	5 %	6 %	10 %	9 %	6 %	5 %	6 %	10 %
SD of E/BE	32 %	19 %	16 %	16 %	25 %	32 %	14 %	13 %	15 %	29 %	34 %	5 %	5 %	7 %	44 %	33 %	7 %	6 %	9 %	43 %
SD of CF/BE	35 %	23 %	19 %	19 %	29 %	36 %	18 %	17 %	19 %	32 %	39 %	10 %	9 %	12 %	46 %	39 %	8 %	7 %	11 %	50 %
Beta of Rev/AT	-3,92	-0,47	0,44	1,46	5,00	-2,15	-0,13	0,48	1,08	2,83	-0,26	0,21	0,56	0,72	0,62	0,11	0,38	0,49	0,55	0,30
Beta of GP/AT	-2,82	-0,26	0,50	1,48	3,57	-5,04	-0,59	0,47	1,69	6,00	-1,31	-0,04	0,56	1,09	1,62	-0,47	0,29	0,55	0,78	0,84
Beta of E/BE	1,64	1,24	1,09	1,31	1,73	0,41	0,74	1,03	1,47	3,29	-7,18	-0,44	0,38	1,47	11,97	-3,16	0,16	0,51	1,16	8,05
Beta of CF/BE	1,22	0,98	0,75	0,74	0,81	0,44	0,64	0,75	0,93	1,76	-3,42	0,04	0,25	0,83	6,36	-7,84	-0,78	0,28	1,58	11,38

Correlations among the variables

The correlation is of interest because of possible overspecification and multicollinearity[18] in the Fama-Macbeth regressions. Table 5 shows the correlation among the fundamental volatility estimates, both the total and systematic estimate. The high correlation of 52% between the volatility of gross profitability and revenues is striking. The gross profit is estimated by subtracting the cost of goods sold from the revenues. The costs of goods sold often vary with the revenues. The volatility of revenues is therefore largely reflected in the volatility of gross profitability. The volatility of earnings and cash flows are even higher correlated with a correlation coefficient of 93%. This is due to earnings being a significant part of the cash flows. The beta of revenues and gross profits, and the beta of earnings and cash flows are also highly correlated, with a correlation coefficient of 49% and 56% respectively. We conclude that multicollinearity may be a problem because of the high correlation, and choose to run several model specifications in our Fama-Macbeth regression to check if the results are robust across various specifications.

We also observe that the standard deviation of revenues, gross-profits, earnings and cash flows are negatively correlated with the book-to-market (BE/ME). The respective correlations are -6%, -26%, -28% and -26%. Similarly, the standard deviations appear to be negatively correlated with size (MCAP), stating respective correlations of -26%, -22%, -11% and -14%. This indicates that firms that tend to have high fundamental volatility also appear to be low-value and small. Interestingly, the standard deviation of gross profits and revenues appears to be positively correlated with profitability, with correlations of 17% and 8%. The standard deviation of earnings and cash flows tend to be negatively correlated with profitability, with correlations of -9% and -10%. It does indicate that more profitable firms tend to smooth their earnings and cash flows to a larger extent. The accounting betas in general show weaker correlations with size and book-to-market. Interestingly, the beta of revenues, gross profit, earnings and cash flows appear to be negatively correlated with profitability. From Table 4C this pattern is somewhat unclear.

[18] Multicollinearity is not a break of OLS assumptions (Woolridge 2014, p.82-86), but can lead to inflated standard errors and problems when trying to determine which factors influence returns (Fabozzi, Markowitz 2011, p. 303)

Table 5: Spearman-rank Correlation Matrix

Table 5 reports the Spearman-rank coefficient between independent variables in the Fama-Macbeth regression. BE is the book value to common equity plus balance sheet deferred taxes, AT is assets and GP is gross profit which is calculated as revenues minus cost of goods sold. E is earnings and is defined as the income to the common equity holders, corrected for deferred taxes, REV is revenues and CF is free cash flow calculated as net income plus depreciation and amortization minus changes in working capital and capital expenditures. All variables constructed using income statement information are from each firm's fiscal year-end in calendar year *t - 1*. The fundamental volatility measures are the rolling 5-year standard deviation (SD), allowing no missing values, of revenues-to-assets (REV/AT), gross-profit-to-assets (GP/AT), earnings-to-book (E/BE) and cash flows-to-book (CF/BE). The accounting betas are estimated by running rolling regressions for each stock, where the dependent variable is the scaled fundamentals (REV/AT, GP/AT, E/BE, CF/BE) of the firm and the explanatory variable is the scaled fundamentals of the market. The scaled fundamentals of the market is estimated by accumulating the scaled fundamentals of all the firms for each calendar year. As with the standard deviations, we estimate the accounting beta using the previous 5 years of accounting data, allowing for no missing values. Other variables are size (log (MCAP)) which is measured in June of year *t*, book-to- market (log (BE/ME)), gross profit (GP/AT), momentum measured as the returns of the last 12th to second month (RET(2,12)) controlled for last month returns (RET(0,1)). All independent variables, except momentum (RET(2,12), RET(0,1)), have been winsorized at the 0,05% and 99,5% level. The sample covers July 1973 to December 2016, excluding financial firms (SIC 6000-6999).

	SD of REV/AT	**SD of GP/AT**	**SD of E/BE**	**SD of CF/BE**	**Beta of REV/AT**	**Beta of GP/AT**	**Beta of E/BE**	**Beta of CF/BE**	**BE/ME**	**MCAP**	**GP/AT**	**RET(0,1)**
SD of GP/AT	52,0 %											
SD of E/BE	21,0 %	40,0 %										
SD of CF/BE	22,0 %	38,0 %	93,0 %									
Beta of REV/AT	-1,0 %	-4,0 %	-6,0 %	-5,0 %								
Beta of GP/AT	-1,0 %	-5,0 %	-7,0 %	-7,0 %	49,0 %							
Beta of E/BE	2,0 %	5,0 %	23,0 %	19,0 %	0,0 %	8,0 %						
Beta of CF/BE	1,0 %	4,0 %	17,0 %	17,0 %	-1,0 %	4,0 %	56,0 %					
BE/ME	-6,0 %	-26,0 %	-28,0 %	-26,0 %	3,0 %	5,0 %	-4,0 %	-3,0 %				
MCAP	-26,0 %	-22,0 %	-11,0 %	-14,0 %	4,0 %	3,0 %	-2,0 %	2,0 %	-33,0 %			
GP/AT	17,0 %	8,0 %	-9,0 %	-10,0 %	-5,0 %	-6,0 %	-4,0 %	-3,0 %	-5,0 %	-6,0 %		
RET(0,1)	0,0 %	1,0 %	0,0 %	0,0 %	-1,0 %	-1,0 %	-1,0 %	-1,0 %	1,0 %	-3,0 %	0,0 %	
RET(2,12)	1,0 %	0,0 %	-1,0 %	0,0 %	-2,0 %	-1,0 %	1,0 %	1,0 %	11,0 %	-8,0 %	4,0 %	22,0 %

5. Asset pricing tests

Fama-Macbeth Procedure

To test if fundamental volatility can explain returns cross sectional, we make use of the Fama-Macbeth procedure, which was first used to test the CAPM by Fama and Macbeth in their 1973 paper. The procedure is known as a two-step procedure, the first step consists of regressing each portfolio (or asset) against proposed factors or characteristics so that we can estimate the betas for these factors, as we do with the market betas. Thereafter we run cross sectional regressions at each period in time on the estimated betas. In the second step, we obtain the premiums, or loadings, for each factor by averaging the coefficients from the cross-sectional regressions.

Since accounting variables are measured precisely for individual stocks there is no need to estimate these betas at a portfolio level, this will only blur the information (Fama and French 1992). Using a sample from July 1973 to December 2016 each individual stock's excess return is regressed on the explanatory variables market beta, size, book-to-market, momentum/past performance, gross profitability, the fundamental volatility measures or accounting betas every month. The fundamental volatility measures are estimated using the accounting data from calendar year $t - 1$ and accounting data four years prior to $t - 1$ (requiring no missing values). The market beta and accounting betas used in the Fama-Macbeth regressions are estimated in post-ranking portfolios, as referred to in Section 3. Other accounting variables are constructed using accounting information from year $t - 1$. Size is measured as the market cap in June year t. The momentum is measured as the returns of the last twelfth to second month controlling for the last month returns. All variables are allowed to change every July, except for momentum which changes every month.

Table 6 shows the Fama-Macbeth regression results using our fundamental volatility measures, controlling for size (log(ME)), book-to-market (log(B/M)), market beta, momentum/past performance (RET(2,12), RET(0,1)) and gross-profitability (GP/AT). The table shows the average coefficient and the t-stat[19]. None of our fundamental volatility

[19] The *t-statistic* for the null (H_0: $\widehat{b_n} = 0$) is calculated as: $t(\widehat{b_n}) = \frac{\widehat{b_n}}{\frac{\sigma(\widehat{b_n})}{\sqrt{T}}}$

measures seems to be significant, except for the revenue volatility which has a t-stat of -2.62, when other volatility measures are not included. Looking at the correlation matrix we do see that the volatility of both gross profit and revenues are highly correlated, the same applies for earnings and cash flows. A possible multicollinearity problem in our regression can thus be an issue when several accounting measures are included in the regressions. However, revenues volatility is significant in all the regression specifications with a t-stat ranging from -2.62 to -2.92, indicating that revenues volatility is relatively robust. In other words, the volatility of revenues seems to be able explain cross-sectional returns in our sample. The negative sign of the revenues volatility indicates that firms with high revenues volatility generates lower average returns than low revenues volatility firms.

It is difficult to interpret this as a risk-story where firms with less volatile revenues are compensated in the form of returns. Intuitively if fundamental volatility is a proxy for information uncertainty, we should find a positive relationship based on the risk-narrative of Easley and O'Hara (2005). Our findings in the Fama-Macbeth regressions are more in line with several studies finding that metrics, such as analyst dispersion (Diether, Malloy, & Scherbina 2002), accrual quality (Bandyopadhyay, Huang, Sun, & Wirjanto 2017) and cash flow volatility (Huang 2009), is priced negatively. Zhang (2006) argues that based on a behavioural story investors tend to overreact and underreact when more information uncertainty is present. Information is incorporated more slowly into prices, leading to a negative relationship between returns and information uncertainty. These findings are also tied to quality investing, in the sense that less volatile fundamentals indicate more stability, thus also higher quality. High quality stocks in general tend to earn a premium compared to low quality stocks, as observed by Asness et al. (2014) and Novy-Marx (2014).

Table 6: Fama-Macbeth procedure on the fundamental volatility (SD).

Table 6 shows the second-step Fama-Macbeth results and the average premiums and t-stats of the total fundamental volatility measures from month-by-month regressions on monthly CRSP returns from July year *t* to June year *t* + 1. BE is the book value of common equity plus balance sheet deferred taxes, AT is assets and GP is gross profit which is calculated as revenues minus cost of goods sold. E is earnings and is defined as the income to the common equity holders, corrected for deferred taxes, REV is revenues and CF is free cash flow calculated as net income plus depreciation and amortization minus changes in working capital and capital expenditures. All variables constructed using income statement information are from each firm's fiscal year-end in calendar year *t* - 1. The fundamental volatility measures are the rolling 5-year standard deviation of revenues-to-assets (REV/AT), gross-profit-to-assets (GP/AT), earnings-to-book (E/BE) and cash flows-to-book (CF/BE). In every regression we have controlled for size (log (MCAP)) which is measured in June of year *t,* book-to-market (log (BE/ME)), gross profit (GP/AT), momentum measured as the returns of the last 12th to second month (RET(2,12)) controlled for last month returns (RET(0,1)), and market betas(post-rank betas). All independent variables, except momentum (RET(2,12), RET(0,1)) and market betas, have been winsorized at the 0,5% and 99,5% level. The sample covers July 1973 to December 2016, excluding financial firms (SIC 6000-6999).

	Type	**Int.**	**log (Size)**	**log (BE/ME)**	**GP /AT**	**Ret (0,1)**	**Ret (2,12)**	**Market Beta**	**SD REV/AT**	**SD GP/AT**	**SD E/BE**	**SD CF/BE**
EQ1	Avg. Coeff.	2,578 %	-0,109 %	0,322 %	0,561 %	-6,250 %	0,271 %	-0,061 %				
	T-stat	5,07	-2,98	5,39	4,19	-17,35	1,79	-0,26				
EQ2	Avg. Coeff.	2,617 %	-0,110 %	0,325 %	0,592 %	-6,336 %	0,270 %	-0,064 %	-0,437 %	0,312 %	0,376 %	-0,186 %
	T-stat	5,50	-3,32	5,66	4,69	-17,78	1,78	-0,28	-2,83	0,56	1,63	-1,26
EQ3	Avg. Coeff.	2,702 %	-0,117 %	0,312 %	0,591 %	-6,275 %	0,274 %	-0,047 %	-0,365 %			
	T-stat	5,37	-3,25	5,23	4,42	-17,44	1,81	-0,20	-2,62			
EQ4	Avg. Coeff.	2,585 %	-0,109 %	0,320 %	0,554 %	-6,284 %	0,275 %	-0,063 %		-0,065 %		
	T-stat	5,27	-3,18	5,76	4,13	-17,54	1,81	-0,27		-0,12		
EQ5	Avg. Coeff.	2,548 %	-0,106 %	0,324 %	0,572 %	-6,300 %	0,270 %	-0,077 %			0,180 %	
	T-stat	5,29	-3,12	5,38	4,42	-17,59	1,78	-0,33			0,92	
EQ6	Avg. Coeff.	2,586 %	-0,110 %	0,316 %	0,563 %	-6,273 %	0,269 %	-0,071 %				0,040 %
	T-stat	5,29	-3,15	5,26	4,34	-17,49	1,78	-0,30				0,40
EQ7	Avg. Coeff.	2,647 %	-0,112 %	0,324 %	0,583 %	-6,304 %	0,275 %	-0,057 %	-0,446 %	0,450 %		
	T-stat	5,39	-3,26	5,86	4,46	-17,59	1,81	-0,25	-2,91	0,75		
EQ8	Avg. Coeff.	2,660 %	-0,113 %	0,318 %	0,608 %	-6,318 %	0,272 %	-0,064 %	-0,382 %		0,207 %	
	T-stat	5,53	-3,34	5,29	4,76	-17,65	1,79	-0,27	-2,92		1,10	
EQ9	Avg. Coeff.	2,691 %	-0,116 %	0,310 %	0,598 %	-6,292 %	0,271 %	-0,058 %	-0,361 %			0,056 %
	T-stat	5,52	-3,36	5,16	4,66	-17,56	1,79	-0,25	-2,70			0,58
EQ10	Avg. Coeff.	2,562 %	-0,107 %	0,322 %	0,572 %	-6,322 %	0,272 %	-0,076 %		-0,210 %	0,206 %	
	T-stat	5,39	-3,25	5,61	4,41	-17,70	1,80	-0,33		-0,43	1,14	
EQ11	Avg. Coeff.	2,587 %	-0,109 %	0,316 %	0,557 %	-6,301 %	0,272 %	-0,072 %		-0,055 %		0,043 %
	T-stat	5,40	-3,27	5,51	4,27	-17,63	1,80	-0,32		-0,11		0,47
EQ12	Avg. Coeff.	2,550 %	-0,107 %	0,321 %	0,563 %	-6,297 %	0,267 %	-0,069 %			0,359 %	-0,195 %
	T-stat	5,30	-3,13	5,32	4,34	-17,61	1,77	-0,30			1,47	-1,32
EQ13	Avg. Coeff.	2,621 %	-0,110 %	0,327 %	0,601 %	-6,341 %	0,272 %	-0,071 %	-0,443 %	0,299 %	0,205 %	
	T-stat	5,51	-3,32	5,72	4,77	-17,76	1,79	-0,31	-2,90	0,54	1,14	
EQ14	Avg. Coeff.	2,644 %	-0,112 %	0,321 %	0,587 %	-6,320 %	0,271 %	-0,067 %	-0,445 %	0,458 %		0,047 %
	T-stat	5,51	-3,34	5,62	4,62	-17,69	1,79	-0,30	-2,90	0,79		0,50
EQ15	Avg. Coeff.	2,657 %	-0,113 %	0,316 %	0,598 %	-6,315 %	0,270 %	-0,057 %	-0,373 %		0,387 %	-0,197 %
	T-stat	5,52	-3,33	5,23	4,67	-17,67	1,78	-0,25	-2,83		1,61	-1,32

Next, we investigate if the systematic component of the fundamental volatility is priced. This is interesting, because if fundamental volatility is a systematic factor the systematic part of the fundamental volatility should be significant in a factor model. Our hypothesis is thus that since revenue volatility is priced, the accounting beta of revenues should also be priced.

Table 7 shows the Fama-Macbeth regression where the systematic fundamental volatility, measured by accounting betas, is included as explanatory variables in addition to the market beta, size, book-to-market, momentum and gross-profitability. We do indeed find that the revenue and gross profit beta are priced cross-sectionally. Since the earnings and cash flow volatility were insignificant in Table 6, it is not surprising that also the accounting betas are insignificant. Interestingly though, regressed independently the gross profit beta is significant with a t-stat of -2.89, but when the revenue beta is included, it loses power and drops to -1.92. We also see that when we only use either the beta of gross profitability or the beta of revenue, the revenue beta is significant at a higher level than the gross profitability beta. The revenue beta has a t-stat of -3.62 alone compared to the beta of gross profitability which has a t-stat as mentioned of -2.89. The revenue beta is significant regardless of model specification with t-stats ranging from -2.05 to -3.71. The beta of gross profitability turns insignificant with a t-stat of -1.17 when the beta of revenues and earnings are included. This point in the direction that the beta of revenues has more explanatory power and is more robust. The negative sign indicates that also the systematic part of the revenue volatility has a negative relationship with average stock returns. Note that it is hard to draw any conclusions regarding the idiosyncratic fundamental volatility[20] based on these regressions. Since we cannot rule out that also the idiosyncratic part is priced, the total fundamental volatility can be a better measure than just the systematic part.

[20] $SD(x_i) = \sqrt{\beta_i^2 VAR(x_m) + VAR(\varepsilon_i)}$, where x_i refers to the scaled fundamentals of the firm, and x_m refers to the scaled fundamentals of the market. $SD(x_i)$ is a estimate of the (total) fundamental volatility, $\beta_i^2 VAR(x_m)$ refers to the systematic fundamental volatility. β_i refers to the accounting betas. $VAR(\varepsilon_i)$, refers to the idiosyncratic fundamental volatility.

Table 7: Fama-Macbeth procedure on the accounting betas.

Table 7 shows the second-stage Fama-Macbeth results and the average premiums and t-stats of the accounting beta measures from month-by-month regressions on monthly CRSP returns from July year *t* to June year *t* + 1. BE is the book value of common equity plus balance sheet deferred taxes, AT is assets and GP is gross profit which is calculated as revenues minus cost of goods sold. E is earnings and is defined as the income to the common equity holders, corrected for deferred taxes, REV is revenues and CF is free cash flow calculated as net income plus depreciation and amortization minus changes in working capital and capital expenditures. All variables constructed using income statement information are from each firm's fiscal year-end in calendar year *t* - 1. The accounting betas are estimated by running rolling regressions for each stock, where the dependent variable is the scaled fundamentals of the firm and the explanatory variable is the the scaled fundamentals of the market. The scaled fundamentals of the market is estimated by accumulating the scaled fundamentals of all the firms for each calendar year, and thereafter dividing the accumulated revenues on the accumulated assets. As with the standard deviations, we estimate the accounting beta using the previous 5 years of accounting data, allowing for no missing values. These raw accounting betas are assigned to deciles, for which the average scaled fundamentals are estimated. The average scaled fundamentals for each deciles is then regressed on the scaled market fundamentals, using the entire sample over time. The resulting 10 accounting beta is the post-ranking accounting beta, which are assigned to each stock in the beta deciles. These betas are used in the Fama-Macbeth. We construct accounting betas scaled fundamentals such as revenues-to-assets (REV/AT), gross-profit-to-assets (GP/AT), earnings-to-book (E/BE) and cash flows-to-book (CF/BE). In every regression we have controlled for size (log (MCAP)) which is measured in June of year *t,* book-to-market (log (BE/ME)), gross profit (GP/AT), momentum measured as the returns of the last 12th to second month (RET(2,12)) controlled for last month returns (RET(0,1)), and market betas(post-rank betas). All independent variables, except momentum (RET(2,12), RET(0,1)) and market betas, have been winsorized at the 0,5% and 99,5% level. The sample covers July 1973 to December 2016, excluding financial firms (SIC 6000-6999)

	Type	Int.	log (Size)	log (BE/ME)	GP /AT	Ret (0,1)	Ret (2,12)	Market Beta	BETA REV/AT	BETA GP/AT	BETA E/BE	BETA CF/BE
EQ1	Avg. Coeff.	2,577 %	-0,109 %	0,322 %	0,562 %	-6,249 %	0,271 %	-0,061 %				
	T-stat	5,06	-2,98	5,39	4,19	-17,34	1,79	-0,26				
EQ2	Avg. Coeff.	2,753 %	-0,111 %	0,315 %	0,504 %	-6,276 %	0,258 %	-0,049 %	-0,096 %	-0,017 %	-0,006 %	0,000 %
	T-stat	5,43	-3,10	5,33	3,73	-17,53	1,70	-0,21	-2,14	-1,10	-1,09	0,02
EQ3	Avg. Coeff.	2,743 %	-0,108 %	0,325 %	0,540 %	-6,254 %	0,267 %	-0,048 %	-0,149 %			
	T-stat	5,37	-2,96	5,44	4,00	-17,35	1,76	-0,20	-3,62			
EQ4	Avg. Coeff.	2,589 %	-0,107 %	0,324 %	0,525 %	-6,253 %	0,266 %	-0,046 %		-0,039 %		
	T-stat	5,11	-2,93	5,44	3,82	-17,39	1,75	-0,19		-2,89		
EQ5	Avg. Coeff.	2,622 %	-0,112 %	0,316 %	0,549 %	-6,272 %	0,266 %	-0,060 %			-0,005 %	
	T-stat	5,17	-3,08	5,31	4,16	-17,46	1,75	-0,26			-1,03	
EQ6	Avg. Coeff.	2,610 %	-0,111 %	0,317 %	0,551 %	-6,241 %	0,268 %	-0,065 %				0,006 %
	T-stat	5,16	-3,05	5,33	4,12	-17,36	1,77	-0,28				0,76
EQ7	Avg. Coeff.	2,685 %	-0,107 %	0,325 %	0,526 %	-6,256 %	0,264 %	-0,042 %	-0,093 %	-0,030 %		
	T-stat	5,25	-2,93	5,46	3,84	-17,39	1,74	-0,18	-2,05	-1,92		
EQ8	Avg. Coeff.	2,773 %	-0,111 %	0,319 %	0,527 %	-6,277 %	0,262 %	-0,049 %	-0,138 %		-0,004 %	
	T-stat	5,44	-3,05	5,36	3,97	-17,46	1,73	-0,21	-3,37		-0,94	
EQ9	Avg. Coeff.	2,780 %	-0,110 %	0,320 %	0,531 %	-6,246 %	0,263 %	-0,052 %	-0,152 %			0,006 %
	T-stat	5,47	-3,04	5,37	3,94	-17,37	1,74	-0,22	-3,71			0,71
EQ10	Avg. Coeff.	2,629 %	-0,110 %	0,319 %	0,509 %	-6,276 %	0,261 %	-0,051 %		-0,029 %	-0,004 %	
	T-stat	5,20	-3,03	5,37	3,74	-17,50	1,72	-0,22		-2,08	-0,91	
EQ11	Avg. Coeff.	2,621 %	-0,109 %	0,318 %	0,518 %	-6,246 %	0,262 %	-0,049 %		-0,041 %		0,008 %
	T-stat	5,20	-3,01	5,36	3,77	-17,41	1,73	-0,21		-2,93		1,02
EQ12	Avg. Coeff.	2,648 %	-0,113 %	0,311 %	0,539 %	-6,269 %	0,264 %	-0,064 %			-0,006 %	0,000 %
	T-stat	5,26	-3,15	5,26	4,11	-17,50	1,74	-0,28			-1,08	0,01
EQ13	Avg. Coeff.	2,730 %	-0,110 %	0,320 %	0,510 %	-6,279 %	0,260 %	-0,046 %	-0,095 %	-0,018 %	-0,004 %	
	T-stat	5,35	-3,03	5,39	3,76	-17,50	1,71	-0,20	-2,12	-1,17	-0,98	
EQ14	Avg. Coeff.	2,717 %	-0,109 %	0,320 %	0,519 %	-6,249 %	0,260 %	-0,046 %	-0,094 %	-0,030 %		0,007 %
	T-stat	5,33	-3,00	5,39	3,79	-17,41	1,72	-0,20	-2,07	-1,96		0,84
EQ15	Avg. Coeff.	2,800 %	-0,112 %	0,314 %	0,518 %	-6,273 %	0,261 %	-0,053 %	-0,139 %		-0,006 %	0,000 %
	T-stat	5,53	-3,13	5,30	3,92	-17,50	1,72	-0,23	-3,40		-1,05	0,01

The Portfolio Formation Procedure

The portfolio formation procedure is a widely used method for testing asset pricing models, particularly due to the flaws related to the Fama and Macbeth regressions: the tendency to put a lot of weight on nano- and micro-cap stocks, but also its sensitivity to outliers and misspecifications (Novy-Marx (2013)). The portfolio formation procedure involves forming portfolios based on the fundamental volatility and considering the performance of the portfolios relative to the excess market returns and factor-mimicking portfolios formed on size, value, momentum and profitability. If the time-series regressions yield a significant alpha, there are abnormal returns left unexplained by the included factors in the regression model. Time-series autocorrelation can potentially be a problem among short-term stock returns. In general, autocorrelation creates problems for the significance inference since the standard errors of the coefficients are biased. All of the time-series regressions in this section and following sections therefore use the Cochrane-Orcutt procedure[21]. In the appendix, we explain how this procedure corrects for autocorrelation.

The estimated fundamental volatility for any fiscal yearend in calendar year $t-1$ is used to form quintiles in June calendar year t. We independently form quintiles for each of the measures of fundamental volatility[22]. The portfolios are formed based on NYSE breakpoints. The reason for doing so is that NYSE is a much more representative exchange than NASDAQ and AMEX, which is dominated by smaller sized companies. The monthly value-weighted excess returns of these portfolios are estimated from July in year t to year $t+1$. We obtain the excess market returns (MKT-RF), size (SMB), value (HML) and momentum (MOM) factors from Kenneth French's online database. The profitability (PMU) factor is constructed as in Novy-Marx (2013)[23].

For each of the volatility measures, we construct long-short portfolios by subtracting the fifth quintile returns from the first quintile. In other words, the returns of the portfolio with the lowest fundamental volatility minus the returns of the portfolio with the highest fundamental volatility is the long-short returns. For each quintile and long-short portfolio, the monthly

[21] The Cochrane-Orcutt procedure only corrected the time-series t-stats slightly, the underlying finding are unaffected regardless whether we use the Cochrane-Orcutt procedure or not.
[22] Total of 8 measures, standard deviation and beta of revenues, gross profits, earnings and cash-flows.
[23] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_factors.html
http://rnm.simon.rochester.edu/data_lib/OSoV/pmu_details.html

value-weighted excess returns are regressed on the MKT-RF, SMB, HML, MOM and PMU. This model is later referred to as the Fama-French 4 factor model (FF4F), augmented by PMU. The regressions on the long-short value-weighted returns are marked as 'LS' in the tables below. The long-short portfolios are also formed by size group, determined by the median size of NYSE stocks. 'LS B' is the long-short portfolio formed in the universe of big stocks, while 'LS S' is the equivalent for small stocks. These size-segmented long-short portfolios are regressed on the SMB, HML, MOM and PMU factors reconstructed for the big and small stock universe independently[24]. Table 8 presents the regressions results using the fundamental volatility, estimated by rolling standard deviations. Table 9 presents the regression results using the systematic portion of fundamental volatility, estimated by accounting betas.

From Table 8 it appears that none of the long-short portfolios formed on the entire universe of stocks ('LS') yields significant alphas. All the alphas has t-stats below 1. This indicates that when we consider the entire universe of stocks none of the strategies formed on the standard deviation of the various fundamentals earns risk-adjusted returns. The standard deviation of revenues, which appeared significant in the Fama-Macbeth regressions, shows a highly significant alpha of 4.27 when regressed on the small stock universe. A strategy that goes long the quintile with lowest revenue volatility and shorts the highest revenue volatility quintile earns risk-adjusted monthly return of 0.34 %. The long-short strategy formed on the standard deviation of earnings also show a significant alpha with a t-stat of 2.25 among the small stock universe, earning a risk-adjusted return of 0.23%. This is lower than the strategy based on the volatility of revenues. Among small stocks overall, the alpha of the long-short portfolio constructed on the standard deviation of revenues seems to be the most significant one with the highest risk-adjusted returns.

Turning to the big stock universe in Table 8, none of the long-short portfolios has highly significant alphas at a five percent level. The low t-stats indicate that the alphas of the long-short portfolios formed on the big stocks are insignificant. The significant alphas found in the

[24] The factors are reconstructed using the only the stocks within the size-group. For the big stock universe, we exclude firms that have a market value in June year *t* (size) below the NYSE median. For the small stock universe, we exclude firms with a market value in June year t above the NYSE median. For each of these samples, the factors are then independently reconstructed using the identical methodology as Fama and French (1993) for the SMB and HML, Novy Marx (2013) for the PMU and Kenneth French's construction of the momentum factor from his only database. http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

small stock universe is a bit problematic since small stocks have tendencies to have higher transaction costs, caused by short constraints or illiquidity. We will discuss this further the robustness section.

From Table 8 it also appears that most of the factors used to explain the long-short portfolios formed on the entire universe of stocks do a good job explaining the returns. Both the SMB and HML load significantly. The highly significant SMB coefficients of -0.47, -0.39, -0.53 and -0.45 for respectively the long-shorts formed on the standard deviation of revenues, gross profit, earnings and cash flows, indicate the positive exposure to big firms and negative exposure to small firms. As observed in Table 3C, low volatility firms tend to be big firms while high volatility firms tend to be small firms. The significant and positive HML loadings indicates that the same long-short portfolios also take positions in value, where we tend go long in value-stock and short in growth-stocks. The PMU appears to be insignificant for the long-short strategy formed on the standard deviation of revenues, with a t-stat of 0.86. For the long-short portfolio formed on the standard deviation of gross profit the PMU is significant and negative, with a t-stat and loading of -4.37 and -0.19. It appears that we have a positive exposure to unprofitable firms and a negative exposure to profitable firms. From the Table 3C it appears that the firms with the lowest gross-profit volatility also tend to be least profitable firms and vice versa. On the contrary, PMU loads positively for the long-short portfolios formed on the earnings and cash flows with respective coefficients of 0.28 and 0.27.

In general, these findings are consistent with the observed correlations in Table 5. Most of the standard deviations appeared negatively correlated with size and value. The profitability appears to have a positive correlation with the standard deviation of revenues and gross-profit, but a negative correlation with the standard deviation of earnings and cash flows.

From Table 9, it appears that the only significant long-short portfolio is formed on the gross profit beta, when regressed on the entire universe of stocks. With a t-stat of 2.23, it earns a monthly risk-adjusted return of 0.25%. Interestingly, when we repeat the same regression on the small stock universe, the alpha becomes insignificant. This is primarily due to the penny-stocks. When we exclude penny-stocks[25], the t-stat of the long-short portfolio formed on the

[25] Excluding firms with a market value < $50 mill or a price per share < $5 (SEC defintions)

gross profit beta goes from 1.38 to 2.23 among the smaller stocks. The corresponding alpha also increases from 0.11% to 0.21%. These regressions are attached in the appendix. Further, in the small stock universe the long-short strategy formed on the accounting beta of revenues appear significant with a t-stat of 2.00 and an alpha of 0.17% in Table 9. These findings are similar to findings in the Fama-Macbeth regressions, where the beta of revenues and gross-profit appeared significant.

The SMB coefficient appears to load negatively for most of the long-short portfolios formed on the accounting betas, for the entire universe of stocks. The SMB coefficients of -0.09, -0.12, -0.21 and -0.01 for the long-short portfolios formed on the revenue, gross profit, earnings and cash flow beta, appear relatively smaller than for the standard deviations. This could be due the generally low correlation between size and the accounting betas, as observed in Table 5. The SMB even renders insignificant for the long-short portfolio formed on the cash flow beta with a t-stat of -0.22. The HML coefficient mostly appears to render insignificant when regressed on the long-shorts for the entire universe of stocks. The long-short portfolio constructed on the revenue beta is one exception, where the HML has a coefficient of 0.25 and a t-stat 5.38. From Table 4C it appears that the firms with high revenues beta also tend to be high-value and vice versa. From the sorts on the other accounting betas it appears that the book-to-market is flatter across the quintiles in Table 4C. MOM appears to be highly significant and positive across the long-shorts formed on the entire universe of stocks. MOM appears to have t-stats of 5.22, 7.08, 4.04 and 4.75 for respectively the long-shorts formed on the beta of revenues, gross-profit, earnings and cash flows.

The PMU loads positively for most of the long-shorts formed on the entire universe of stocks, except for the gross profit beta. The PMU has a t-stat of 1.1 when used to explain the long-short portfolio formed on the beta of gross profit. Counter-intuitively, the positive loading of the PMU indicates the positive exposure to profitable firms and negative exposure to unprofitable firms by going long in firms with low accounting betas and shorting high accounting beta stocks. These findings highlight the noise in the accounting betas and questions the predictive power of the raw accounting betas. We further discuss this topic in the robustness section.

Table 8: The portfolio formation results (SD)

Table 8 shows the regression results from the portfolio formation procedure. The fundamental volatility here is measured using the standard deviation (SD) of various fundamentals. The SD is estimated using 5 years of previous fundamentals, allowing for no missing values. The fundamentals referred to are revenues-to-assets (REV/AT), Gross profit-to-assets (GP/AT), Earnings-to-book equity (E/BE) and Cash flows-to-book equity (CF/BE). Earnings (E) refers to the income to common shareholders, before extraordinary items, added income-statement deferred taxes. Cash flows (CF) refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. Book equity (BE) refers to the common equity added balance-sheet deferred taxes. The fundamental volatility estimates for any fiscal yearend in calendar year *t* - 1 is used to form quintiles in the end of June year *t*. The fundamental volatility portfolios are formed annually using NYSE breaks. The first quintile represents the firms with the least volatility, while the fifth quintile represents the firm with the highest volatility. For each quintile the value-weighted monthly excess returns are estimated. The excess returns of the quintiles are regressed on the excess market returns (MKT-RF), size (SMB), book-to-market (HML), momentum (MOM) obtained from French's database, and Novy-Marx's profitability factor (PMU) constructed as in Novy-Marx (2013). Along the horizontal axis the explanatory factors are aligned, stating the coefficient of factor and the t-stat. The dependent variable is the excess return for each quintile or long-short portfolio. 'LS' is the long-short portfolio formed by subtracting the fifth quintile returns from the first quintile. 'LS B' is the regressions in the big stock universe, while 'LS S' is the regressions in the small stock universe. The regression are time series and we use the Cochrane Orchutt procedure to correct for autocorrelation. All returns are in percent, and the alphas show the risk adjusted returns for each quintile and the long-short portfolios. The sample covers July 1973 to December 2016, excluding financial firms (SIC 6000-6999).

		Alpha		*MKT - RF*		*SMB*		*HML*		*MOM*		*PMU*		R^2
		Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	
SD of REV/AT	1 (L)	0,11 %	2,05	0,87	74,76	-0,19	-11,65	0,07	3,47	0,02	1,53	-0,03	-1,25	92 %
	2	-0,01 %	-0,13	0,96	76,33	-0,15	-8,05	0,01	0,45	0,04	3,09	0,16	6,74	93 %
	3	0,11 %	1,71	1,01	71,33	0,03	1,33	-0,09	-3,72	0,01	0,65	0,02	0,74	92 %
	4	0,07 %	1,08	1,02	68,18	0,06	2,57	-0,08	-3,31	-0,02	-1,23	-0,04	-1,31	92 %
	5 (H)	0,02 %	0,22	1,04	55,54	0,28	10,39	-0,15	-4,89	-0,08	-4,43	-0,06	-1,87	89 %
	LS (L-H)	**0,10 %**	**0,87**	**-0,17**	**-6,98**	**-0,47**	**-13,64**	**0,21**	**5,44**	**0,10**	**4,12**	**0,04**	**0,86**	**43 %**
	LS B (L-H)	0,21 %	1,68	-0,16	-5,68	-0,46	-8,30	0,14	3,10	0,03	1,31	-0,02	-0,30	28 %
	LS S (L-H)	0,34 %	4,27	-0,18	-13,14	-0,36	-8,53	0,08	2,98	0,09	5,69	-0,32	-10,86	55 %
SD of GP/AT	1 (L)	0,14 %	2,31	0,85	64,75	-0,21	-11,48	0,12	5,81	0,02	1,90	-0,13	-5,34	90 %
	2	0,03 %	0,44	0,95	70,02	-0,09	-4,78	0,08	3,65	0,03	2,13	0,10	4,13	91 %
	3	-0,02 %	-0,23	0,99	70,72	-0,06	-3,17	0,04	1,70	0,02	1,10	0,10	3,89	92 %
	4	0,09 %	1,47	1,02	69,28	0,03	1,60	-0,15	-6,39	0,00	-0,10	0,01	0,29	92 %
	5 (H)	0,10 %	1,45	1,05	64,65	0,17	7,51	-0,31	-11,95	-0,05	-3,41	0,05	1,79	92 %
	LS (L-H)	**0,04 %**	**0,36**	**-0,20**	**-8,66**	**-0,39**	**-12,10**	**0,44**	**11,93**	**0,08**	**3,70**	**-0,19**	**-4,37**	**54 %**
	LS B (L-H)	0,18 %	1,75	-0,17	-6,85	-0,21	-4,45	0,37	9,50	0,08	3,89	-0,20	-4,28	49 %
	LS S (L-H)	0,10 %	1,14	-0,28	-17,25	-0,57	-10,91	0,47	15,08	0,02	1,26	-0,05	-1,32	74 %
SD of E/BE	1 (L)	0,10 %	1,67	0,87	66,02	-0,20	-10,68	0,05	2,42	0,01	1,08	0,18	7,17	90 %
	2	0,04 %	0,89	0,95	85,83	-0,11	-6,75	-0,01	-0,59	0,00	-0,34	0,06	2,96	94 %
	3	0,12 %	2,04	0,96	71,82	-0,07	-3,42	-0,07	-3,06	0,01	0,89	-0,05	-2,01	92 %
	4	-0,03 %	-0,37	1,04	73,62	0,05	2,25	-0,03	-1,22	-0,01	-0,74	-0,08	-3,16	93 %
	5 (H)	0,00 %	-0,01	1,12	58,70	0,33	12,21	-0,15	-4,73	-0,04	-1,90	-0,11	-3,12	90 %
	LS (L-H)	**0,10 %**	**0,80**	**-0,25**	**-9,69**	**-0,53**	**-14,44**	**0,20**	**4,70**	**0,05**	**2,02**	**0,28**	**5,82**	**48 %**
	LS B (L-H)	0,21 %	1,68	-0,20	-7,40	-0,51	-9,51	0,19	4,28	0,03	1,11	0,29	5,50	34 %
	LS S (L-H)	0,23 %	2,25	-0,37	-21,14	-0,74	-13,27	0,31	8,94	0,00	-0,17	0,42	10,79	76 %
SD of CF/BE	1 (L)	0,07 %	1,33	0,92	79,31	-0,19	-11,18	0,02	0,87	0,02	1,71	0,05	2,44	93 %
	2	0,04 %	0,69	0,94	82,54	-0,10	-6,17	-0,04	-2,09	0,02	1,94	0,05	2,50	94 %
	3	0,11 %	1,97	0,97	76,81	-0,02	-1,04	0,03	1,66	-0,04	-2,96	0,08	3,34	93 %
	4	0,04 %	0,68	1,00	76,68	0,06	3,31	-0,06	-2,89	-0,01	-0,75	-0,01	-0,58	93 %
	5 (H)	0,04 %	0,55	1,10	64,31	0,27	10,86	-0,19	-7,00	-0,01	-0,66	-0,21	-6,72	92 %
	LS (L-H)	**0,02 %**	**0,26**	**-0,18**	**-8,50**	**-0,45**	**-14,59**	**0,21**	**6,02**	**0,03**	**1,46**	**0,27**	**6,64**	**48 %**
	LS B (L-H)	0,08 %	0,83	-0,11	-5,00	-0,52	-11,58	0,20	5,29	0,02	1,15	0,25	5,68	36 %
	LS S (L-H)	0,16 %	1,92	-0,29	-20,10	-0,43	-9,74	0,31	11,29	0,05	2,77	0,43	13,69	76 %

Table 9: The portfolio formation results (Betas)

Table 9 shows the regression results from the portfolio formation procedure for the accounting betas. The accounting betas are estimated by running rolling regressions for each stock, where the dependent variable is the scaled fundamentals of the firm, while the explanatory variable is the the scaled fundamentals of the market. The scaled fundamentals of the market are estimated by accumulating the scaled fundamentals of all the firms for each calendar year. We estimate the accounting betas using the previous 5 years of accounting data, allowing for no missing values. The scaled fundamentals referred to are revenues-to-assets (REV/AT), Gross profit-to-assets (GP/AT), Earnings-to-book equity (E/BE) and Cash flows-to-book equity (CF/BE). Earnings (E) refers to the income to common shareholders, before extraordinary items, added income-statement deferred taxes. Cash flows (CF) refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. Book equity (BE) refers to the common equity added balance-sheet deferred taxes. The accounting beta for any fiscal yearend in calendar year *t* - 1 is used to form quintiles in the end of June year *t*. The quintiles are formed annually using NYSE breaks. The first quintile represents the firms with the lowest accounting betas, while the fifth quintile represents the firm with the highest accounting betas. For each quintile the value-weighted monthly excess returns are estimated. The excess returns of the quintiles are regressed on the excess market returns (MKT-RF), size (SMB), book-to-market (HML), momentum (MOM) obtained from French's database, and Novy-Marx's profitability factor (PMU) constructed as in Novy-Marx (2013). Along the horizontal axis the explanatory factors are aligned, stating the coefficient of factor and the t-stat. The dependent variable is the excess return for each quintile or long-short portfolio. 'LS' is the long-short portfolio formed by subtracting the fifth quintile returns from the first quintile. 'LS B' is the regressions in the big stock universe, while 'LS S' is the regressions in the small stock universe. The regression are time series and we use the Cochrane Orchutt procedure to correct for autocorrelation. All returns are in percent, and the alphas show the risk adjusted returns for each quintile and the long-short portfolios. The sample covers July 1973 to December 2016, excluding financial firms (SIC 6000-6999).

		Alpha		*MKT - RF*		*SMB*		*HML*		*MOM*		*PMU*		R^2
		Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	
BETA of REV/AT	1 (L)	0,00 %	-0,06	1,00	63,63	0,05	2,17	0,05	2,03	0,05	3,15	0,24	8,19	90 %
	2	0,10 %	1,77	0,91	73,64	-0,14	-8,16	0,01	0,65	0,02	1,75	0,05	2,21	92 %
	3	0,06 %	1,18	0,93	76,18	-0,13	-7,43	0,00	-0,01	0,01	0,71	-0,03	-1,11	93 %
	4	0,04 %	0,72	0,99	77,98	-0,05	-2,90	-0,03	-1,25	0,02	1,88	0,05	2,03	93 %
	5 (H)	0,10 %	1,12	1,00	50,35	0,14	4,82	-0,20	-6,09	-0,10	-5,02	-0,17	-4,64	87 %
	LS (L-H)	**-0,10 %**	**-0,84**	**0,00**	**-0,03**	**-0,09**	**-2,25**	**0,25**	**5,38**	**0,15**	**5,22**	**0,42**	**7,92**	**16 %**
	LS B (L-H)	0,11 %	0,92	-0,04	-1,18	-0,18	-2,97	0,23	4,80	0,13	4,90	0,46	8,12	16 %
	LS S (L-H)	0,17 %	2,00	0,01	0,52	0,15	3,17	-0,05	-1,91	0,10	5,63	0,07	2,26	10 %
BETA of GP/AT	1 (L)	0,15 %	2,20	0,99	61,52	-0,01	-0,47	-0,10	-3,99	0,09	5,64	0,12	3,87	90 %
	2	0,11 %	2,02	0,90	73,92	-0,12	-6,71	0,04	1,88	0,03	2,13	-0,01	-0,31	92 %
	3	0,04 %	0,67	0,92	73,41	-0,14	-7,73	0,10	4,75	0,01	1,00	-0,07	-3,07	92 %
	4	0,09 %	1,63	0,95	78,15	-0,06	-3,63	0,02	1,27	0,02	1,44	0,07	2,99	93 %
	5 (H)	-0,09 %	-1,34	1,03	61,62	0,11	4,65	-0,16	-6,17	-0,10	-5,89	0,06	2,00	91 %
	LS (L-H)	**0,25 %**	**2,23**	**-0,03**	**-1,25**	**-0,12**	**-3,25**	**0,06**	**1,40**	**0,19**	**7,08**	**0,05**	**1,10**	**12 %**
	LS B (L-H)	0,37 %	3,43	-0,05	-1,84	-0,20	-3,68	-0,03	-0,74	0,14	5,41	0,05	0,98	10 %
	LS S (L-H)	0,11 %	1,38	-0,04	-2,78	-0,07	-1,52	0,08	2,95	-0,01	-0,75	0,11	3,35	9 %
BETA of E/BE	1 (L)	0,08 %	1,08	0,99	64,10	-0,01	-0,48	-0,05	-1,94	0,02	1,47	0,04	1,40	90 %
	2	0,10 %	1,80	0,91	78,04	-0,13	-7,91	0,00	-0,16	0,02	1,92	0,06	2,96	93 %
	3	0,06 %	1,17	0,93	70,99	-0,12	-6,25	0,05	2,40	0,02	1,85	0,14	5,70	92 %
	4	0,04 %	0,58	0,97	64,66	-0,04	-1,92	-0,04	-1,78	-0,02	-1,51	-0,05	-1,78	91 %
	5 (H)	-0,02 %	-0,19	1,09	56,75	0,20	7,33	-0,09	-2,94	-0,09	-4,58	-0,13	-3,48	89 %
	LS (L-H)	**0,09 %**	**0,69**	**-0,10**	**-3,65**	**-0,21**	**-5,32**	**0,05**	**1,03**	**0,11**	**4,04**	**0,17**	**3,21**	**14 %**
	LS B (L-H)	0,18 %	1,36	-0,09	-3,25	-0,37	-6,71	0,06	1,20	0,08	3,09	0,17	3,02	16 %
	LS S (L-H)	0,14 %	1,41	-0,08	-4,56	-0,14	-2,62	0,02	0,59	0,03	1,72	0,14	3,65	12 %
BETA of CF/BE	1 (L)	0,00 %	0,02	1,01	65,65	0,12	5,50	-0,11	-4,42	0,03	2,19	0,01	0,39	91 %
	2	0,03 %	0,66	0,97	75,59	-0,13	-6,90	-0,05	-2,31	0,01	0,52	0,03	1,20	93 %
	3	0,15 %	3,12	0,92	74,01	-0,10	-5,51	0,02	0,91	0,02	1,30	0,05	2,26	92 %
	4	-0,01 %	-0,22	0,94	70,48	-0,10	-5,21	0,01	0,44	-0,01	-0,38	0,07	2,85	92 %
	5 (H)	0,16 %	2,21	1,05	63,37	0,13	5,48	-0,08	-2,91	-0,08	-5,03	-0,20	-6,32	91 %
	LS (L-H)	**-0,16 %**	**-1,51**	**-0,05**	**-1,95**	**-0,01**	**-0,22**	**-0,03**	**-0,76**	**0,12**	**4,75**	**0,21**	**4,58**	**9 %**
	LS B (L-H)	-0,07 %	-0,67	-0,02	-0,96	-0,11	-2,19	0,03	0,70	0,09	3,79	0,21	4,33	7 %
	LS S (L-H)	0,04 %	0,48	-0,07	-4,73	-0,07	-1,57	0,02	0,59	0,04	2,16	0,15	4,64	13 %

Spanning tests

The long-short returns (LS) regressed in the table 8 and 9, were simply estimated by subtracting the value-weighted returns of the upper quintile from the lower quintile, formed on the various measures of fundamental volatility. The value-weighting to a large extent ensures that the returns are achievable, in the sense that the returns are estimated by weighting the bigger stocks more. The bigger stocks tend to be liquid, with smaller transaction costs and with less short-constraints. At the same time, value-weighting minimizes the return variance of the portfolios as highlighted by Fama and French (1993). One downside related to value-weighting the returns is that the biggest weights are given to the biggest stocks in the portfolio, which raises the question of a representative sample of stocks. The opposite would be to equal-weight the returns but then the small stocks would be dominating the sample, again raising the question of a representative sample without the impact of size.

Fama and French (1993) tackle this by estimating four value-weighted portfolios when constructing the HML. They separately estimate the value-weighted returns of the small value stocks, big value stocks, small growth stocks and big growth stocks. They create the HML-factor by equal weighting the returns from the big growth stocks and the small growth stocks, which thereafter is subtracted from the equivalent for value stocks[26]. This creates a HML-factor that gives more balanced weights to each of the stocks by month. Fama and French (1993) choose the portfolio formation arbitrarily, since it was not affecting the end result. For other risk-factors this might have an impact if the returns are slightly stronger among the smaller stocks.

Rather than calculating the long-short returns by subtracting the value-weighted returns of the upper and lower quintile as in Table 8 and 9, the long-short returns could be estimated in a similar manner as the HML-factor. The main benefit as highlighted earlier is the more balance size weighting. For our spanning-test in Table 10 and 11 we therefore estimate long-short returns for all of the fundamental volatility estimates as the following:

[26] $HML = (Value,\ Small + Value,\ Big)/2 - (Growth,\ Small + Growth,\ Big)/2$

$$\frac{1st\ Quintile\ (X), Small + 1st\ Quintile\ (X), Big}{2} - \frac{5th\ Quintile\ (X),\ Small + 5th\ Quintile\ (X), Big}{2}$$

X = the fundamental volatility measure that the quintiles are formed on: standard deviation or beta of revenues, gross profit, earnings or cash flows (8 measures in total).

Small firms and big firms are assigned to portfolios independently using the NYSE median as breakpoint.

“1st Quintile (X), Small” is the value-weighted monthly returns of the small stocks in the 1st quintile formed on X.
“1st Quintile (X), Big” is the value-weighted monthly returns of the big stocks in the 1st quintile formed on X.
“5th Quintile (X), Small” is the value-weighted monthly returns of the small stocks in the 5th quintile formed on X.
“5th Quintile (X), Big” is the value-weighted monthly returns of the big stocks in the 5th quintile formed on X.

In Table 10 we present our first spanning test. Along the vertical axis, we align the long-short portfolios formed on the different fundamental volatility measures. Along the horizontal axis, we align the asset pricing models used to explain the long-short portfolios on the vertical axis. The table presents the alphas and the corresponding t-stats from the regressions. As the results show in Table 10, some of the long-short portfolios do appear to yield significant alphas, when compared to Table 8 and 9. In Table 10 the long-short portfolio formed on the standard deviation of revenues and earnings appears to have significant alphas with respectively t-stats of 2.40 and 2.48, compared to 0.87 and 0.80 in the Table 8. This is due to a more balanced size weighting.

From Table 10 it appears that the Fama-French three-factor model (FF3F) does not entirely explain the alphas of the long-short portfolios formed on the various measures of fundamental volatility. The long-short portfolios formed on the standard deviation of gross profit and the beta of cash flows are the only portfolios with insignificant alphas, with respective t-stats of 1.87 and 1.27. As momentum is included to the FF3F-model (FF4F), the alpha of the long-short portfolios formed on the standard deviation and beta of revenues lose significance with respective t-stats of 1.82 and 1.32. In addition, the alpha of the long-short portfolio created on the beta of earnings appears to be insignificant with a t-stat of 1.33. The long-short portfolios with significant alphas, after the inclusion of the PMU-factor, appear to be formed on the standard deviation of revenues, earnings and the beta of gross profit. When we include the PMU-factor, the alpha of the long-short portfolios formed on the standard deviation of revenues reappears as significant. In other words, when we assess the alpha of the long-short portfolio created on the standard deviation of revenues, the inclusion of PMU appears to be important to prevent an omitted variable bias. This could also be the case for the other long-short portfolios.

Note that almost all of the alphas that are significant show a positive alpha, which indicates that firms with low fundamental volatility tend to earn a risk-adjusted returns compared to firms with high fundamental volatility. These results are consistent with the findings of Huang (2009), Zhang (2006) and Grantham (2004).

From the spanning test in Table 10, it appears that the long-short portfolios are able to explain some of the alphas found in other long-short portfolios. When the portfolio formed on the revenue volatility is included as an explanatory variable with the PMU and FF4F-model (FF4F+PMU), the alpha of the portfolio formed on the standard deviation of earnings loses significance. The same happens when we instead include the portfolio formed on the standard deviation of earnings to explain the long-short portfolio formed on the standard deviation of revenues. The alpha of the portfolios formed on the standard deviation of earnings and revenues show respectively t-stats of 1.51 and 1.36, down from 2.48 and 2.40. None of the portfolios formed on the accounting betas appear to explain the alphas of the portfolios formed on the standard deviation of revenues and earnings. Yet, the long-short portfolio formed on the standard deviations appear to make the portfolio formed on the gross profit beta insignificant. The t-stat of the alpha goes from 2.06 to 1.43 when the long-short portfolio formed on the standard deviation of revenues is included, to explain the long-short portfolio formed on the beta of gross profit.

Table 10: Spanning-test with long-short fundamental volatility portfolios.

Vertically the dependent variables are aligned, which are the returns of the long-short portfolios constructed on the various measures of fundamental volatility. The fundamental volatility measures (X) refer to the standard deviation (SD) and beta (Beta) of the scaled revenues (REV/AT), scaled gross-profit (GP/AT), scaled earnings (E/BE) and scaled (CF/BE). The long-short portfolios are constructed by independently assigning the stocks into fundamental volatility quintiles and two size portfolios, using NYSE-breakpoints. The value-weighted average returns of low fundamental volatility stocks (1st quintile) is independently estimated by size portfolios, similarly value-weighted average returns of the high fundamental volatility stocks (5th quintile) is estimated by size portfolios. The big and small value-weighted returns are equal-weighted for low fundamental volatility stocks and high fundamental volatility stocks before they're subtracted from each other, estimating the monthly long-short returns (LS(X)):

$$\frac{1st\ Quintile\ (X), Small + 1st\ Quintile\ (X), Big}{2} - \frac{5th\ Quintile\ (X),\ Small + 5th\ Quintile\ (X), Big}{2}$$

Horizontally the explanatory models are aligned. FF3F refers to the Fama-French 3-factor model, FF4F refers to the Fama-French 3-factor model augmented by momentum (UMD), while FF4F+PMU refers to the FF4F-model augmented by profitability (PMU). The columns to the right of FF4F+PMU includes the the various long-short portfolios formed on the fundamental volatility one at a time (LS(Xi) ≠ LS(Xj)), as explanatory variables with the FF4F+PMU. The regression equation is therefore the following: $LS(X_i) = \alpha + \beta_{MKT-RF} * (\mathrm{MKT} - \mathrm{RF}) + \beta_{SMB} * \mathrm{SMB} + \beta_{HML} * \mathrm{HML} + \beta_{MOM} * \mathrm{MOM} + \beta_{PMU} * \mathrm{PMU} + \beta_{Xj} * LS(X_j)$, where LS(X) refers to the returns of the long-short portfolios formed on the various fundamental volatility measures (X). The table below shows the alphas and the corresponding t-stats for the regressions.

					LS(Xj)							
LS(Xi)	**TYPE**	**FF3F**	**FF4F**	**FF4F + PMU**	**SD of REV/AT**	**SD of GP/AT**	**SD of E/BE**	**SD of CF/BE**	**Beta of REV/AT**	**Beta of GP/AT**	**Beta of E/BE**	**Beta of CF/BE**
SD of REV/AT	α	0,24 %	0,16 %	0,21 %		0,14 %	0,10 %	0,14 %	0,21 %	0,16 %	0,19 %	0,21 %
	T(α)	2,91	1,82	2,40		1,95	1,36	1,75	2,58	1,95	2,30	2,45
SD of GP/AT	α	0,17 %	0,10 %	0,14 %	0,02 %		-0,02 %	0,05 %	0,14 %	0,08 %	0,12 %	0,15 %
	T(α)	1,87	1,03	1,52	0,26		-0,27	0,56	1,56	0,89	1,36	1,65
SD of E/BE	α	0,48 %	0,44 %	0,27 %	0,14 %	0,15 %		0,12 %	0,28 %	0,22 %	0,24 %	0,28 %
	T(α)	4,06	3,63	2,48	1,51	2,00		1,38	2,53	2,03	2,41	2,53
SD of CF/BE	α	0,35 %	0,34 %	0,16 %	0,09 %	0,10 %	0,03 %		0,16 %	0,14 %	0,15 %	0,17 %
	T(α)	3,75	3,52	1,98	1,18	1,41	0,47		2,01	1,73	1,87	2,10
Beta of REV/AT	α	0,24 %	0,13 %	0,01 %	-0,10 %	-0,03 %	-0,06 %	-0,02 %		-0,10 %	-0,02 %	0,02 %
	T(α)	2,44	1,32	0,10	-1,13	-0,35	-0,63	-0,26		-1,26	-0,30	0,21
Beta of GP/AT	α	0,34 %	0,23 %	0,18 %	0,12 %	0,13 %	0,11 %	0,15 %	0,18 %		0,15 %	0,20 %
	T(α)	3,95	2,61	2,06	1,43	1,60	1,28	1,74	2,48		1,86	2,33
Beta of E/BE	α	0,25 %	0,14 %	0,07 %	0,00 %	0,02 %	-0,03 %	0,01 %	0,07 %	-0,02 %		0,10 %
	T(α)	2,37	1,33	0,67	0,01	0,24	-0,28	0,10	0,73	-0,18		1,00
Beta of CF/BE	α	0,10 %	0,03 %	-0,05 %	-0,07 %	-0,08 %	-0,07 %	-0,08 %	-0,05 %	-0,11 %	-0,08 %	
	T(α)	1,27	0,37	-0,68	-0,88	-0,97	-0,89	-1,02	-0,68	-1,42	-1,10	

Interestingly, when we exclude nano-cap and penny-stocks from the spanning test in Table 11, the alphas of the long-short portfolios formed on the standard deviation of revenues and earnings disappear. The respective t-stats of the alphas are 0.57 and 0.28 when regressed on the FF4F-model, augmented by PMU. It therefore does appear that most of the abnormal returns come from the smaller stocks. Particularly the long-short portfolios constructed on the standard deviation of revenues and earnings do not appear robust across sizes, considering that they lose their significance. These results are consistent with the notion that the significance of revenues volatility, found in the Fama-Macbeth regressions, could be due to the equal weighting of the smallest stocks. In the robustness section, we will discuss potential downsides related to alpha returns found among the smaller stocks. Only the portfolio formed on the beta of gross profitability remains significant, with a t-stat of 2.15 in Table 11 compared to 2.06 in Table 10. The long-short portfolio formed on the gross profit beta also appears to improve its performance with an alpha of 0.20% in table 11 compared to 0.18% in table 10.

Table 11: Spanning-test excl. firms with price<$5 or MCAP<$50 mill.

This spanning-test excludes any stock with a price per share below $5 (SEC-definition of Penny-stocks) or size below $50 mil. (also known as nano-caps). Vertically the dependent variables are aligned, which are the returns of the long-short portfolios constructed on the various measures of fundamental volatility. The fundamental volatility measures (X) refer to the standard deviation (SD) and beta (Beta) of the scaled revenues (REV/AT), scaled gross-profit (GP/AT), scaled earnings (E/BE) and scaled (CF/BE). The long-short portfolios are constructed by independently assigning the stocks into fundamental volatility quintiles and two size portfolios, using NYSE-breakpoints. The value-weighted average returns of low fundamental volatility stocks (1st quintile) is independently estimated by size portfolios, similarly value-weighted average returns of the high fundamental volatility stocks (5th quintile) is estimated by size portfolios. The big and small value-weighted returns are equal-weighted for low fundamental volatility stocks and high fundamental volatility stocks before they're subtracted from each other, estimating the monthly long-short returns (LS(X)):

$$\frac{1st\ Quintile\ (X), Small + 1st\ Quintile\ (X), Big}{2} - \frac{5th\ Quintile\ (X),\ Small + 5th\ Quintile\ (X), Big}{2}$$

Horizontally the explanatory models are aligned. FF3F refers to the Fama-French 3-factor model, FF4F refers to the Fama-French 3-factor model augmented by momentum (UMD), while FF4F+PMU refers to the FF4F-model augmented by profitability (PMU). The columns to the right of FF4F+PMU includes the the various long-short portfolios formed on the fundamental volatility one at a time (LS(Xi) ≠ LS(Xj)), as explanatory variables with the FF4F+PMU. The regression equation is therefore the following: $LS(X_i) = \alpha + \beta_{MKT-RF} * (\text{MKT} - \text{RF}) + \beta_{SMB} * \text{SMB} + \beta_{HML} * \text{HML} + \beta_{MOM} * \text{MOM} + \beta_{PMU} * \text{PMU} + \beta_{Xj} * LS(X_j)$, where LS(X) refers to the returns of the long-short portfolios formed on the various fundamental volatility measures (X). The table below shows the alphas and the corresponding t-stats for the regressions.

					LS(Xj)							
LS(Xi)	**TYPE**	**FF3F**	**FF4F**	**FF4F + PMU**	**SD of REV/AT**	**SD of GP/AT**	**SD of E/BE**	**SD of CF/BE**	**Beta of REV/AT**	**Beta of GP/AT**	**Beta of E/BE**	**Beta of CF/BE**
SD of REV/AT	α	0,08 %	0,02 %	0,05 %		0,07 %	0,04 %	0,07 %	0,04 %	0,00 %	0,02 %	0,05 %
	T(α)	0,97	0,20	0,57		1,07	0,55	0,84	0,48	0,04	0,30	0,57
SD of GP/AT	α	-0,03 %	-0,09 %	-0,05 %	-0,08 %		-0,06 %	-0,02 %	-0,06 %	-0,10 %	-0,07 %	-0,04 %
	T(α)	-0,30	-0,95	-0,52	-1,11		-0,90	-0,22	-0,64	-1,05	-0,84	-0,48
SD of E/BE	α	0,12 %	0,10 %	0,03 %	-0,01 %	0,06 %		0,07 %	0,02 %	-0,02 %	-0,01 %	0,03 %
	T(α)	1,11	0,88	0,28	-0,10	0,72		0,72	0,21	-0,18	-0,05	0,28
SD of CF/BE	α	0,05 %	0,02 %	-0,06 %	-0,08 %	-0,04 %	-0,07 %		-0,07 %	-0,09 %	-0,08 %	-0,06 %
	T(α)	0,55	0,28	-0,81	-1,03	-0,58	-1,01		-0,83	-1,07	-1,01	-0,80
Beta of REV/AT	α	0,22 %	0,10 %	0,03 %	0,01 %	0,04 %	0,02 %	0,04 %		-0,11 %	-0,02 %	0,04 %
	T(α)	2,07	0,98	0,28	0,06	0,45	0,25	0,42		-1,40	-0,28	0,38
Beta of GP/AT	α	0,34 %	0,23 %	0,20 %	0,19 %	0,21 %	0,20 %	0,21 %	0,19 %		0,16 %	0,21 %
	T(α)	3,73	2,40	2,15	2,01	2,35	2,06	2,21	2,59		1,96	2,33
Beta of E/BE	α	0,26 %	0,13 %	0,09 %	0,07 %	0,11 %	0,08 %	0,11 %	0,08 %	-0,02 %		0,11 %
	T(α)	2,56	1,23	0,90	0,78	1,12	0,90	1,08	0,95	-0,19		1,08
Beta of CF/BE	α	0,09 %	0,02 %	-0,03 %	-0,03 %	-0,03 %	-0,03 %	-0,02 %	-0,04 %	-0,10 %	-0,06 %	
	T(α)	1,02	0,23	-0,39	-0,38	-0,33	-0,39	-0,20	-0,44	-1,18	-0,78	

6. Explaining idiosyncratic risk

Idiosyncratic risk is reduced by diversifying. If you are more interested in investing in a few quality stocks, it could be of interest to find alternative methods to reduce your exposure to idiosyncratic risk. Even though the measures of fundamental volatility do appear to have mixed significance in explaining the systematic risk, there is a possibility that they explain the idiosyncratic risk.

To understand the impact fundamental volatility has on idiosyncratic risk we run a Fama-Macbeth regression. The monthly excess returns from July calendar year t to June calendar year $t + 1$ are regressed on the FF4F-model augmented by PMU for each stock annually. By doing so we obtain estimates of the monthly residuals for each stock.[27] We then estimate one annual standard deviation of the residuals, using the estimated residuals from July calendar year t to June calendar year $t + 1$. This estimate is aligned with the measures of fundamental volatility, for any fiscal yearend, from calendar year $t - 1$. The standard deviation of the residuals is an estimate of the idiosyncratic risk for each stock each year (from 1973 to 2016). The estimated standard deviation of the residuals is used as the left-hand side variable and regressed on our fundamental volatility measures in a Fama-Macbeth procedure. In Table 12 we present the regression output from the second stage using the standard deviations. Table 13 repeats the regression only using the accounting betas instead.

The estimation of the annual idiosyncratic risk for each stock is done in a similar manner as Arena, Haggard and Yan (2008). The drawbacks related to this methodology is particularly the noisy estimates of the idiosyncratic risk. There is a possibility that the results would have been different when the idiosyncratic risk for each stock is estimated over a longer time period. Drawing statistically clear inferences could therefore be somewhat problematic. Still, the main benefit of using Fama-Macbeth regressions is that it allows the regressions to be run on individual stocks. Investigating firm-specific risk by forming portfolios is questionable, since the firm-specific risk is diversified away to a larger extent.

[27] This method of calculating the idiosyncratic risk is similar to Arena, Haggard and Yan (2012). They only use the CAPM to measure the idiosyncratic return volatility. Ang et al (2006) also estimates the idiosyncratic volatility in the same manner, only that they use monthly rebalancing and daily data and a FF3F model.

Table 12 Panel A shows the regressions on the entire set of stocks, while the regressions in Panel B repeats the Fama-Macbeth regressions on firms that are bigger than the NYSE median size. The significance found in a Fama-Macbeth regression on the entire set of stocks could be due to significance among micro- and nano-caps, not necessarily among bigger stocks. This is because the Fama-Macbeth regressions equal weights each observation. By running a separate regression on the bigger stocks, we are able to assess whether the findings on the entire set of stocks are present among bigger stocks as well.

Looking at Panel A in Table 12, it appears that the standard deviations have significant power in explaining idiosyncratic risk. The univariate regressions on the standard deviation of revenues, gross profits, earnings and cash flows show significant coefficients, with respective t-stats of 29.14, 30.71, 8.42 and 14.23 for the entire sample of stocks. In Panel B it also appears that the fundamental volatility significantly explains the idiosyncratic volatility among the biggest stocks. All of the coefficients appear to positive, indicating that high fundamental volatility is associated with high idiosyncratic risk and vice versa. Interestingly, the standard deviation of gross profit appears to have the biggest impact on idiosyncratic risk. The standard deviation of gross profit has the highest coefficient consistently in all of the regressions, spanning from 17.35% to 26.32%.

Table 12: Idiosyncratic risk regressed on fundamental volatility

The monthly excess returns from July calendar year *t* to June calendar year *t* + 1 is regressed on the FF4F-model including PMU for each stock annually. By doing so we obtain the estimated monthly residuals for each stock. One annual standard deviation of the residuals is estimated, using the estimated residuals from July calendar year *t* to June calendar year *t* + 1 for each stock. These estimates are aligned with the measures of fundamental volatility for any fiscal yearend from calendar year *t* - 1. The standard deviation of the residuals is then regressed on the measures of fundamental volatility. The tables below show the second step results of the Fama-Macbeth. Panel A reports the regression results on the entire set of stocks, Panel B reports the results on firms bigger than the NYSE median. SD refers to the standard deviation of various fundamentals. The SD is estimated using 5 years of previous fundamentals, allowing for no missing values. The fundamentals referred to are revenues-to-assets (REV/AT), gross profit-to-assets (GP/AT), earnings-to-book (E/BE) and cash flows-to-book equity (CF/BE). Earnings refers to the income to common shareholders, before extraordinary items, added income-statement deferred taxes. Cash flows refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. BE refers to the common/ordinary equity added deferred taxes.

		Panel A: Entire sample					*Panel B: Size > NYSE Median*				
	TYPE	**INT.**	**SD REV/AT**	**SD GP/AT**	**SD E/BE**	**SD CF/BE**	**INT.**	**SD REV/AT**	**SD GP/AT**	**SD E/BE**	**SD CF/BE**
EQ1	Avg. Coeff.	5,96 %	1,76 %	17,35 %	3,28 %	0,79 %	4,18 %	1,28 %	11,55 %	4,81 %	1,06 %
	T-stat	27,32	8,72	19,15	6,49	3,00	24,92	5,74	12,31	3,98	2,98
EQ2	Avg. Coeff.	6 %		19,70 %	3,28 %	0,85 %	4,24 %		13,24 %	4,91 %	1,06 %
	T-stat	27,45		23,86	6,58	3,14	24,75		14,64	3,98	2,95
EQ3	Avg. Coeff.	7,26 %			4,80 %	0,89 %	4,77 %			6,28 %	1,20 %
	T-stat	28,64			7,73	2,88	24,58			4,22	3,14
EQ4	Avg. Coeff.	7,28 %				3,90 %	4,87 %				2,69 %
	T-stat	29,06				14,23	25,86				8,37
EQ5	Avg. Coeff.	7,34 %			5,60 %		4,81 %			7,56 %	
	T-stat	29,48			8,42		24,84			5,15	
EQ6	Avg. Coeff.	6,22 %		26,32 %			4,39 %		16,98 %		
	T-stat	28,85		30,71			26,28		18,07		
EQ7	Avg. Coeff.	6,83 %	7,22 %				4,66 %	4,27 %			
	T-stat	30,52	29,14				27,28	15,16			
EQ8	Avg. Coeff.	6,05 %	2,12 %	23,33 %			4,31 %	1,51 %	14,88 %		
	T-stat	28,44	10,11	26,62			26,20	6,81	16,88		
EQ9	Avg. Coeff.	6,14 %		19,89 %	4,04 %		4,27 %		13,49 %	6,01 %	
	T-stat	28,13		24,14	7,52		24,86		15,20	4,99	
EQ10	Avg. Coeff.	6,44 %	5,46 %			3,31 %	4,47 %	3,72 %			2,41 %
	T-stat	28,25	25,19			15,35	26,09	13,47			8,72
EQ11	Avg. Coeff.	5,99 %	1,84 %	17,40 %	3,98 %		4,20 %	1,35 %	11,69 %	5,89 %	
	T-stat	27,83	9,05	19,10	7,58		24,93	6,23	12,61	5,04	
EQ12	Avg. Coeff.	6,47 %	5,14 %		4,21 %	0,76 %	4,42 %	3,32 %		5,68 %	1,09 %
	T-stat	28,37	22,62		7,42	2,68	25,40	12,68		4,25	2,98
EQ13	Avg. Coeff.	5,89 %	1,72 %	19,12 %		2,63 %	4,19 %	1,40 %	13,16 %		2,02 %
	T-stat	26,64	8,44	22,40		12,06	24,97	6,03	13,86		7,99
EQ14	Avg. Coeff.	6,50 %	5,24 %		4,88 %		4,44 %	3,42 %		6,80 %	
	T-stat	28,89	23,43		8,57		25,45	13,57		5,21	
EQ15	Avg. Coeff.	6,02 %		21,39 %		2,70 %	4,26 %		15,07 %		2,04 %
	T-stat	26,74		26,13		11,61	24,91		15,41		7,76

From Table 13 it appears that the accounting betas significantly explains the idiosyncratic risk as well. For the entire sample of stocks, it appears that most of the accounting betas are significant, except for the beta of gross profit that appears insignificant in some of the regressions. The beta of gross profit renders insignificant with a t-stat with of 0.91, when regressed alone in Panel A. The beta of gross profit reappears as significant, in the univariate regression among the bigger stocks in Panel B, with a t-stat of 7.03. Overall, the beta of gross profit appears to be a less robust predictor of idiosyncratic risk across sizes.

In both Panel A and B, the cash flow beta appears to have significant and negative coefficients in all the regressions. In Panel A the coefficient of the cash flow beta ranges from -0.41% to -0.22%, in Panel B the coefficient ranges from -0.15% to -0.06%. The negative coefficients indicate that if the market increases its scaled cash flows and the firm tends to decrease its scaled cash flows, it is associated with more idiosyncratic volatility. On the other hand, the positive coefficient of the earnings beta indicates that firms that tend to increase their scaled earnings with the market, tend to have higher idiosyncratic risk. Since the various coefficients of accounting betas have different signs, it is somewhat unclear how to interpret the impact of accounting betas. If we believe that the accounting betas reflect the same underlying information, these findings are puzzling. It does appear that the systematic fundamental volatility tends to increase the idiosyncratic volatility, if we believe the accounting betas contain the same underlying information. Two of the three significant accounting betas have positive coefficients. Both the revenues and earnings beta appears to have positive and significant coefficients of 0.33% and 0.13%, and t-stats of 2.94 and 9.17 in the univariate regressions.

These coefficients could also indicate the impact of accruals on idiosyncratic risk. For instance, consider the results in EQ3 in Panel A. The cash flow beta has a coefficient of -0.22%, while the earnings beta has a coefficient of 0.19%. If the market increases both its scaled earnings and cash flows, the firm that tends to increase its earnings but decrease the cash flows with the market is associated with higher idiosyncratic risk. This could indicate that firms with high accruals tend to be perceived with higher idiosyncratic risk. These conclusions are somewhat indecisive, due to the strong correlation between the accounting betas and since we do not explicitly control for accruals.

Table 13: Idiosyncratic risk regressed on accounting betas

The monthly excess returns from July calendar year *t* to June calendar year *t* + 1 is regressed on the FF4F-model including PMU for each stock annually. By doing so we obtain the estimated monthly residuals for each stock. One annual standard deviation of the residuals is estimated, using the estimated residuals from July calendar year *t* to June calendar year *t* + 1 for each stock. This estimate is aligned with the post-ranking accounting betas for any fiscal yearend in calendar year *t* - 1. The standard deviation of the residuals is then regressed on the post-ranking accounting betas. The tables below show the second step results of the Fama-Macbeth. Panel A reports the regression results on the entire set of stocks, Panel B reports the results on firms bigger than the NYSE median. Raw accounting beta are estimated by regressing the previous 5 years of firm-specific fundamentals on a market benchmark, allowing for no missing values. These betas are assigned into 10 portfolios. For each portfolio the average fundamentals are estimated for each year, these estimates are regressed on the market equivalent across the entire sample. The resulting post-ranking beta is referred to as the post-ranking accounting beta (BETA) (See section 3). The fundamentals referred to are revenues-to-assets (REV/AT), gross profit-to-assets (GP/AT), earnings-to-book (E/BE) and cash flows-to-book equity (CF/BE). Earnings refers to the income to common shareholders, before extraordinary items, added income-statement deferred taxes. Cash flows refers to the earnings added depreciation subtracting changes in working capital and capital expenditure. BE refers to the common/ordinary equity added deferred taxes. The market benchmark is estimated dividing the accumulated the fundamentals (REV, GP, E, CF) on the corresponding accumulated scale (A, BE) for each year.

		Panel A: Entire sample					*Panel B: Size > NYSE Median*				
	TYPE	**INT.**	**BETA REV/AT**	**BETA GP/AT**	**BETA E/BE**	**BETA CF/BE**	**INT.**	**BETA REV/AT**	**BETA GP/AT**	**BETA E/BE**	**BETA CF/BE**
EQ1	Avg. Coeff.	7,30 %	0,39 %	-0,13 %	0,19 %	-0,41 %	4,75 %	0,22 %	0,03 %	0,10 %	-0,15 %
	T-stat	30,11	3,45	-4,50	10,45	-11,83	24,78	4,60	1,90	11,80	-8,25
EQ2	Avg. Coeff.	8 %		-0,06 %	0,20 %	-0,42 %	4,99 %		0,07 %	0,10 %	-0,15 %
	T-stat	32,01		-2,35	10,45	-11,99	26,63		4,38	11,83	-8,40
EQ3	Avg. Coeff.	7,67 %			0,19 %	-0,42 %	5,05 %			0,10 %	-0,15 %
	T-stat	31,45			10,35	-11,89	27,18			11,89	-8,13
EQ4	Avg. Coeff.	8,09 %				-0,22 %	5,18 %				-0,06 %
	T-stat	31,82				-9,33	27,31				-3,13
EQ5	Avg. Coeff.	7,82 %			0,13 %		5,04 %			0,08 %	
	T-stat	31,06			9,17		26,97			12,31	
EQ6	Avg. Coeff.	8,07 %		0,02 %			5,02 %		0,12 %		
	T-stat	31,73		0,91			26,81		7,03		
EQ7	Avg. Coeff.	7,68 %	0,33 %				4,71 %	0,36 %			
	T-stat	28,32	2,94				25,65	7,77			
EQ8	Avg. Coeff.	7,58 %	0,44 %	-0,05 %			4,74 %	0,26 %	0,08 %		
	T-stat	27,66	3,46	-1,51			25,22	6,38	4,83		
EQ9	Avg. Coeff.	7,88 %		-0,07 %	0,13 %		4,97 %		0,06 %	0,08 %	
	T-stat	31,39		-2,55	9,11		26,42		4,37	12,26	
EQ10	Avg. Coeff.	7,72 %	0,28 %			-0,22 %	4,76 %	0,35 %			-0,06 %
	T-stat	28,87	2,50			-9,31	25,69	7,05			-3,30
EQ11	Avg. Coeff.	7,35 %	0,48 %	-0,16 %	0,13 %		4,71 %	0,25 %	0,02 %	0,08 %	
	T-stat	29,05	4,11	-4,84	9,29		24,72	5,31	1,32	12,31	
EQ12	Avg. Coeff.	7,45 %	0,17 %		0,19 %	-0,41 %	4,76 %	0,24 %		0,10 %	-0,15 %
	T-stat	30,37	1,66		9,94	-11,82	24,86	5,09		11,99	-7,96
EQ13	Avg. Coeff.	7,65 %	0,35 %	-0,01 %		-0,22 %	4,79 %	0,24 %	0,09 %		-0,07 %
	T-stat	28,20	2,79	-0,50		-9,76	25,32	5,50	5,63		-3,77
EQ14	Avg. Coeff.	7,53 %	0,22 %		0,13 %		4,73 %	0,25 %		0,08 %	
	T-stat	29,03	2,09		8,65		24,83	5,98		12,34	
EQ15	Avg. Coeff.	8,04 %		0,04 %		-0,23 %	5,04 %		0,13 %		-0,07 %
	T-stat	31,98		1,55		-9,65	26,97		7,38		-3,91

7. Robustness

Abnormal stock returns can also be due to data mining. Data mining could arise if we use the same set of returns and rerun tests along enough dimensions until we find a factor that appear to predict returns. One way to deal with this is to emphasize robustness tests, for instance by applying different datasets and see if these anomalies also exist there. Momentum, size and value seems to exist internationally (Fama and French 2012) thus the data mining problem seem to not be huge issue for these anomalies[28]. Regarding several of the other anomalies data mining could still be a problem. Since we look at eight metrics of fundamental volatility, there is a chance that some of the found significance is due to coincident and not causality. We therefore choose to run some robustness tests to prevent any wrongful conclusion due to data mining.

Regressions by sub-periods

We used CRSP/COMPUSTAT data from 1968 to 2016 for the asset pricing tests. There is a possibility that the fundamental volatility actually renders significant only for specific subsections of the sample. Even though varying significance points towards less robust results, it is interesting to see whether fundamental volatility historically has had a bigger impact on stock returns. We therefore regress the long-short portfolios again, but splitting the sample into two sub-periods: 1970-1995 and 1995-2016.

In table 14 we present the time-series regressions where we have regressed the various long-short portfolios on the FF4F model, augmented by the PMU factor. It appears that the significant alpha found for the long-short portfolio formed on the gross profit beta largely is due to the sample before 1995. In the newer sample, the long-short portfolio is insignificant. Interestingly, the portfolio formed on the standard deviation of revenues appears to be significant in the newer sample. As observed in the spanning-tests, this is mostly due to the smaller stocks. If we remove penny-stocks from the same regressions, even this portfolio becomes insignificant[29].

[28] Momentum has in newer times been becoming weaker, particularly in the period post 1990s. In our Novy-Marx replication (1963 to 2010) the momentum rendered significant. In our Fama-Macbeth regression the momentum on average didn't render significant (1973 to 2016). There has also been published newer studies highlighting the that the alpha coming from momentum strategies has become insignificance as Bhattachariya, Li and Sonaer (2017).

[29] The alpha of portfolio formed on the standard deviation of revenues has a t-stat of 1.17 excluding penny-stocks. See appendix.

Table 14: Regressions by sub-period.

Vertically the dependent variables are aligned - which is the returns of the long-short portfolios constructed on the various measures of fundamental volatility. The fundamental volatility measures (X) refer to the standard deviation (SD) and beta (Beta) of the scaled revenues (REV/AT), scaled gross-profit (GP/AT), scaled earnings (E/BE) and scaled (CF/BE). The long-short portfolios are constructed by independently assigning the stocks into fundamental volatility quintiles and two size portfolios, using NYSE-breakpoints. The value-weighted average returns of low fundamental volatility stocks (1st quintile) is independently estimated by size portfolios, similarly value-weighted average returns of the high fundamental volatility stocks (5th quintile) is estimated by size portfolios. The big and small value-weighted returns are equal-weighted for low fundamental volatility stocks and high fundamental volatility stocks before they are subtracted from each other, estimating the monthly long-short returns (LS(X)):

$$\frac{1st\ Quintile\ (X), Small + 1st\ Quintile\ (X), Big}{2} - \frac{5th\ Quintile\ (X),\ Small + 5th\ Quintile\ (X), Big}{2}$$

Horizontally the explanatory factors are aligned. We use the Fama-French 3-factor model augmented by momentum (MOM), and profitability (PMU). The regression equation is therefore the following: $LS(X_i) = \alpha + \beta_{MKT-RF} * (MKT - RF) + \beta_{SMB} * \text{SMB} + \beta_{HML} * \text{HML} + \beta_{MOM} * \text{MOM} + \beta_{PMU} * \text{PMU}$, where LS(X) refers to the returns of the long-short portfolios formed on various the fundamental volatility measures (X). The table below rapports the regression coefficients and corresponding t-stats.

Sub-period	LS portfolio (dep. variable)	*Alpha*		*MKT - RF*		*SMB*		*HML*		*MOM*		*PMU*		R^2
		Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	
Post 1995	SD of REV/AT	0,13 %	1,17	-0,27	-9,98	-0,26	-7,45	0,23	6,31	0,09	3,94	-0,24	-4,80	56 %
Pre 1995	SD of REV/AT	0,01 %	0,06	-0,18	-6,89	-0,40	-9,87	0,11	2,08	0,02	0,53	-0,07	-1,41	49 %
Post 1995	SD of GP/AT	0,02 %	0,19	-0,29	-9,97	-0,42	-10,88	0,56	13,95	0,05	1,84	-0,20	-3,54	70 %
Pre 1995	SD of GP/AT	-0,03 %	-0,25	-0,19	-7,45	-0,34	-8,51	0,29	5,56	0,01	0,16	-0,28	-5,71	64 %
Post 1995	SD of E/BE	-0,02 %	-0,23	-0,31	-11,47	-0,40	-11,30	0,40	10,87	0,03	1,18	0,21	4,11	70 %
Pre 1995	SD of E/BE	0,03 %	0,18	-0,28	-8,58	-0,43	-8,44	0,22	3,16	0,02	0,41	0,27	4,15	45 %
Post 1995	SD of CF/BE	-0,15 %	-1,49	-0,24	-9,29	-0,28	-8,68	0,37	10,79	0,04	2,05	0,27	5,68	64 %
Pre 1995	SD of CF/BE	-0,04 %	-0,33	-0,15	-6,58	-0,35	-9,59	0,33	7,06	0,02	0,67	0,32	7,11	49 %
Post 1995	BETA of REV/AT	0,04 %	0,28	-0,13	-4,11	0,08	1,89	0,20	4,75	0,11	4,12	0,17	2,90	23 %
Pre 1995	BETA of REV/AT	0,16 %	1,21	0,07	2,49	-0,19	-4,46	0,00	-0,06	0,10	2,75	0,27	5,09	22 %
Post 1995	BETA of GP/AT	0,17 %	1,54	-0,08	-2,87	-0,01	-0,28	0,18	4,68	0,09	3,67	0,20	3,69	20 %
Pre 1995	BETA of GP/AT	0,29 %	2,27	-0,01	-0,21	-0,19	-4,67	-0,13	-2,48	0,10	3,01	-0,09	-1,85	17 %
Post 1995	BETA of E/BE	0,06 %	0,50	-0,21	-7,11	-0,16	-4,33	0,08	1,92	0,06	2,42	0,17	3,10	35 %
Pre 1995	BETA of E/BE	0,18 %	1,16	-0,05	-1,67	-0,19	-3,91	0,05	0,81	0,18	4,51	0,11	1,77	13 %
Post 1995	BETA of CF/BE	-0,03 %	-0,27	-0,18	-7,23	-0,06	-1,72	0,04	1,15	0,04	1,77	0,18	3,83	30 %
Pre 1995	BETA of CF/BE	0,01 %	0,06	0,05	1,89	-0,01	-0,27	-0,04	-0,83	0,09	2,76	0,10	1,84	8 %

Applying different look-back periods

The look-back period of 5 years was chosen partly since Asness et al. (2014) used five years of accounting data to estimate the earnings volatility. There is a possibility that the look-back period is different for various investors. Still, we believe that five years of accounting data should be sufficient due to two reasons. If we choose a too long look-back period, there is a possibility that the fundamental volatility reflects more of the history than the present. A too short look-back period makes the estimates statistically questionable and noisy due to few observations. In other words, these problems arise since annual accounting data is not high frequency data. Quarterly accounting data might therefore have a slight advantage compared to using annual accounting data as we do. One issue with quarterly accounting data is the quarterly rebalancing in the portfolio formation procedure, which is associated with substantially higher the transaction costs.

We believe it is important to see how the explanatory power of fundamental volatility changes as we apply different look-back periods. This is particularly of interest since the look-back period of 5 years appears to be chosen arbitrarily by Asness et al. (2014) and Zhang (2006). We run the Fama-Macbeth regressions including one measure of fundamental volatility at the time, where the fundamental volatility is estimated using various time frames. Table 15 reports the average coefficient and the t-stat of the coefficient. The regressions are done on the entire sample of stocks and on the stocks in the upper size quintile. The latter regression is of interest since the portfolio formation procedure puts more weight on the biggest stocks.

The regression including all sizes show that the standard deviation and the accounting beta of revenues remain significant for all the look-back periods. The accounting beta of gross profit appears to lose significance when estimated on a longer time-period when regressed on the entire universe of stocks. Going from the 5-year look-back to 10-year look-back the t-stat goes from -2.89 to -1.52. Unsurprisingly, the standard deviation and the accounting beta of revenues turn insignificant regardless of look-back periods when regressed on only the big stocks. The gross profit beta, which appeared to be robust among bigger stocks, is only significant using the 5-year look-back period among the bigger stocks. The fact that the gross profit beta loses its significance when estimated using different look-back periods among the bigger stocks, makes us question the robustness of the estimate.

Table 15: Fama-Macbeth coefficients using different look-back periods

The table below stats the regression outputs from the second-step of the Fama-Macbeth procedure. The table rapports the coefficients and t-stats of the various fundamental volatility measures. The returns are regressed on the market beta, size, value, short-term momentum, long-term momentum and profitability, in addition to using the various fundamental volatility measures one at a time. The Fama-Macbeth regression formulation is the following: $Ret. = \alpha + \beta_{\text{Market beta}} * \text{Market beta} + \beta_{\log(\text{size})} * \log(\text{size}) + \beta_{\frac{BE}{ME}} * \log\left(\frac{\text{BE}}{\text{ME}}\right) + \beta_{Ret(0.-1)} * \text{Ret}(0,-1) + \beta_{Ret(-2.-12)} * \text{Ret}(-2,-12) + \beta_X * \text{X}$, where X refers to the fundamental volatility measures. SD refers to the standard deviation, while BETA refers to the post-ranking accounting betas. REV/AT is the revenues scaled to assets, GP/AT is the gross-profit scaled to assets, E/BE is the earnings scaled to book-equity. CF/BE is the cash flows scaled to book-equity. Earnings (E) refers to the income to common shareholders before extraordinary items added the deferred taxes. Cash flows (CF) refers to income to common shareholders before extraordinary items added the deferred taxes and depreciation subtracting changes in working capital and subtracting capital expenditure. Book-equity (BE) refers to the common/ordinary equity added deferred taxes. Look-back period refers to the number of years applied to compute the STD and BETA, allowing no missing values

Panel A: Coefficients from second-step Fama-Macbeth regressions.

Look-back period	**4**		**5**		**6**		**10**	
Type	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**
SD REV/AT	-0,49 %	-3,38	-0,36 %	-2,62	-0,42 %	-3,11	-0,48 %	-3,60
SD GP/AT	-0,23 %	-0,45	-0,07 %	-0,12	-0,05 %	-0,09	0,19 %	0,32
SD E/BE	0,05 %	0,26	0,18 %	0,92	0,24 %	1,19	0,11 %	0,58
SD CF/BE	0,01 %	0,08	0,04 %	0,40	0,05 %	0,44	-0,10 %	-0,98
BETA REV/AT	-0,17 %	-3,97	-0,15 %	-3,62	-0,16 %	-4,26	-0,09 %	-2,79
BETA GP/AT	-0,03 %	-2,44	-0,04 %	-2,89	-0,04 %	-2,37	-0,04 %	-1,52
BETA E/BE	0,00 %	-0,07	0,00 %	-1,03	0,00 %	-0,26	0,01 %	1,31
BETA CF/BE	0,02 %	2,76	0,01 %	0,76	0,01 %	0,98	0,00 %	0,32

Panel B: Coefficients from second step-Fama-Macbeth regressions, | Biggest stocks (Upper 20%)

Look-back period	**4**		**5**		**6**		**10**	
Type	**Coeff,**	**T-stat**	**Coeff,**	**T-stat**	**Coeff,**	**T-stat**	**Coeff,**	**T-stat**
SD REV/AT	-0,05 %	-0,15	0,07 %	0,21	0,05 %	0,16	0,19 %	0,60
SD GP/AT	-0,41 %	-0,40	0,01 %	0,01	0,83 %	0,87	0,94 %	1,08
SD E/BE	-0,71 %	-0,83	0,03 %	0,03	0,47 %	0,52	0,97 %	1,32
SD CF/BE	0,12 %	0,35	0,13 %	0,39	0,08 %	0,25	-0,36 %	-1,07
BETA REV/AT	-0,05 %	-0,53	-0,08 %	-0,89	-0,03 %	-0,43	0,03 %	0,44
BETA GP/AT	-0,05 %	-1,77	-0,06 %	-2,32	-0,02 %	-0,67	-0,03 %	-1,04
BETA E/BE	-0,01 %	-1,29	-0,01 %	-1,11	0,00 %	-0,15	0,00 %	-0,29
BETA CF/BE	0,01 %	0,61	0,02 %	1,23	0,01 %	0,61	0,01 %	0,44

Issues with small-stock significance

As observed in our Fama-Macbeth regressions, some of fundamental volatility measures showed strong significance. Repeating the same regressions only on the stocks in the biggest size-quintile shows that none of the standard deviations are significant, only the beta of gross profit as shown in Table 15. Overall, these observations support our findings in the portfolio formation procedure. In this section we discuss some of the issues related to abnormal returns found among smaller stocks.

Since neither the Fama-Macbeth nor the times-series regressions control for any transaction costs, abnormal returns could be due to transactions costs. Frazzini, Israel, & Moskowitz (2015) address the costs related to bid-ask spreads, market impact and commissions. For large institutions trading costs related to commissions and bid-ask spreads tend to be relatively small, since they do not vary much with the size of the trade. The most significant cost of trading is related to market impact, which more or less describes the cost of illiquidity.

Smaller stocks do appear to be associated with higher trading costs according to the estimates provided by Frazzini et al. (2015). Note that Frazzini et al. (2015) explain the trading costs based on the actual costs of their own hedge fund. They discuss a few papers that has tried to estimate the trading costs, but ended up overstating the trading costs for larger institutions. For our thesis, we do not attempt to estimate the trading costs, mostly because trading costs depend on the marginal investor and since there is a high likelihood for estimation errors. In our spanning test, we found that many of the long-short portfolio lost their alpha when we removed penny-stocks, without adjusting for any trading costs. Controlling for trading costs therefore appears of little value for our thesis. As for the long-short portfolio formed on the gross profit beta, a lot of the alpha significance comes from the bigger stocks. Trading costs could still explain the significance, but it seems somewhat less likely considering that trading costs are lower for bigger firms.

Short constraints could explain abnormal returns if a lot of the returns come from shorting. Generally small, illiquid stocks are often associated with short constraints[30]. For the long-short portfolios that showed significant alphas in the small stock universe, this could be an issue. For a strategy formed on the gross profit beta this does not appear to be the immediate case.

On a general note, the exclusion of penny-stocks or nano-caps could also have its downsides. If we believe that the fundamental volatility proxies for information uncertainty and this uncertainty is a true risk factor for smaller stocks, excluding penny-stocks is questionable. For particularly micro and nano-cap stocks information is less accessible. These companies are for instance not required to file with the SEC and tend to have less analyst coverage. The

[30] These type of stocks are is less frequently lent away for shorting purposes - Jones and Lamont (2002)

standards of the publications are therefore likely to be poorer[31]. A lot of the information uncertainty is therefore likely to be coming from the smaller stocks. One the other hand, if this is specific for smaller stocks only, one could surely argue that it is not a market-wide systematic risk factor.

Do the raw accounting betas actually have predictive power?

It is possible that the accounting betas, estimated on the previous 5 years of annual data, deviates from the true accounting betas. Since we use annual data we do not have many appealing alternatives. If we apply a longer look-back period, the number of firms with accounting betas is likely to drop significantly, giving us an unrepresentative sample of mostly big and mature firms. As we have observed in Table 15, using longer look-back periods appears to reduce the significance of the accounting beta in the Fama-Macbeth. Since the post-ranking accounting betas cannot be used to form portfolios in real-time, we used the raw accounting betas in the portfolio formation procedure. It is therefore interesting to see whether these accounting betas deviate a lot from the post-ranking accounting betas. Forming portfolios on betas that deviate significantly from the post-ranking betas, is a potential source of error since we most likely do not form the portfolios on the true beta. We can therefore not reject that the portfolios formed on the true betas could have yielded different results.

From Table 16 it appears that many of the firms that are estimated to have negative raw accounting betas, end up with the post-ranking accounting betas estimated to be zero or positive. This appears to be the case for the beta of gross-profit and revenues. The t-stats of the post-ranking accounting beta of revenues and gross profit appear to be 3.44 and -1.24, for the first decile formed on the raw accounting beta. By going long in stocks with low gross profit beta, we therefore appear to invest in firms that tend to have a gross profitability that is unaffected by a market downfall. On the other end, we short firms that tend to be highly exposed to a market downfall. The positive alpha from this strategy supports Grantham’s (2004) proposition that firms that tend to provide an “insurance against economic downturns” tend to be underpriced in the market.

[31] https://www.sec.gov/reportspubs/investor-publications/investorpubsmicrocapstockhtm.html

Table 16: post-ranking accounting betas and t-stats

The raw accounting betas are estimated by regressing the firms previous 5-years of scaled fundamentals on the market benchmark. We allow for no missing values. The market benchmark is annually estimated by accumulating the fundamentals of all the stocks and dividing by the corresponding accumulated scalar. The scaled fundamentals refer to revenues-to-assets (REV/AT), gross-profit-to-assets (GP/AT), earnings-to-book (E/BE) and cash flows-to-book (CF/BE). The market benchmark is estimated dividing the annually accumulated revenues on the accumulated assets, similarly for the other scaled fundamentals. After assessing the raw accounting beta, we sort them into 10 portfolios. For each of these portfolios we estimate the average scaled fundamentals for each year. These averages are then regressed on the market benchmark using the entire sample (1968 to 2016). The derived accounting beta is the post-ranking accounting beta. In the table below we present the post-ranking betas and the corresponding t-stats from the last step of the post-ranking.

		Type	**Beta of REV/AT**	**Beta of GP/AT**	**Beta of E/BE**	**Beta of CF/BE**
Portfolios formed on the Raw accounting β	1	Post. Accounting β	0,88	-0,82	-3,76	-4,77
		T(β)	3,44	-1,24	-2,30	-4,49
	2	Post. Accounting β	1,00	0,16	-0,17	-0,08
		T(β)	9,63	0,65	-0,56	-0,29
	3	Post. Accounting β	0,93	0,22	0,08	0,21
		T(β)	6,62	1,25	0,42	1,31
	4	Post. Accounting β	1,00	0,70	0,10	0,38
		T(β)	8,47	3,42	0,81	3,49
	5	Post. Accounting β	1,14	0,87	0,35	0,37
		T(β)	12,81	4,85	3,09	5,02
	6	Post. Accounting β	1,27	1,30	0,50	0,54
		T(β)	17,28	8,53	4,08	8,63
	7	Post. Accounting β	1,17	1,19	0,89	0,65
		T(β)	13,21	9,10	6,80	4,53
	8	Post. Accounting β	1,23	1,35	1,44	0,68
		T(β)	14,23	9,02	7,12	3,21
	9	Post. Accounting β	1,35	1,76	2,51	0,85
		T(β)	10,81	7,32	5,94	2,35
	10	Post. Accounting β	2,36	3,80	15,52	2,69
		T(β)	9,36	7,65	7,52	1,43

8. Conclusion

Based on our study we found mixed evidence that the fundamental volatility is a systematic risk factor. Even though we found the revenue volatility and its beta to be significant in the Fama-Macbeth regressions, we only found them to be significant among smaller stocks in the portfolio formation procedure. This points us in the direction that the Fama-Macbeth findings might not be robust across sizes. As for the systematic fundamental volatility, we found that the beta of gross profit appears to be a significant in both the Fama-Macbeth and portfolio formation procedure across sizes, particularly when we exclude penny-stocks. Among the accounting betas, the returns are found to be lower for the high accounting betas stocks than for the low accounting beta stocks, which clearly contradicts any risk story.

The significance, especially for the revenue volatility and revenue beta, seems to be stronger among small caps. Strategies based on the revenue volatility will therefore face higher transaction costs and potentially be unprofitable as a trading strategy. On a more positive note, most of the significance of the beta of gross profit comes from the bigger stocks, which should suffer less from the issues regarding transaction costs. Still, it is worrisome that when splitting the sample into two sub periods, 1970-1995 and 1995-2016, the alpha found in the long-short portfolio formed on beta of gross profit rendered insignificant in the in the newer sample. This indicates that the alpha of the long-short portfolios formed on the gross profit beta is mostly coming from the oldest sample, which could mean the long-short strategy unprofitable going ahead even though it rendered significant in-sample. The revenue volatility on the other hand is only significant in the latter sub period, particularly among the smaller stocks, indicating that this effect is more interesting today, despite the small stock issues.

Since we look at eight metrics of fundamental volatility in total. There is a chance that some of the found significance is due to coincident and not causality. Up until now more than 316 factors has been found that explains the cross section of returns in stocks, and most of them has been discovered in the last 10 years. It is reasonable to say that that this is too good to be true. Harvey, Liu & Zhu (2016) has therefore been arguing that a critical value of at least 3 should be applied when assessing the significance of abnormal returns. For example, when using the portfolio formation procedure, we found a t-stat of 2.23 for the beta of gross profitability when regressed on the whole universe of stock. Even though this is considered significant, it may still be too low compared to the framework of Harvey et al. (2016).

Even though we found mixed evidence that the fundamental volatility affects the systematic risk, we found more promising evidence that the fundamental volatility affects the idiosyncratic risk. So the question remains: why should idiosyncratic risk matter for quality investors? Warren Buffett is probably the most cited investor on the topic of quality investing. On diversification, Buffett has argued that "diversification is protection against ignorance. It makes little sense if you know what you are doing"[32]. Quality investors therefore do not appear to advocate for diversification. If it is the case the quality investors tend to be less diversified, understanding and assessing the idiosyncratic risk becomes much more important. Investing in firms with low fundamental volatility does appear to be an efficient way to reduce idiosyncratic risk on according to our Fama-Macbeth regressions. If this is the case, investing in stocks with low fundamental volatility could partly do the same job as diversification. Notice that our Fama-Macbeth regressions shows a significant intercept, indicating that even if we had bought firms with zero fundamental volatility the idiosyncratic risk would still be present. Unless the intercept can be modelled to be zero by including other factors, investing in stocks with low fundamental volatility does not appear to be an adequate substitute for diversification.

[32] http://eu.wiley.com/WileyCDA/Section/id-817935.html

9. References

- Anderson, E. W.,, Eric, G., Juergens, J. L. (2005) “Do Heterogeneous Beliefs Matter for Asset Pricing?” The Review of Financial Studies 2005; 18 (3): 875-924.
- Ang, A., Hodrick, R., Xing, Y. & Zhang, X. (2006) “The Cross-Section of Volatility and Expected Returns” The Journal of Finance 61(1), 2006, 259-299.
- Arena, M., Haggard, S., & Yan, X. (2008) “Price Momentum and Idiosyncratic Volatility” Financial Review 43(2), 2008, 159-190
- Asness, C., Frazzini, A., & Pedersen, L. (2014) “Quality Minus Junk”. AQR Working paper
- Asness, C., Moskowitz, T., & Pedersen, L. (2013) “Value and Momentum Everywhere” The Journal of Finance 68(3), 2013, 929-985
- Bandyopadhyay, S., Huang, A., Sun, K. & Wirjanto, T. (2017) “The return premiums to accruals quality” Review of Quantitative Finance and Accounting 48(1), 2017, 83-115
- Beaver, W., Kettler, P. & Scholes, M. (1970) “The Association Between Market Determined and Accounting Determined Risk Measures” The Accounting Review 45(4), 1970, 654-682
- Bhattachariya, D., Li, W. & Sonaer, G. (2017) “Has momentum losts its momentum?” Review of Quantitative Finance and Accounting, 48 (1), 2017, 191-218
- Bodie, Z., Kane, A. & Marcus, A. (2014). “Investments” McGraw-Hill Education
- Brousseau, C. and Z. Gu (2013) “How Is Accruals Quality Priced by the Stock Market?” Working paper (Quebec, Canada/Minneapolis, MN: Laval University/University of Minnesota).
- Core, J.E., W.R. Guay and R.V. Verdi. (2008) “Is accruals quality a priced risk factor?” Journal of Accounting and Economics 46(1), 2008, 2-22.
- Daniel, K., Hirshleifer, D., & Subrahmanyam, A. (1998) “Investor psychology and security market over- and under-reactions” Journal of Finance 53, 1998, 1839–1886.
- Daniel, K., Hirshleifer, D., & Subrahmanyam, A. (2001) “Overconfidence, arbitrage and equilibrium asset pricing” Journal of Finance 56, 2001, 921–965.
- Diether, K.B., Malloy, C.J. & Scherbina, A. (2002) “Differences of Opinion and the Cross Section of Stock Returns.” The Journal of Finance 57, 2002, 2113-2141.

- Easley, D. & O'Hara, M. "Information and the Cost of Capital" The Journal of Finance 59.4, 2004, 1553-1583.
- Fama, E. & French, K. (1992) “The Cross-Section of Expected Stock Returns” The Journal of Finance 47(2), 1992, 427-465.
- Fama, E. & French, K. (1993) “Common risk factors in the returns on stocks and bonds” The Journal of Fincancial Economics 33(1), 1993, 3-56.
- Fama, E. & French, K. (2003) “The CAPM: Theory and Evidence”
- Francis, J., LaFond, R., Olsson P. & Schipper, K. (2004) “Cost of Equity and Earnings Attributes” The Accounting Review 79(4), 2004, 967-1010
- Francis, J., LaFond, R., Olsson P. & Schipper, K. (2005) “The market pricing of accruals quality” Journal of Accounting & Economics 39, 2005, 295-327
- Frazzini, A., Israel, R. & Moskowitz, T. (2015) “Trading Costs of Asset Pricing Anomalies” (December 5, 2012). Fama-Miller Working Paper; Chicago Booth Research Paper No. 14-05.
- Frazzini, A., Kabiller, D., & Pedersen, L. (2013) “Buffett's alpha”. Cambridge, MA: National Bureau of Economic Research (NBER), 2013. (National Bureau of Economic Research. Working Paper Series; No. 19681)
- Grantham (2004) “The Case for Quality – The Danger of Junk “. GMO White Paper.
- Harvey, C., Liu, Y. & Zhu, H. (2016) “...and the Cross-Section of Expected Returns,” Review of Financial Studies 29, 2016, 5-68.
- Hirshleifer, D. (2001) “Investor psychology and asset pricing” Journal of Finance 56, 2001, 1533–1596.
- Huang A. (2009) “The cross section of cashflow volatility and expected stock returns” Journal of Empirical Finance 16, 2009, 409–429
- Hughes, J., Liu, J. & Liu, J. (2007) “Information Asymmetry, Diversification, and Cost of Capital” The Accounting Review 82(3), 2007, 705-729
- Jegadeesh, N., & Titman, S. (1993) “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency” The Journal of Finance 48(1), 1993, 65-91
- Jones, C. & Lamont, O. (2002) “Short-sale constraints and stock returns” Journal of Financial Economcis 66, (2-3), 2002, 207-239.
- Knight, F. (1921). “Risk, Uncertainty, and Profit”. Hart, Schaffner, and Marx Prize Essays, no. 31. Boston and New York: Houghton Mifflin.

- Lakonishok, J., Shleifer, A. & Vishny, R. (1995) “Contrarian Investment, Extrapolation and Risk”. The Journal of Finance, 49(5), 1994, 1541-1578
- Lambert, R., Leuz, C. & Verrecchia, R. (2008) “Information Asymmetry, Information Precision, and the Cost of Capital” Review of Finance 16(1), 2008, 1-29
- Minton, B. & Schrand, C. (1999) “The impact of cash #ow volatility on discretionary investment and the costs of debt and equity financing” Journal of Financial Economics 54, 1999, 423-460.
- Novy-Marx, R. (2013) “The Other Side of Value: The Gross Profitability Premium”, Journal of Financial Economics 108(1), 2013, 1-28.
- Novy-Marx, R. (2014) “Quality Investing”. Working paper
- Rosenberg, B. & Guy, J. (1976) “Prediction of Beta from Investment Fundamentals: Part One” Financial Analysts Journal, 32(3), 1976, 62-70.
- Rosenberg, B. & Guy, J. (1976) “Prediction of Beta from Investment Fundamentals: Part Two” Financial Analysts Journal, 32(4), 1976, 60-72.
- Zhang, F. (2006) “Information Uncertainty and Stock Returns” Journal of Finance 61, 2006, 105–137

10. Appendix

Cochrane-Orcutt Procedure:

Time-series autocorrelation can potentially be a problem among short-term stock returns. In general, autocorrelation creates problems for the significance inferens since the standard errors of the coefficients are biased. All of the time-series regressions therefore use the Cochrane-Orcutt procedure. The procedure did not change the underlying findings, only corrected the t-stats slightly. The procedure models out the residuals by iteration, which is beneficial since we do not know the number of lags needed to correct for the autocorrelation (Wooldridge (2014)). Consider the following simplified example: The Cochrane-Orcutt procedure starts by estimating coefficients and residuals of the regression model, for instance: $\boldsymbol{y_t = \beta_0 + \beta_1 x_{1,t} + u_t}$. Autocorrelation implies that the lagged residuals explains the estimated residuals, the Cochrane-Orcutt procedure therefore regresses the estimated residuals on the lagged residuals: $\hat{u}_{\boldsymbol{t}} = \boldsymbol{\delta} + \boldsymbol{\rho}\hat{u}_{\boldsymbol{t-1}} + \boldsymbol{v_t}$. Using the predicted ρ the dependent and independent variables are transformed and regressed again in the following form: $\boldsymbol{y_t{}^* = \beta_0{}^* + \beta^*{}_1 x_{1,t}{}^*} + (\boldsymbol{u_t} - \hat{\rho}\,\hat{u}_{\boldsymbol{t-1}})$, where $\boldsymbol{y_t{}^* = y_t} - \hat{\rho}\,\boldsymbol{y_{t-1}})$ and $\boldsymbol{x_t{}^* = x_t} - \hat{\rho}\,\boldsymbol{x_{t-1}})$. This is the first iteration of the Cochrane-Orcutt procedure. The next iteration repeats the same steps on the transformed model. The Cochrane-Orcutt procedure keeps running these iterations until the estimated ρ differs very little compared to the previous iteration. After all of the iterations, the coefficient and autocorrelation adjusted t-stat are estimated.

A1: Portfolio formation results excluding penny-stocks (PRC<$5 or MCAP<$50 mill.)

		Alpha		*MKT - RF*		*SMB*		*HML*		*MOM*		*PMU*		R^2
		Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	
STD of REV/AT	1 (L)	0,12 %	2,01	0,86	68,57	-0,20	-11,39	0,06	2,91	0,01	1,05	-0,04	-1,61	91 %
	2	0,03 %	0,48	0,95	77,52	-0,16	-8,96	0,03	1,56	0,04	3,59	0,16	6,96	93 %
	3	0,10 %	1,84	1,02	77,50	-0,05	-2,71	-0,08	-3,93	0,01	1,11	0,04	1,75	93 %
	4	0,11 %	1,54	1,01	64,57	0,02	1,00	-0,11	-4,33	-0,02	-1,11	-0,06	-2,12	91 %
	5 (H)	0,13 %	1,64	1,03	55,99	0,20	7,62	-0,14	-4,69	-0,08	-4,46	-0,07	-2,07	89 %
	LS (L-H)	**-0,01 %**	**-0,06**	**-0,17**	**-6,99**	**-0,41**	**-11,48**	**0,20**	**5,05**	**0,09**	**3,78**	**0,04**	**0,82**	**37 %**
	LS B (L-H)	0,21 %	1,61	-0,18	-5,95	-0,37	-6,34	0,12	2,42	0,01	0,30	-0,06	-1,01	24 %
	LS S (L-H)	0,13 %	1,44	-0,23	-14,13	-0,18	-3,13	0,13	4,34	0,04	2,03	-0,29	-8,85	51 %
STD of GP/AT	1 (L)	0,17 %	2,72	0,85	62,55	-0,22	-11,18	0,12	5,37	0,02	1,56	-0,17	-6,58	89 %
	2	0,06 %	1,02	0,92	70,14	-0,11	-6,01	0,08	3,86	0,02	1,62	0,09	3,77	91 %
	3	0,04 %	0,58	0,98	68,42	-0,08	-4,06	0,06	2,59	0,05	3,55	0,09	3,50	91 %
	4	0,08 %	1,24	1,02	64,58	-0,01	-0,23	-0,14	-5,62	-0,01	-0,81	0,03	1,18	91 %
	5 (H)	0,19 %	2,79	1,03	63,82	0,10	4,24	-0,30	-11,46	-0,05	-2,98	0,05	1,86	92 %
	LS (L-H)	**-0,02 %**	**-0,22**	**-0,18**	**-7,90**	**-0,32**	**-9,74**	**0,42**	**11,37**	**0,07**	**3,14**	**-0,22**	**-5,20**	**51 %**
	LS B (L-H)	0,19 %	1,88	-0,16	-6,56	-0,14	-2,72	0,35	8,39	0,08	3,50	-0,21	-4,31	48 %
	LS S (L-H)	0,01 %	0,15	-0,30	-16,04	-0,22	-3,26	0,50	14,69	-0,05	-1,86	-0,12	-3,12	67 %
STD of E/BE	1 (L)	0,12 %	1,89	0,86	61,06	-0,21	-10,42	0,07	3,03	0,01	0,48	0,17	6,69	89 %
	2	0,05 %	1,10	0,94	82,34	-0,13	-7,88	-0,03	-1,59	0,01	0,55	0,06	2,91	94 %
	3	0,15 %	2,47	0,96	71,56	-0,11	-5,71	-0,08	-3,45	0,03	2,06	-0,07	-3,00	92 %
	4	0,03 %	0,51	1,01	68,04	0,00	-0,04	-0,03	-1,15	-0,03	-2,13	-0,06	-2,08	91 %
	5 (H)	0,09 %	1,11	1,10	64,08	0,20	8,16	-0,15	-5,32	-0,04	-2,18	-0,09	-2,90	91 %
	LS (L-H)	**0,03 %**	**0,29**	**-0,24**	**-9,55**	**-0,41**	**-11,46**	**0,22**	**5,32**	**0,04**	**1,81**	**0,26**	**5,61**	**41 %**
	LS B (L-H)	0,21 %	1,69	-0,20	-7,17	-0,45	-8,05	0,18	3,72	0,02	0,62	0,23	4,21	29 %
	LS S (L-H)	0,06 %	0,55	-0,37	-18,21	-0,25	-3,44	0,36	9,54	-0,05	-1,67	0,29	6,87	62 %
STD of CF/BE	1 (L)	0,09 %	1,67	0,91	75,16	-0,20	-11,45	0,05	2,51	0,03	2,53	0,07	3,12	92 %
	2	0,06 %	1,03	0,93	74,83	-0,12	-6,59	-0,08	-4,01	0,02	1,67	0,01	0,50	93 %
	3	0,11 %	1,97	0,97	74,20	-0,04	-2,33	0,04	2,05	-0,03	-2,64	0,08	3,54	93 %
	4	0,06 %	1,14	0,98	78,41	0,02	1,28	-0,04	-2,08	-0,02	-1,39	0,00	0,07	94 %
	5 (H)	0,20 %	2,69	1,07	65,64	0,16	7,06	-0,21	-7,74	-0,02	-1,36	-0,18	-5,82	92 %
	LS (L-H)	**-0,12 %**	**-1,28**	**-0,16**	**-7,47**	**-0,36**	**-11,98**	**0,26**	**7,46**	**0,06**	**2,63**	**0,25**	**6,39**	**42 %**
	LS B (L-H)	0,05 %	0,57	-0,10	-4,29	-0,45	-9,55	0,19	4,89	0,01	0,60	0,21	4,60	29 %
	LS S (L-H)	0,03 %	0,38	-0,25	-15,77	-0,19	-3,29	0,37	12,30	-0,02	-0,81	0,37	11,26	63 %

		Alpha		*MKT - RF*		*SMB*		*HML*		*MOM*		*PMU*		R^2
		Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	
BETA of REV/AT	1 (L)	0,07 %	0,93	1,00	60,93	0,02	0,67	0,07	2,46	0,06	3,82	0,23	7,56	90 %
	2	0,15 %	2,52	0,90	70,29	-0,18	-9,58	0,02	0,84	0,02	1,75	0,02	0,86	91 %
	3	0,08 %	1,39	0,92	72,46	-0,16	-8,59	-0,01	-0,57	0,00	0,34	0,00	-0,10	92 %
	4	0,06 %	0,98	0,98	75,39	-0,05	-2,95	-0,02	-0,88	0,01	0,98	0,09	3,60	93 %
	5 (H)	0,14 %	1,51	1,00	49,22	0,08	2,70	-0,20	-6,03	-0,09	-4,37	-0,21	-5,61	86 %
	LS (L-H)	**-0,07 %**	**-0,55**	**0,00**	**0,00**	**-0,07**	**-1,58**	**0,27**	**5,69**	**0,15**	**5,19**	**0,44**	**8,44**	**16 %**
	LS B (L-H)	0,10 %	0,84	-0,03	-1,02	-0,11	-1,63	0,25	4,68	0,12	4,15	0,43	6,77	11 %
	LS S (L-H)	0,29 %	2,87	0,00	-0,12	-0,10	-1,52	-0,09	-2,87	0,16	6,87	0,07	1,83	11 %
BETA of GP/AT	1 (L)	0,21 %	2,99	0,98	59,04	-0,05	-2,02	-0,09	-3,27	0,09	5,15	0,12	3,90	89 %
	2	0,11 %	2,07	0,90	72,40	-0,16	-8,96	0,04	1,95	0,04	3,40	-0,02	-0,70	92 %
	3	0,06 %	0,98	0,92	71,07	-0,13	-6,95	0,09	4,26	0,00	-0,36	-0,06	-2,70	91 %
	4	0,12 %	2,12	0,94	75,01	-0,08	-4,39	0,02	1,15	0,01	0,95	0,06	2,56	93 %
	5 (H)	-0,02 %	-0,36	1,02	63,24	0,06	2,45	-0,16	-6,31	-0,09	-5,83	0,04	1,31	91 %
	LS (L-H)	**0,24 %**	**2,16**	**-0,04**	**-1,60**	**-0,11**	**-2,79**	**0,08**	**1,75**	**0,18**	**6,73**	**0,08**	**1,65**	**11 %**
	LS B (L-H)	0,36 %	3,29	-0,05	-1,80	-0,19	-3,33	0,02	0,50	0,15	5,84	0,09	1,63	10 %
	LS S (L-H)	0,21 %	2,17	-0,05	-2,82	-0,07	-1,23	0,00	-0,07	0,03	1,33	0,00	-0,03	2 %
BETA of E/BE	1 (L)	0,15 %	2,24	0,97	64,74	-0,08	-3,75	-0,02	-1,01	0,03	2,18	0,06	2,19	90 %
	2	0,14 %	2,48	0,89	72,17	-0,15	-8,43	-0,05	-2,50	0,00	-0,13	0,05	1,98	92 %
	3	0,06 %	1,04	0,92	65,43	-0,14	-6,81	0,08	3,60	0,04	2,52	0,14	5,45	90 %
	4	0,08 %	1,26	0,97	69,01	-0,07	-3,28	-0,03	-1,22	-0,01	-0,84	-0,02	-0,96	92 %
	5 (H)	0,06 %	0,68	1,08	55,94	0,15	5,52	-0,13	-3,93	-0,09	-4,51	-0,15	-4,20	89 %
	LS (L-H)	**0,08 %**	**0,62**	**-0,10**	**-3,77**	**-0,23**	**-5,82**	**0,10**	**2,31**	**0,12**	**4,47**	**0,21**	**4,12**	**16 %**
	LS B (L-H)	0,19 %	1,46	-0,11	-3,76	-0,40	-6,79	0,05	1,01	0,09	3,53	0,16	2,68	17 %
	LS S (L-H)	0,36 %	3,40	-0,14	-7,47	-0,10	-1,51	-0,04	-1,12	0,11	4,45	0,04	1,14	15 %
BETA of CF/BE	1 (L)	0,08 %	1,24	0,99	65,86	0,06	2,94	-0,09	-3,61	0,03	1,80	0,02	0,72	91 %
	2	0,06 %	1,06	0,96	71,67	-0,15	-7,94	-0,06	-2,82	0,01	0,95	0,02	1,01	92 %
	3	0,15 %	2,96	0,93	70,24	-0,13	-6,68	0,03	1,43	0,01	0,71	0,08	3,16	92 %
	4	0,05 %	0,90	0,93	71,90	-0,11	-6,07	0,00	-0,09	0,00	-0,23	0,04	1,63	92 %
	5 (H)	0,19 %	2,62	1,03	60,18	0,09	3,78	-0,09	-3,28	-0,09	-5,42	-0,19	-6,12	90 %
	LS (L-H)	**-0,11 %**	**-1,04**	**-0,05**	**-1,94**	**-0,03**	**-0,78**	**0,01**	**0,17**	**0,12**	**4,71**	**0,22**	**4,70**	**9 %**
	LS B (L-H)	-0,05 %	-0,43	-0,04	-1,30	-0,13	-2,41	0,10	2,11	0,10	4,20	0,26	4,91	9 %
	LS S (L-H)	0,11 %	1,16	-0,07	-3,91	-0,08	-1,29	-0,01	-0,40	0,05	2,36	0,16	4,51	7 %

A2: Sub-period regressions excluding penny-stocks (PRC < $5 or MCAP <$50)

Sub-period	LS portfolio (Dep. variable)	*Alpha*		*MKT - RF*		*SMB*		*HML*		*MOM*		*PMU*		R^2
		Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	
Post 1995	SD of REV/AT	0,28 %	2,35	-0,28	-10,45	-0,24	-6,79	0,21	5,86	0,11	5,12	-0,28	-5,54	56 %
Pre 1995	SD of REV/AT	0,12 %	1,05	-0,14	-5,98	-0,44	-12,06	0,13	2,69	0,06	2,07	-0,01	-0,23	52 %
Post 1995	SD of GP/AT	0,16 %	1,22	-0,31	-9,69	-0,45	-10,72	0,60	13,99	0,08	2,89	-0,14	-2,33	70 %
Pre 1995	SD of GP/AT	0,18 %	1,62	-0,18	-7,71	-0,45	-12,06	0,29	6,12	0,01	0,21	-0,22	-4,64	68 %
Post 1995	SD of E/BE	0,16 %	1,27	-0,33	-10,82	-0,46	-11,67	0,47	11,56	0,07	2,91	0,29	5,11	72 %
Pre 1995	SD of E/BE	0,28 %	1,66	-0,27	-9,08	-0,60	-12,57	0,17	2,79	0,00	0,11	0,38	6,01	56 %
Post 1995	SD of CF/BE	0,04 %	0,36	-0,26	-9,29	-0,36	-9,84	0,39	10,48	0,06	2,39	0,33	6,49	67 %
Pre 1995	SD of CF/BE	0,15 %	1,53	-0,19	-8,98	-0,47	-13,97	0,32	7,65	-0,02	-0,55	0,39	9,08	65 %
Post 1995	BETA of REV/AT	0,03 %	0,28	-0,12	-3,96	0,05	1,33	0,19	4,56	0,09	3,49	0,17	3,00	22 %
Pre 1995	BETA of REV/AT	0,13 %	1,13	0,05	2,15	-0,11	-2,88	0,00	0,08	0,12	3,83	0,27	5,46	20 %
Post 1995	BETA of GP/AT	0,15 %	1,39	-0,07	-2,55	-0,04	-1,16	0,21	5,54	0,08	3,51	0,21	4,02	24 %
Pre 1995	BETA of GP/AT	0,33 %	3,11	0,01	0,47	-0,14	-3,79	-0,15	-3,12	0,07	2,12	-0,12	-2,47	14 %
Post 1995	BETA of E/BE	0,02 %	0,13	-0,21	-7,23	-0,17	-4,56	0,05	1,22	0,02	1,02	0,14	2,63	34 %
Pre 1995	BETA of E/BE	0,20 %	1,31	-0,01	-0,44	-0,12	-2,76	0,09	1,49	0,15	3,95	0,13	2,20	8 %
Post 1995	BETA of CF/BE	-0,02 %	-0,23	-0,18	-7,34	-0,05	-1,44	0,01	0,41	0,04	2,09	0,23	5,03	35 %
Pre 1995	BETA of CF/BE	0,00 %	-0,04	0,05	2,14	0,00	0,03	-0,09	-2,10	0,07	2,47	0,00	0,09	9 %