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Financial Economics

Master Thesis

Quality Dynamics in a Dynamic Economy

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Rotterdam, 2019

Abstract

This research paper studies the quality factor within U.S equity markets from 1962 through 2018. Quality is a market characteristic that has explanatory power on the cross section of expected returns, often exhibiting high risk-adjusted returns and consistent benchmark outperformance when orchestrated as an investment strategy. The investigation of quality through the scope of portfolio analyses, linear regressions and fixed-effects models gives license to this study to critique the presence, pricing and dimensional drivers of the factor. The research affirms that a robust quality factor exists within the sample universe, and further provides convincing evidence entailing the drivers of this factor to be dynamic throughout the economic cycle. This inspection ultimately positions the quality factor as an anomalous market characteristic that independently, and simultaneously, captures profitability and safety fundamentals conditional on the surrounding economic environment.

Contents

1 Introduction

Research in the domain of factor investing is vast, detailing a wide range of market characteristics, many of which exhibit traits that cannot be reconciled with the Efficient Market Hypothesis. These factors are known to hold explanatory power on the cross section of expected returns, and are thus of great importance to researchers and practitioners alike. Interestingly, many of the factors that have been identified in academic publications corroborate to an idea of capturing assets that are of high calibre. This has resulted in a proliferation of studies and investment strategies that are established on foundations laid with subjective perspectives of high-grade assets. One of the most puzzling of these factors is therefore one of composite quality.

The literature presents a comprehensive collection of factors that seek to characterize the quality of a stock, many of them expressed solely through one fundamental measure or a collection of likewise fundamentals. This presents a situation in which a universally agreed upon definition of quality is lacking in financial literature, thus incentivising research to identify a common inclusive quality classification. The concept of a quality factor is further complicated by a variety of explanations posed for its persistence within financial markets, along with a non-existent clarification pertaining to the drivers of its performance in the field of investments. Such considerations have led to the motivation of this particular research endeavour.

The aim of this research paper is to identify the presence and performance of a composite quality factor in U.S equity markets, address its coherence with efficient market beliefs and finally determine the drivers of its performance. The defining research question of the study is to ascertain if the drivers of the quality factor are dynamic throughout the economic cycle. This research question allows the study to submit a deeper understanding of the nature of quality factor, and aid in the refinement of its definition. The culminating objective of the paper is therefore to identify and catalogue these drivers in order to remedy the research statement posed.

The research of Asness, Frazzini & Pedersen (2013), Daco (2018) and Novy-Marx (2013) explore the presence of multidimensional quality factors in financial markets through the deployment of portfolio analyses. These analyses allow the authors to capture the performance of various quality definitions, and therefore document their relationship with expected returns. These authors deploy both hypothetical and simple economic indicators to further test for the factors consistency in expanding or contracting economic environments.

This study examines a multidimensional quality factor through a similar quantitative method, yet expands upon the definition of quality by creating a factor that encapsulates 20 balanced fundamental measures spanning 4 dimensions. This allows the research to assess an extensive composite quality factor on an broader scale that previously documented, thus moving research closer to a universal definition of the factor. Moreover, this study imparts precise economic indicators on the model in order to inspect the presence and performance of the factor in various economic states. This expansion upon prior studies allows the paper to attain a more detailed scope of the factors performance. In essence, these extensions permit the study to offer a new robust definition of the quality factor upon which further research can be built, along with providing an intensive assessment of the factor throughout various stages of the economic cycle, which until this point was a novelty in the literature.

While Asness et al. (2013), Daco (2018) and Novy-Marx (2013) identify strong performance with regards to the quality factor, the literature does not present a resolution to the drivers of such performance. The central tenet of this study is to tackle this unanswered question. This is achieved through a fixed-effects model that appraises the relationship between the quality factor and its dimensional drivers. The model is imparted with the economic indicators to critique how these interactions behave contingent of the surrounding environment, thus allowing the research question to be answered, and the drivers of the factor to be catalogued. This innovation in the methodology highlights a new aspect of the factor to be explored in future research, along with providing evidence previously not established in the literature.

The portfolio analyses carried out in this study indicate that a compound quality factor is present in U.S equity markets, exhibiting risk-return relationships that cannot be reconciled with theories of efficient markets. These findings lend support to the foundational papers upon which this study is motivated, in which the quality factor is depicted as a market anomaly (Asness et al. 2013; Daco, 2018; and Novy-Marx, 2013). The portfolio analyses in this study further elaborates on the work of the authors by suggesting the factors persistence and performance holds throughout periods of economic expansion, recession, depression and recovery.

The results regarding the linear regression involving the requisite asset pricing models imply that the quality factor identified in this study is indeed a pricing anomaly. In this sense the nature of the pricing of quality stocks does not capture the subsequent high performance of high quality stocks, and the low performance of low quality stocks. These results correspond to the findings of Asness et al. (2013), indicating that a broader definition of a composite quality factor remains unexplained by risk-based justifications.

The results pertaining to the fixed-effects model reveal that the profitability dimension of quality drives its performance when considering a sample-wide analysis of the factor. Despite this, the model identifies that both the profitability and safety dimensions contribute to the factor both independently and simultaneously, throughout the economic cycle. Essentially, these findings report a solution to the research question posed in the paper. This advocates that a true composite quality factor is dynamic in its nature, possessing the ability to capture profitability and safety characteristics while holding explanatory power on the cross section of expected returns.

The remainder of the paper is carried out as follows. Section 2 contains the Literature Review, in which research that has been conducted regarding factors in finance, the quality factor and the economic cycle is documented. This section is finalized with the formulation of the research hypotheses. Section 3 is the Data segment of the paper, which catalogues the sample characteristics and databases used to carry out the study, along with the construction of the variables required for analyses. Section 4 presents the Methodology established for the analysis of the presented hypotheses, as-well as detailing the relevant Robustness Checks. Section 5 reports the Results of these analyses, while Section 6 is laid out for the Discussion of the findings and implications revealed from such analyses. Section 7 is the Conclusion of the research paper. Section 8 and 9 record the References and Appendix used for the study.

2 Literature Review

2.1 Factors in Finance

The question of what drives stock returns has been a topic of discussion in financial literature since its inception. One of the oldest models of stock returns is the Capital Asset Pricing Model (CAPM), which became a foundation of modern financial theory throughout the 1960s (Lintner, 1965, Mossin, 1966, Sharpe, 1964 and Treynor, 1966). This model proposes that the drivers of stock returns are systematic and idiosyncratic risk, because systematic risk cannot be diversified away investors are compensated for the risk borne from their market sensitivity. Research on this topic continued with the introduction of the Arbitrage Pricing Theory (APT), which models expected stock returns through multiple factors (Ross, 1976). A factor is a characteristic of a selection of securities that is strongly related to the risk and return of these stocks. Research implies that factors must exhibit consistency over long periods in order to be significant in explaining expected returns (Bender, Briand, Melas & Subramanian, 2013), and can be categorized as macroeconomic, statistical or fundamental in their nature. Interestingly, the theory of Ross (1976) does not directly state what these characteristics are, insinuating that such forces are likely to be dynamic over time.

Improvements in financial reporting and technological computational power has strongly contributed to the collection of factors identified in the finance literature. Haugen & Heins (1972) recognized a negative risk-return relationship between U.S stocks, implying that low volatility equities outperformed their high volatility counterparts, this became known as the low volatility factor. The research of Stattman (1980) documents the presence of a value factor, which refers to the tendency of high book-to-market value stocks to outperform low book-to-market growth stocks. Banz (1981) identified the size factor, arguing that smaller firms have higher risk adjusted returns than larger firms. Fama & French (1992) later confirm the legitimacy of these findings. Jegadeesh & Titman (1993) discovered that firms that have performed well relative to peers in the near past, tend to continue to outperform in the near future, this factor is known as momentum.

The research of Harvey, Liu & Zhu (2013) posit that 316 factors have been tested relative to the date of their study, and assuming a constant rate of discovery, the authors estimate that over 600 factors will be identified by the end of the next two decades. This plethora of findings forms what Cochrane (2011), characterizes as a "zoo of factors", one of the most interesting of these being the quality factor.

2.2 The Quality Factor

Since Graham (1965) there has been a long industry tradition of investing in quality stocks to generate strong investment performance. Despite the roots of quality being traceable to the early foundations of financial literature, the research regarding a quality factor is relatively new (Bouchaud, Ciliberti, Landier, Simon & Thesmar, 2016). A quality factor is a characteristic of a grouping of stocks that explains the risk and return of these stocks. Quality is generally constructed using an array of accounting fundamentals. Asness et al. (2013) define quality as "characteristics that investors should be willing to pay a higher price for, everything else equal", in essence aspects of a firm that induces its stocks to be attractive to investors. These characteristics indicate the out-performance of high quality stocks relative to low quality stocks, and the inability of models to recognize such superior performance in the price of high quality stocks. The quality factor is therefore related to expected returns.

The research regarding this factor focuses on a variety of different indicators of quality. In contrast to factors that have been readily introduced in Section 1 of the literature review, quality lacks a clear and universally accepted definition. This is a product of the subjective nature involved in defining a quality characteristic, along with the scope of available and viable definitions (Daco, 2018). For instance, an investor may consider the credit ratings, corporate governance, ethical standards or the general financial strength of a stock, either individually or simultaneously, in order to define quality (Damodaran, 2016). This section of the review will therefore explore the ways in which quality can be measured, thus determining the best approach for examining the factor

2.2.1 Individual Measures of Quality

The literature review identifies a number of studies that recognize the existence of a quality factor through the lens of an individual fundamental measure. Novy-Marx (2013) provides evidence that stocks that rank highly in terms of gross profits-to-assets outperform those with weaker a measure. Hou, Xue & Zhang (2015) highlight that high ROE stocks earn on-average, higher returns than low ROE stocks. Mohanram (2005) indicates that the same holds true for analyzing the growth features of stocks. Frazzini & Pedersen (2014) identify that stocks with low beta outperform those with higher a higher market sensitivity, while a similar pattern is found for stocks with low leverage (George & Hwang, 2010). In a similar vein, the research of Altman (1968) and Ohlson (1980) posits that stocks with low credit risk characteristics outperform stocks with high credit risk. Moreover, stocks that have high accruals tend to under-perform peers with low accruals (Sloan, 1996). Baker & Wurgler (2002) show that stocks that repurchase outperform those that don't.

Each of these measures relate a certain market characteristic, such as a stocks profitability, growth, safety or management expressed through a single measure, to the overall quality of a stock. These individual measures capture a subjective view of quality, offering a sole insight to the performance of the specific factor. Thus, while these measurements can capture quality, they do so through one dimension, therefore such measurements do not comprehensively define a quality factor, rather a dimensional one that may relate to one aspect of quality.

2.2.2 Multidimensional Measures of Quality

In order to eschew the limitation of focusing on a sole dimension of quality, modern research pertaining to the factor implies that a quality stock should be defined as one that simultaneously exhibits various aspects, or dimensions, that relate to quality (Asness et al. 2013). This method used to define the factor thus incorporates a multitude of measures in order to capture an overall quality characteristic.

The use of multidimensional quality methodologies is strongly supported in the literature. The research of Graham (1973) aims to capture quality and value investments simultaneously, proposing a number of quality criteria that investors must consider when seeking such investments. Novy-Marx (2014) expands upon these criteria to form an overall quality score which can be assigned to stocks. The score encapsulates the financial safety and stability, earnings quality and payout capabilities of stocks to form this score. The financial strength score proposed by Piotroski (2000) is similar to the initial study of Graham, in the sense that is aims to exploit value and quality at once. Since high BM firms tend to be financially distressed (Fama & French, 2005), the quality score is based on financial strength indicators in order to maximize efficiency, such as profitability, operating efficiency, liquidity and leverage fundamentals. The study of Grantham (2004) considers low leverage, high profitability, and low earnings volatility as quality dimensions, and implies that stocks which exhibit these characteristics are likely to outperform those who display lesser measures. Asness et al. (2013) identify a quality stock through the manipulation of the Gordon Growth model, defining quality with profitability, growth, safety and payout dimensions. These dimensions are computed through a multitude of fundamentals relating to the characteristics they reflect. The findings of this paper suggest the presence of a global quality factor.

This method of analyzing a quality factor allows researchers to shift their focus from analyzing one dimension of a quality, and allows them to assess the presence of a factor that encompasses a variety of relevant characteristics, and thus a true composite quality factor.

2.3 Explanations of Quality

A vast range of research focuses on explaining the presence of factors that are well documented in the literature. Despite this, the relative infancy of the quality factor and its inherent subjectivity has restricted research that aims to identify reasons for its presence. Moreover, the multidimensional nature of true quality renders it difficult to classify with a unified explanation, prompting critics to argue that quality cannot be deemed as a single risk factor, rather a combination of various risk factors and behavioural biases (Daco, 2018). This section of the literature will review some of the statistical, risk-based and behavioural explanations for the presence of the quality factor that have been put forward by researchers. This provides the research with a comprehension of why the quality factor persists.

2.3.1 Statistical Explanations

Several papers suggest that the presence of a multitude of factors identified in the literature are simply a result of the measurement errors, data mining and methodological bias that are linked to empirical analysis. Research indicates that in examining pricing anomalies, often only the most significant and attractive results are published, exposing findings to data mining concerns (Lo & MacKinlay, 1990 and Black, 1993). This notion is supported by Harvey, Lui & Zhu (2016), who argue that such data mining issues render conventional statistical significance no longer adequate to support findings. When considering quality specifically, it is evident that its multidimensional nature may expose it to measurement error, while also imparting an over-fitting bias upon results, meaning that the combination of multiple individual measures that generate high returns will naturally predict high returns (Novy-Marx, 2013). Such findings imply that there is no quality factor present in financial markets, insinuating that it is simply an outcome of data manipulation.

2.3.2 Risk Based Explanations

Research in support of the Efficient Market Hypothesis propose a risk-based view, in which the presence of the quality factor can be explained by a form of systematic risk that explains the high returns of quality stocks. In this case, high quality stocks would generate high returns because the investor would be exposed to a quality related risk in which they are compensated for with a quality premium (Bouchaud et al. 2016).

Well known risk factor strategies reward investors for taking negative skewness risk. In essence this means investing in stocks that have a high propensity to perform poorly, for example size stocks. On the contrary, quality factor strategies are found to have a positive skewness, with a very small likelihood of under-performing (Bouchaud et al. 2016). Thus, a plausible risk based explanation has not yet fully reconciled why high quality stocks earn higher returns and are less risky, when compared to low quality stocks. However, a number of studies have presented explanations for the presence of the quality factor. The research of Bouchaud et al. (2016) posits a possible solution for the presence of the quality factor. The authors note that stocks with high average cash-flow to assets fundamentals might indicate that their corresponding firms are operating on profitable but risky segments of the economy, thus investors are compensated for this risk by the quality premium. Zhang (2005) reinforces the risk based view by positing that the large investments that are made by quality firms are often costly to reverse, again allowing investors to be compensated by the quality premium.

2.3.3 Behavioural Explanation

The behavioral viewpoint of factor premiums takes an approach in which the behavior of investors is irrational and subject to bias, thus creating anomalous patterns in the stock market that contradicts the Efficient Market Hypothesis. The cornerstone of this view is the work of Kahneman & Tversky (1979), this led to an expansion of studies that aim to explain the presence of anomalous market factors through human cognition and behavior. The research dedicated to this viewpoint has yielded a variety of explanations for the existence of factor premia, such as socioeconomic and psychological factors (Kumar, 2009). The behavioral viewpoint also assumes that limits to arbitrage prevent investors from correcting market inefficiencies, thus allowing for anomalous market factors to persist (Hong & Sraer, 2012).

Considering the quality factor, the research of Bouchaud et al. (2016) indicates that the persistence of the quality factor may be due to the misplaced focus of investors. In this argument, the authors propose that investors systematically under-weigh important market indicators in favor of more salient forms of information, thus incorporating only certain information when forming their beliefs, and allowing anomalous quality factor returns to remain in the market. In a separate study the authors propose that the conservatism bias, in which individuals insufficiently update their priors, leads to a price under-reaction to good or bad news (Bouchaud, Krueger, Landier & Thesmar, 2019). The study reveals that analysts are pessimistic regarding the returns of highly profitable stocks, and that the profitability anomaly is more persistent for stocks followed by analysts who update their beliefs conservatively.

2.4 Quality Investing

As exhibited, a large body of literature has identified certain factors that are related to the risk return relationship of stocks, many of these producing a greater performance that the broad market index (Ang, Hodrick, Xing, Xing & Zhang, 2013). Such factors are considered good candidates for factor investment strategies, as they have historically produced factor premiums realized in the risk-return relationship of these stocks when sorted on the factors characteristic (Bender et al. 2013). Factor investing is the investment process which seeks to identify factors that are rewarded with superior risk-adjusted performances, from which the investor can then harvest premia through exposure to factor itself. Such strategies are designed with a long position and a corresponding short position that reflects the nature of the factor, for instance assuming long positions in over performing assets and short positions in the under-performing assets relative to the factor (Ang et al. 2013). This strategy allows investors to make an absolute return based on the out-performance of one asset over another (Blitz, 2016).

With regards to quality, a vast literature supports the implementation of such quality based investment strategies. Pillars in the quality literature, such as Graham (1965), Greenblatt (2006) and Grantham (2004) have issued belief in strategies that revolve around quality investments. For example, the research of Novy-Marx (2014) highlights that the definition of quality provided by Grantham (2004) has motivated the Morgan Stanley Capital International (MSCI) quality index. "The Little Book that Beats the Market" further issues attraction to the art of quality investing (Greenblatt, 2006). Moreover, the deployment of these strategies have been shown to be highly correlated to the performance of the mutual fund industry (Van Gelderen & Huij, 2014), and can even be largely attributed to the success of Berkshire Hathaway (Frazzini & Asness, 2014).

This collection of research highlights the saturation of quality investments strategies across financial markets. Therefore exploring the performance and drivers of such strategies is an interesting analysis to undertake.

2.5 The Economic Cycle

The Economic cycle articulates the evolution of the economy throughout time. The research of Burns (1946) established the standard definition of the cycle, indicating that it is "a type of fluctuation found in the aggregate economic activity". The cycle therefore holds implications for monetary policy, credit availability, profit margins and therefore investment activity (Hamilton 2015). Such sentiment is reflected in the research of Emsbo-Mattingly, Hofschire, Litvak & Lund-Wilde (2017), who note that the fluctuations in activity of an economy can be a critical determinant of equity performance. It is therefore important in this study to identify a comprehensive measure of the economic cycle. Theories citing the movement of the cycle have posited that the economy moves along a wave like shape, experiencing highs and lows in a continuous fashion (Kondratiev, 1925; Schumpeter, 1939 and Kuczynski, 1987) .

While the literature represents a vast scope of measures and definitions of the economic cycle, the 4-stage model proposed by Schumpeter (1939) provides a clean definition of the economic cycle and its phases. The author presents economic expansion as the stage between the middle value of the cycle until its peak, economic recession as the stage between its peak and following mid value, economic depression is categorized as the stage between the latter mid value of the cycle and its trough, and economic recovery is defined as the stage between the trough and the mid value of the cycle. The research of de Groot (2006) identifies the two initial stages of this model as periods in which the economy is in a positive state, while the latter two encompass periods in which the economy is in a negative state. An insight to the manner in which the cycle behaves, along with a comprehension of how to define its stages, is central to assessing the presence and performance of quality, along with its inherent drivers throughout each stage of the economic cycle.

2.6 Quality in the Economic Cycle

The presence of subjective quality factors are strongly indicated in the literature review of Section 2.2,as such a vast amount of research documents the presence of strong performance relating to various quality factors throughout different stages of the economy. This literature is explored to gain an insight to the quality factor in regards to its performance in a dynamic market environment.

Asness et al. (2013) specifically identifies that the quality factor (QMJ) generates high risk adjusted returns in periods of economic upturn and downturn. This finding is supported by Daco (2018), who constructs a similar factor and replicates the high risk-adjusted returns generated by a quality factor portfolio in phases of economic expansion and contraction. Bazgour, Heuchenne & Sougné (2016) indicate that high quality and liquid assets are more desirable during volatile times, lending support to the flight to quality argument in favor of the quality factor. Joyce & Mayer (2012) describe the flight to quality as "knee-jerk movements towards solid fundamentals during tail events", implying that investors tilt their portfolios from low quality to high quality assets in times of economic stress. Such rebalancing has the effect of enhancing the returns to high quality assets due to the inflow of investment, and restricting the returns to low quality assets due to the outflow of investment, thus accentuating the quality factor. This performance could indicate a defensive aspect of characteristics that are related to expected returns. Daco (2018) remarks that quality is conditioned on such flights to quality when the economy experiences stress. In review, these studies reflect that a quality factor should perform well in a dynamic economic environment.

While these studies identify the performance of quality throughout stages of the economy, the definitions used to identify the economic environment are standard, considering only growth and contraction. Moreover, they do not attempt to determine how the drivers of quality, be they individual or multidimensional measures, behave throughout different economic periods.

2.7 Hypothesis Formulation

The literature identifies a wide scope of robust financial factors that have explanatory power on the risk and return relationships present in the stock market (Stattman, 1980; Banz, 1981; Fama & French, 1993 and Jagadeesh & Titman, 1993). In the research of such factors, it is evident that many of them relate to the quality of the underlying firm (Asness et al, 2013; Novy-Marx, 2014; Grantham, 2004; Piotroski, 2000 and Daco, 2018). This implores one to question if an overall quality factor exists in financial markets. This leads to the formation Hypothesis 1.

- Hypothesis 1: A robust quality factor is present in financial equity markets.

While such a hypothesis has both implications for researchers, it is also of interest to determine if the quality factor outperforms a relevant market benchmark. This topic of conversation is directed more toward the benefits for practitioners, who can implement quality-style strategies to generate consistent performance (Ang et al, 2013; Novy-Marx, 2014; Van

Gelderen & Huij, 2014 and Blitz, 2016). Such consideration leads to the forming of the Hypothesis 2

- Hypothesis 2: A quality based investment strategy consistently outperforms the market benchmark.

The review identifies various categories of explanations for the presence of the quality factor in financial markets (Bouchaud et al. 2016; Bouchaud et al. 2019 and Novy-Marx, 2014). While is is not central to the purpose of the paper, it is of importance to identify if the factor can be reconciled with theories of efficient markets. This consideration leads to the development of Hypothesis 3.

- Hypothesis 3: The quality factor is a pricing anomaly in U.S financial equity markets.

The review also identified a number of studies that define quality in various ways, and often through different dimensions (Asness et al. 2013; Grantham, 2004; Novy-Marx, 2014 and Daco, 2018). These dimensions can be combined to produce a composite quality factor. Considering the wealth of literature that defines quality as a single dimension (Novy-Marx, 2013; Frazzini & Pedersen, 2014; Mohanram, 2005 and Baker & Wurgler, 2002), it is of interest in this study to asses if the factor is driven by a single dimension. The study therefore considers if the quality factor is masked as one dimension, thus contributing to the formulation of Hypothesis 4.

- Hypothesis 4: The quality factor is driven by an individual dimension.

The review also provided a wealth of research that supports the strong performance of a quality factor in various economic environments (Asness et al. 2013; Daco, 2018 and Novy-Marx, 2014), therefore it is of interest to consider which dimensions drive the performance of the factor in various stages of the economic cycle. Uncovering variation in the drivers of quality would oppose the conformation of Hypothesis 4, implying that the drivers of this factor are dynamic throughout the market environment. Hypothesis 5 behaves as a counter-hypothesis to Hypothesis 4, thus implying that only one of these statements will hold after the analyses in this paper have been implemented.

- Hypothesis 5: The dimensional drivers of quality are dynamic in a changing economic environment.

These hypothesis reflect questions of interest that have arisen throughout the literature pertaining to the quality factor. The counter argument presented between Hypothesis 4 and

5 implies that the acceptance of either leads to the rejection of the unconfirmed hypothesis, thus this study will assess the five presented hypotheses with the aim of confirming four and rejecting one of the propositions. These hypotheses act as a guide for the ensuing methodology and analyses that will take place in the paper.

3 Data

3.1 Data Sources

The sample universe consists of U.S equities present on the NYSE, AMEX and NASDAQ exchanges from 1962 to 2018 inclusively, producing 2,720,019 observations from 9,896 floated firms. Returns are reported monthly, quoted in U.S dollars and are sourced from the Centre for Research in Security Prices (CRSP) database. The returns have been delisted to account for the returns of stocks that are no longer listed on the exchanges in the sample, restricting the effects of survivorship bias on this study. The sample universe of returns have also been Winsorized to exclude outliers that may distort the analysis, allowing for the generation of conservative findings. Furthermore, portfolio returns used in this study are modelled to incorporate transaction costs. These are created by assuming a quantity of 10 basis points accounts for the costs incurred when a stock moves from one portfolio to another, and are thus computed with portfolio returns to attain returns less transaction costs.

The relative accounting fundamentals that are required to construct the dimensions of quality and the composite quality factor, are reported annually and are retrieved from the merged CRSP-COMPUSTAT database. The Fama-French 3 factor (Fama & French, 1993) and the Carhart 4 factor (Carhart, 1997) models are implored as asset pricing models in the research, the factors inherent in these models is sourced the Kenneth French data library. The economic indicator used to define each of the four stages of the business cycle is the monthly GDP ratio-to-trend, which was obtained from the Organization of Economic Cooperation and Development (OECD) Statistics database.

3.2 Dimensional Scores

The literature reveals a variety of ways in which a quality factor can be measured. This research paper defines quality stocks as those that simultaneously exhibit strong quality dimensions. The profitability, growth, safety and payout dimensions are calculated independently by assigning five measures to each dimension. Each measure is then ranked and standardized to obtain a z-score, allowing the study to calculate a dimension score by averaging the five relevant standardized measures. This reduces noise and issues parity across the measurements used to determine each dimension. The methodology used to construct each dimension is similar to the study of Asness et al. (2013), but is expanded by adding an additional measure to each of the profitability and growth dimensions, while considering two supplementary measures for the payout dimension. If a particular measure suffers from data availability, the average of the remaining measures are used in order to generate as many observations as possible. This methodology provides the study with four composite measure,s each reflecting one dimension of quality; profitability, growth, safety and payout. The scores computed from this section can be used to rank stocks by each dimension. Table 13 in the Appendix reports the summary statistics for these dimensions.

3.2.1 Profitability

The profitability of a stock reflects the sustainable aspect of a firm's profits relative to book-values, and is a characteristic that investors should be willing to pay a premium for. This study combines the research of Hanauer & Huber (2018), Hou et al. (2015), Novy-Marx (2013), Asness et al. (2013) and Ball et al. (2015) in order to create a profitability factor. The measures used to define profitability include high return on assets (ROA), return on equity (ROE), gross profits over assets (GPOA), gross margin (GMAR) and cash flow over assets (CFOA). The profitability dimension score is therefore calculated as;

$$Profitability = zROA + zROE + zGPOA + zGMAR + zCFOA \tag{1}$$

The computation of this measure produces 2,314,785 observations, each detailing the profitability dimension on a stock. These sub-measures used exhibit low to negative correlation amongst one another, ranging from -0.92 to 0.12, indicating the creation of a diverse profitability score. This dimensional profitability factor proposes that stocks which rank highly across a variety of profitability measures will generate high risk adjusted returns relative to stocks that rank lower in these measures.

3.2.2 Growth

The growth of a stock reflects a consistent increase in a firm's sustainable profits relative to book-values, and is a characteristic that a firm should be willing to pay a premium for. This study focuses on the research of Mohanram (2005) to guide the definition of a growth factor. In line with the research of Asness et al. (2013), this study determines growth as the five-year change in residual per-share profitability measures. Therefore, the measures used to define this growth are the five-year change in return on assets (ROA), return on equity (ROE), gross profits over assets (GPOA), gross margin (GMAR) and cash flow over assets (CFOA). The growth dimension score is therefore computed as;

$$Growth = z\Delta ROA + z\Delta ROE + z\Delta GPOA + z\Delta GMAR + z\Delta CFOA \tag{2}$$

The computation of this measure generates 1,526,770 observations, providing a growth characteristic for each stock. The correlations among the sub-measures used are strong and positive, ranging from 0.001 to 0.98, insinuating that a large portion of the growth score may be captured by few of the measures. In this case, the CFOA and GPOA measure display high correlation amongst one another, along with the ROA measure simultaneously. This growth dimension factor implies that stocks which experience consistent and long term growth, outperform those who don't exhibit these characteristics.

3.2.3 Safety

The safety of a stock refers to its ability to generate stable returns and to withstand adverse market conditions, all while behaving as an attractive investment vehicle for market participants. The research of Frazzini & Pedersen (2014), Asness et al. (2013), Altman (1968), Ohlson (1980), George & Hwang (2010) and Ang et al. (2009) contributed to the definition of a safety factor. The measures used to articulate the safety of a stock are low earnings volatility (EVOL), low beta (BAB), a low Ohlson O-score (OHL), a high Altman Z-score (ALT) and low leverage (LEV). A safety dimension score is therefore expressed as;

$$Safety = zEVOL + zBAB + zOHL + zALT + zLEV \tag{3}$$

This composite safety measure generates 2,663,817 observations, each identifying the safety characteristic of a stock. The correlation of the variables deployed in the construction of this score are dramatically low and mostly negative. This indicates that the constructed score represents a diverse safety characteristic. A safety dimension factor implies that firms which exhibit strong defensive fundamentals outperform their counterparts who score poorly in such measures.

3.2.4 Payout

The payout of a stock refers to its ability to generate shareholder dividends and meet debtor obligations. This characteristic should appeal to investors as it illustrates the firm's ability to provide a payout. The measures used to define the payout dimension are motivated by the research of Asness et al. (2013), Sloan (1996) and Baker & Wurgler (2002). These measures include low net equity issuance (EISS), low net debt issuance (DISS), high net payout over profits (NPOP), a high payout ratio (PAY) and low accruals (ACC). The safety dimension is thus calculated as;

$$Payout = zEISS + zDISS + zNPOP + zPAY + zACC \tag{4}$$

The creation of the score generates 2,530,827 observations, each of which individually capture the payout characteristic of an stock. The correlations amongst these variables is low and mostly negative, ranging from -0.0548 to 0.0258. Thus, the composite payout factor represent a diverse and wide ranging payout characteristic. As a payout factor, stocks that exhibit strong management and payout fundamentals should generate higher risk-adjusted returns than stocks that are associated with weak management and payout fundamentals.

3.3 Quality

As mentioned in the Section 3.2, this research defines quality stocks through a multi-dimensional model that considers profitability, growth, safety and payout characteristics simultaneously. In order to determine which stocks simultaneously exhibit strong quality characteristics, a z-score for quality is calculated by taking the average of the four standardized dimensional scores. The quality score is therefore calculated as;

$$Quality = zProfitability + zGrowth + zSafety + zPayout \tag{5}$$

The computation of this composite quality score produces 2,695,147 observations, each in which the overall quality of an stock is identified. The correlation among the quality score and its dimensions are as follows; profitability (0.808), growth (0.686), safety (0.873) and payout (0.807). These statistics imply that composite quality score effectively, and simultaneously, captures a multitude of dimensions which can be used to determine the quality of an asset. The research of Asness et al. (2013) states that these characteristics should influence investors to be willing to pay a higher price for such stocks. Therefore, a quality stock that incorporates these dimensions should also command a higher price. A quality factor implies that high quality firms will generate greater risk-adjusted returns than low quality firms.

3.4 Economic Cycle

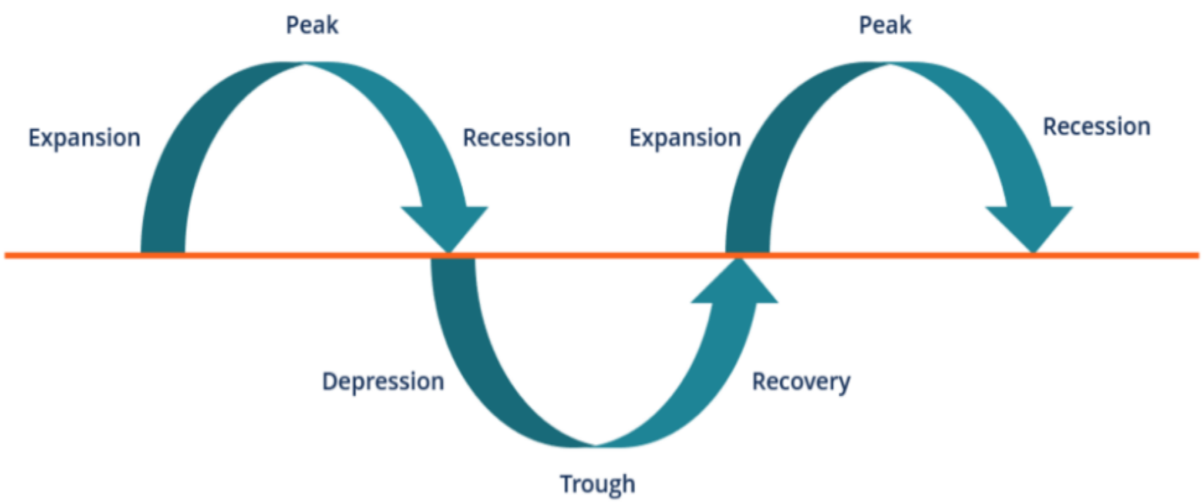
In order to define the evolution of the economy, the study must determine a reliable economic indicator that can identify the four-stage cycle of the economy posited by Schumpeter (1939). The GDP ratio-to-trend, along with its monthly growth, is used in this study to form the indicator variables used in the portfolio analyses and the fixed-effects model.

The GDP ratio-to-trend determines if the economy is in a strong, weak or neutral state. In analyzing the how this indicator changes on a monthly basis, this paper can determine if the economy is also in fact expanding or contracting. By combining the GDP ratio-to-trend and its monthly growth pattern, this research paper can articulate a coherent proxy for Schumpeter's cycle. Establishing economic expansion, recession, depression and recovery indicators provides the research the opportunity to assess the performance of the factor under specific real-world economic scenarios, along with allowing the study to determine if the drivers of the factor are stationary or dynamic throughout these scenarios. The former holds vast implications for the presence of the quality factor, while the latter is central with regards to resolving the research question proposed by this paper.

The economic indicator takes a value of 1 when representing phases of economic expansion, while taking values of 2, 3 and 4 for stages of economic recession, depression and recovery respectively. These indicators constitute one-month periods of the economic environment in the sample universe. A detailed description of how these variables are formed is found in Section 9.2 of the Appendix, which also includes a number of alterations of this definition.

Figure 1: The Economic Cycle.
Imaged below is a graph that outlines the economic cycle and its inherent stages; expansion, recession, depression and recovery. The visual presentation of the cycle and its stages is useful for a comprehension of how the economic indicator variables are complied to define the economic environment for this analysis. The cycle is determined by the GDP trend-to-ratio, and the relative growth of this variable. Combining these two variables allows the economic environment to be determined in a 4 phase cycle, thus allowing the study to replicate an economy in line with that of Schumpeter (1939).

The Economic Cycle



The blue arrows distinguishes the movements of the economic cycle, while the orange line running parallel across the figure represents the mid cycle value. The GDP ratio-to-trend identifies if the economy is above or below this mid cycle value, therefore isolating positive (Expansion and Recession) and negative (Depression and Recovery) economic states. The change in GDP ratio-to-trend determines if the economy is further expanding (Expansion and Recovery) or contracting (Recession and Depression), represented in the figure as the trend between trough and peak or peak and trough. Thus the combination of these variables can be used to construct the cycle as seen above. The stages are thus identified as follows; economic expansion is identified as a positive and expanding economic state, economic recession is a positive and contracting economic state, economic depression is a negative and contracting economic state, and recovery is a negative and expanding economic state.

4 Methodology

4.1 Portfolio Analysis

A portfolio analysis refers to the process of breaking down and studying the details of an investment portfolio in order to determine its makeup and performance. This analysis is deployed to investigate the presence and performance of the quality score constructed in Section 3.3.

Equity portfolios are created by ranking the universe of stocks on their quality score. Stocks are assorted into 10 deciles, each representing 10% allotments of stocks based on this score. Decile 1 represents stocks of the lowest quality, while decile 10 represents those of the highest. The methodology follows that of Fama & French (1992), generating 4 value-weighted portfolios, each re-balanced monthly to account for the movement of stocks across portfolios and to create a liquid set of investments. Portfolio 1 represents stocks in deciles 1-3, capturing the bottom 30% of quality stocks, Portfolio 2 represents stocks in deciles 4-7, capturing the middle 40% of quality stocks and Portfolio 3 represents stocks in deciles 8-10, capturing the top 30% of quality stocks in the sample. Portfolio 4 represents the quality factor portfolio, a risk free investment vehicle that assumes a long position in Portfolio 3, while simultaneously funding this position via a short position in the Portfolio 1. Returns are regressed on the return on the market portfolio, using the Newey-West Estimator to account for heteroskedasticity and auto-correlation. This procedure is carried out on sample-wide and economically defined samples in the data-set.

The portfolio analysis is interpreted by inspecting performance measures such as the Sharpe ratio, the excess return per unit of risk, and Jensen's Alpha, the excess return over the benchmark. These measures determine if the portfolios are in line with efficient markets beliefs, which suggest that high high and consistent Sharpe and Alpha measures are impossible. Reporting strong performance measures implies that quality holds explanatory power on expected returns, and is thus a market anomaly. Such findings would suggest the presence of a quality factor in equity markets, thus contributing to the assessment of Hypothesis 1 and 2.

Hypothesis 1 is also critiqued via Sharpe ratio hypothesis test, in which the Sharpe measures of each portfolio are tested for statistical difference amongst one-another. Large and significant differences between the portfolios would lend further credibility to the reported differences in quality portfolios, thus further evaluating Hypothesis 1.

4.2 Asset Pricing Regression

Asset pricing models aim to determine the fundamental value, and therefore the appropriate return, of an asset (Krause, 2001). In this study, the returns generated by the quality factor are examined under the scope of the Fama-French 3, and the Carhart 4 Factor models.

An Ordinary-Least-Squares (OLS) regression is carried out on the quality factor and the factors inherent to each asset pricing model. In the Fama-French 3 Factor Model, the quality factor, as identified by the quality factor portfolio (Portfolio 4), takes the role of the dependant variable, while the return on the market portfolio, size and value factors take the role of the independent variables. In the Carhart 4 Factor Model, the quality factor, again represented by the quality factor portfolio (Portfolio 4), takes the role of the dependant variable, while the return on the market portfolio, size, value and momentum factors take the form of the independent variables This regressions are expressed as follows;

$$Quality = \alpha_t + \beta_1 MKTRF_t + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_t \quad (6)$$

$$Quality = \alpha_t + \beta_1 MKTRF_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_t \quad (7)$$

The linear regression allows the study to inspect the parameters in a linear relationships between the dependant (Y) and independent explanatory variables (X). The intercept (α) reported by the model is the expected mean of the dependant variable when the independent variable means are 0. This indicates the how much of the dependant variable is not captured by the independent variables. The beta coefficients (β) indicate the change in Y when X changes by 1. The error term (ε) represents the margin of error in the statistical model. The statistical significance of these findings are supported by standard errors and t-statistics.

The beta coefficients reported will indicate the explanatory power that the factors, inherent to the models, hold on the quality factor. Table 11 in the Appendix reports the correlations of these factors with quality. The table implies that the market, size and value factors will hold little relation with quality given their low correlations. Despite this, it is plausible that the momentum factor will display a positive interaction with quality, given its mid-level correlation with the factor. Issuing attention to the intercept allows the study to determine if the these models can effectively capture the pricing of the returns generated by the quality factor portfolio, thus assessing the pricing nature of the quality factor. These linear regression models are designed specifically to test Hypothesis 3.

4.3 Fixed Effects Regression Analysis

A fixed-effects regression is a statistical model designed to determine the relationships between the dependant and independent variables, while controlling for the impact of certain parameters.

The fixed-effects model is deployed in the research in order to evaluate the drivers of the quality factor. In this model, the quality factor, as identified by the quality factor portfolio (Portfolio 4), is regressed on the dimensions of which it consists, namely the profitability, growth, safety and payout scores, which have been designed in Section 3.2. This regression is imparted with four indicator variables, each representing the phases of the economic cycle determined in Section 3.4. The model fixes the effects of firm and time variance characteristics in the data-set, thus allowing the study to asses the net effect of the explanatory variables on the quality factor, insuring results are not corrupted by such parameters. The model is expressed as;

$$Quality = \alpha_t + \beta_1 Profitability_t + \beta_2 Growth_t + \beta_3 Safety_t + \beta_4 Payout_t + \gamma \sum_{i=1}^{4} Stage_i Score_j + \varepsilon_t \tag{8}$$

This fixed-effects model produces a sample-wide analysis in which the indicator variables take no value, and an economically defined analysis, in which each phase of the economic cycle is explored. In this methodology, the intercept (α) and error term (ε) are again of significance when interpreting the output and effectiveness of the model. Importantly, the sign reported on the models beta coefficients (β) indicates either a positive or negative interaction between the quality factor and its dimensional factors, for instance a positive coefficient will imply a positive relationship. The statistical significance of these findings are supported by standard errors and t-statistics. Table 10 in the Appendix reports the correlations between the composite quality score and its dimensional scores. The table records high correlations between the factor and its dimensions, suggesting that the interaction between the dependant and independent variables are likely to be strong and statistically significant.

The fixed-effects model first inspects these empirical relationships on a sample-wide basis, allowing the study to determine how the factor is driven on-average, thus assessing Hypothesis 4. The model then investigates these relationships across the stages of the economy, thus inspecting cycle dependent interactions through the deployment of the dummy variables. This allows the study to address Hypothesis 5, in-turn confirming or rejecting Hypothesis 4, and providing an answer to the research question posed.

4.4 Robustness Checks

This section of the methodology outlines a number of robustness checks that have been implemented in the study. These checks have been designed to test the validity of the results that have been produced in the main findings of the research.

4.4.1 07/08 US Financial Crisis Sample

This robustness check involves analyzing an isolated sub-sample within the data-set, specifically the period surrounding the 07/08 U.S financial crisis. This is carried out to identify if the findings generated from this analysis holds resemblance to those expressed Section 4.3.

The sub-sample consists of one full economic cycle ranging from March 2007 until March 2010, thus producing 36 months for assessment. This cycle includes 10-months of continuous economic expansion, 8-months of continuous recession, 10-months of continuous depression and 8-months of continuous recovery. The structure of this sample allows the study to replicate the methodology explored in Section 4.3, deploying a fixed-effects regression of the quality factor, as defined by the quality factor portfolio (Portfolio 4), on the profitability, safety, growth and payout scores. The model is again imparted with the economic indicators, as previously expressed, in order to critique the dynamics of the drivers of the quality factor.

The sub-sample analysis is designed to form a compact representation of the full data-set, and therefore allows the study to determine if the behavior of the drivers of the quality factor are stationary or dynamic throughout the economic cycle. Essentially assessing if the outcome relating to the fixed-effects model, explored in Section 4.3, are robust to an analyses of a shorter and more volatile period for financial markets.

The intercept (α) and error term (ε) of the model, along with the beta coefficient (β) of each dimension, are central to the interpretation of the outcome of the fixed-effects model. The statistical significance of these findings are supported by standard errors and t-statistics. The purpose of this sub-sample fixed-effects model is to determine the validity of findings related to the drivers of the quality factor throughout the economic cycle, therefore this analysis contributes to the evaluation of Hypothesis 4 and 5.

4.4.2 Alternative Definition of The Economic Cycle

This robustness check involves altering the time frame of the economic indicators in order to create a different classification for each phase of the economic cycle. This is carried out in order to determine if similarities hold between this robustness check, and the analysis explored in Section 4.3.

This check defines each state of the economy by determining the average GDP ratio-to-trend, along with the average of the change in the GDP ratio-to-trend, over 3-trailing months. The economic indicator for each stage of the cycle is then updated using these calculations, conforming to the original economic computation expressed in Section 3.4.

A fixed-effects regression model, identical to that of Section 4.3, is then deployed with the newly defined economic indicators. In this model the quality factor, classified by the quality factor portfolio (Portfolio 4), is regressed upon its dimensions; profitability, growth, safety and payout scores. The new defined dummy variables are imparted to assess cycle dependant loading results for the factors driver, thus determining if a more exhaustive time frame used to identify the economic state holds parallels with the fixed-effects model initially deployed in Section 4.3.

The intercept (α) and error term (ε) reported in the regression allows the research to critique the effectiveness of the model, while the beta coefficient (β) details the relationships between quality and its dimensions. The statistical significance of these findings are supported by standard errors and t-statistics. By re-assessing the fixed-effects model, the study can evaluate if the findings regarding the drivers of the quality factor are robust to using a substitute definition for the stages of the economic cycle. This analysis therefore contributes to the assessment of Hypothesis 4 and 5. An alternate version of this robustness check, that defines the indicators using 6-months of trailing data, is reported in Table 8 of the Appendix.

4.4.3 Principle Components Analysis

This robustness check is concerned with using an alternate approach in the construction of the dimensional factors from which the quality factor is computed. These factors are implemented into statistical model in order to determine if parallels exist between their relationship with the quality factor, and the interactions examined in Section 4.3.

A principle components analysis is conducted for each quality dimension, taking into account the 5 measures of which each dimension consists. This allows the measures to be compounded into a sub-factor that captures variation in the measures of each dimension, thus creating characteristics similar to those of the dimensional scores. The outcomes of these analyses are reported in Table 15 of the Appendix. The sub-factors generated from the principle components analyses are designed to substitute for the original dimensional scores explored in Section 3.3.

A fixed-effects regression model, in line with that of Section 4.3, is deployed on the sample with the newly formed sub-factors. The quality factor, as defined by the quality factor portfolio (Portfolio 4), takes the role of the dependent variable, while each of the factors generated by the analyses are implemented as independent variables. The standard economic indicators are imparted on the model to allow for the assessment of the interaction between the quality factor and its dimensions. The model takes the form of;

$$Q = \alpha_t + \beta_1 P1_t + \beta_2 P2_t + \beta_3 G1_t + \beta_4 G2_t + \beta_2 S1_t + \beta_3 S2_t + \beta_4 PO1_t + \beta_2 PO2_t + \beta_3 + \gamma \sum_{i=1}^{4} Stage_i Score_j + \varepsilon_t \quad (9)$$

The intercept (α) and error term (ε), beta coefficient (β) and statistical significance (standard errors and t-statistics) generated from the fixed-effects model are central to the interpretation of these findings. The aim of this robustness check is to determine if the results related to the drivers of the quality factor in the economic cycle are robust to to an alternative method of constructing the dimensional variables. This check therefore provides further inspection of Hypothesis 4 and 5, specifically through the lens of a principle components analysis.

4.4.4 Dynamic Re-balancing Portfolio Analysis

This robustness check is designed to determine if the findings regarding the drivers of the quality factor can be translated into a cycle-dependant investment strategy that yields high risk-adjusted returns, and outperforms the benchmark portfolio.

A dynamic re-balancing portfolio is constructed to tilt its investments toward specific styles when the economy changes its state, as determined by the economic indicators expressed in Section 3.4. This portfolio continues to hold such investments until the economic environment alters its state again. The tilting of the portfolio is conditioned strictly on the drivers of quality identified in each stage of the cycle. This allows the portfolio to accentuate the positive drivers of quality returns while shunning the dimensions that affect the factors returns negatively, thus streamlining and maximizing the performance of the quality factor.

A portfolio analysis is then carried out in a similar manner to that of Section 4.1, generating monthly value-weighted returns that are regressed on the return on the market portfolio using the Newey-West Estimator to account for heteroskedasticity and auto-correlation. The performance of the long-short re-balancing portfolio can be inspected through the Sharpe ratio and Jensen's Alpha, while the statistical significance of these findings is expressed by a t-statistic. The re-balancing portfolio analysis allows the the research to investigate if the the performance of a quality portfolio can be enhanced by relying on the results presented pertaining to the drivers of the quality factor. In essence, this analysis identifies if the economic cycle-dependant portfolio outperforms the quality factor portfolio (Portfolio 4), as identified in Section 4.1 of the methodology.

Given such composition, it is expected that the dynamic re-balancing portfolio will outperform the quality factor portfolio. Recording greater Sharpe and Alpha measures in the re-balancing portfolio would imply that this portfolio does indeed outperform the quality factor. This analysis holds vast implications for practitioners, who in understanding the drivers of factor performance, can generate efficient and effective investment strategies that outperform traditional vehicles. Given its conditioning on the dynamic loading pattern of quality dimensions, this portfolio could, under assumption, be considered a true representation of a dynamic quality factor. In this case, recording a strong performance in the re-balancing portfolio, above that of the quality factor, would aid in the evaluation of Hypothesis 1, 2, 4 and 5.

5 Results

5.1 Portfolio Analysis

This section of the paper presents the results for the portfolio analysis as outlined in Section 4.1. The results pertaining to Portfolios 1 through 4 are expressed in Table 1.

Panel A displays the results for a portfolio analysis carried out over the whole sample universe of U.S stocks from 1962 through 2018. The results show that Portfolio 1 generates a low Sharpe ratio of 0.021. Moreover, this portfolio generates a small negative Alpha of -0.004, which is statistically significant. The monthly Sharpe ratio of 0.10 pertaining to Portfolio 2 highlights that mid quality stocks outperform low quality stocks, specifically with regard to the returns generated per unit of risk. The Alpha relating to this portfolio is negative, yet to a lesser extant than that of Portfolio 1, despite the results being statistically insignificant. The monthly Sharpe ratio of 0.18 recorded in the results for Portfolio 3 insinuates that high quality stocks outperform those of lower or mid-level quality. The portfolio also presents a positive and statistically significant Alpha. A Sharpe ratio of 0.32 recorded in the results for Portfolio 4 implies that the portfolio on average generates high risk-adjusted. Furthermore, a positive Alpha of 0.0024 specifies that this portfolio consistently outperforms the benchmark, this is supported by a t-statistic of 7.74.

Panel B presents results for a portfolio analysis across each stage of the economic cycle. The inclusion of economic expansion, recession, depression and recovery phases allows the study to assess if the quality factor identified in Panel A can be confirmed throughout each stage of a dynamic economy. Across these portfolio analyses it is evident that Portfolio 3 consistently produces positive Sharpe ratios ranging from 0.214 to 0.427, excluding negative and insignificant results presented in periods of economic recession. These portfolios generate higher return per unit of risk than the low and mid-level quality portfolios (Portfolio 1 and 2). Similar results hold regarding the respective Alphas produced by these portfolios. Portfolio 4 in Panel B illustrates monthly Sharpe ratios of 0.379, 0.227, 0.256 and 0.341 for expansion, recession, depression and recovery phases respectively, insinuating a high return per unit of risk associated with these portfolios. Moreover, Portfolio 4 produces positive and significant Alphas through all stages of the cycle in which it is analyzed.
The Sharpe ratio hypothesis test, as displayed in Table 16 of the Appendix, further reveals that each portfolio exhibits strong statistical differences between one-another, therefore solidifying the distinction in performance amongst these portfolios.

Table 1: This table displays the results for the portfolio analysis performed on the quality score. The construction of the quality portfolios is in line with the methodology carried out in Section 4.1, producing 4 value weighted portfolios. Portfolio 1 represents stocks of low quality, Portfolio 2 contains stocks of medium quality, while Portfolio 3 corresponds to stocks of high quality. Portfolio 4 represents the quality factor portfolio, a long-short portfolio that buys high quality stocks while funding this position through the sale of low quality stocks. Panel A reports the related results for each portfolio within the sample universe. Panel B similarly identifies the performance of the four quality portfolios, this time within each stage of the economic cycle; expansion, recession, depression and recovery.

Portfolio Analysis

Panel A		Quality Portfolio 1	Quality Portfolio 2	Quality Portfolio 3	Quality Portfolio 4
1962-2018	Mean	0.001	0.004	0.008	0.007
	Stdev	0.044	0.044	0.045	0.023
	Sharpe	0.021	0.101	0.187	0.321
	Alpha	-0.004	-0.000	0.003	0.002
	Tstat	-6.10	-0.57	4.80	7.74

Panel B		Quality Portfolio 1	Quality Portfolio 2	Quality Portfolio 3	Quality Portfolio 4
Expansion	Mean	0.001	0.003	0.009	0.008
	Stdev	0.043	0.044	0.046	0.021
	Sharpe	0.037	0.089	0.214	0.379
	Alpha	0.003	0.001	0.005	0.003
	Tstat	-3.35	-1.51	4.04	5.22

Portfolio Analysis Continued

Panel B		Quality Portfolio 1	Quality Portfolio 2	Quality Portfolio 3	Quality Portfolio 4
Recession	Mean	-0.008	-0.004	-0.002	0.005
	Stdev	0.048	0.044	0.050	0.026
	Sharpe	-0.170	-0.108	-0.042	0.227
	Alpha	-0.002	-0.001	0.003	0.011
	Tstat	-2.77	-1.07	1.74	3.16
Depression	Mean	0.006	0.010	0.013	0.006
	Stdev	0.055	0.048	0.047	0.026
	Sharpe	0.121	0.207	0.288	0.256
	Alpha	-0.001	0.001	0.005	0.001
	Tstat	-3.17	1.85	3.79	12.43
Recovery	Mean	0.007	0.011	0.014	0.006
	Stdev	0.040	0.038	0.034	0.020
	Sharpe	0.192	0.308	0.427	0.341
	Alpha	-0.004	-0.000	0.003	0.004
	Tstat	-5.51	-1.06	0.33	5.68

Quality Portfolios 1, 2 and 3 represent allotments of quality stocks in ascending order. Quality Portfolio 4 represents the long-short quality factor investment which can be identified as the quality factor. The statistics presented pertaining to these portfolios include the mean (Mean) and standard deviation (Std.Dev) of portfolio returns. Moreover, risk-adjusted performance measures such as the Sharpe ratio (Sharpe) and Jensen's Alpha (Alpha) are also displayed. The statistical significance of these findings is recorded in the t-statistic (Tstat) for each portfolio. These measures are used to identify the presence and performance of the quality factor among U.S stocks in the sample from 1962 to 2018.

5.2 Asset Pricing Regression

This section of the paper reports the results for the OLS regressions expressed in equations 6 and 7 in Section 4.2. The regressions are designed to determine if the quality factor portfolio, identified in Section 5.1, is priced correctly in the market. This allows the study to assess the pricing status of the quality portfolio. These results are presented in Table 2.

Column 1 details the results pertaining to the Fama-French 3 factor model, in which the return of the quality factor is regressed on the return on the market portfolio, along with the value and size factors. The negative coefficients recorded for return on the market portfolio and the value factor imply that these independent variables are not positively related to the returns generated by the quality factor. These findings are supported by significant t-statistics and p-values. Despite the recording of a positive relationship between size factor and the dependent variable, the accompanying t-statistic and p-value indicates that the size factor is not robust in having explanatory power on the quality factor. The constant reported in this regression indicates the portion of the quality factor portfolio that is left unexplained in the regression. The coefficient presented for the constant is significant to 1% level and is supported by a robust t-statistic of 9.99. In essence. This implies that a large portion of the returns generated by the quality portfolio are unexplained by the Fama-French 3 factor model.

Column 2 reports the results relating to the Carhart 4 factor model, in which the quality factor portfolio is regressed on the return on the market portfolio, and the value, size and momentum factors. The results relating to independent variables common between the Carhart and the Fama-French factor models are identical, excluding the loading of the return on the market portfolio which is significant to the level of 5%. The coefficient for the momentum factor is large, significant at the 1% level and supported by a strong t-statistic of 4.07. This indicates that the momentum factor positively explains a portion of the returns generated by the quality factor portfolio. Similar to the results reported in column 1, the constant is positive and significant to the 1% level, and is further accompanied by a robust t-statistic of 8.07. This suggest that the Carhart 4 factor model also fails to explain a large portion of the returns generated by the quality portfolio.

Table 2: This table displays the results for the linear regression of the quality factor, identified in Section 5.1, on the Fama-french 3 factor and the Carhart 4 factor models, represented in column 1 and 2 respectively. Quality is therefore regressed on the return to the market portfolio and the value, size and momentum factors. The intercept for each regression is also identified, along with the relevant number of observations and goodness-of-fit.

Asset Pricing Regression Analysis

Variables		1 Quality Factor	2 Quality Factor
MKTRF	Coef.	-0.069***	-0.045*
	Std. Err.	0.026	0.024
	Tstat.	-2.6	-1.85
HML	Coef.	-0.209***	-0.165***
	Std. Err.	0.047	0.048
	Tstat.	-4.43	-3.43
SMB	Coef.	0.057	0,055
	Std. Err.	0.045	0.047
	Tstat.	1.26	1.17
UMD	Coef.		0.123***
	Std. Err.		0.030
	Tstat.		4.07
Constant	Coef.	0.008***	0.007***
	Std. Err.	0.001	0.001
	Tstat.	9.99	8.07
Obs		684	684
R-squared		0.071	0.116

The results indicate the coefficient (Coef), standard error (Std.Err.) and t-statistic (Tstat) for the factors present in the Fama-French 3 factor and Carhart 4 factor models; the return on the market portfolio (MKTRF), the value factor (HML), the size factor (SMB) and the momentum factors (UMD). The intercept (Constant), number of observations (Obs) and goodness-of-fit (R-squared) are also reported. The notation on the coefficient implies statistical significance at the following p-value levels; *** p<0.01, ** p<0.05, * p<0.1

5.3 Fixed Effects Regression Analysis

This section of the results presents the findings that are related to the fixed-effects regression model, explored in Section 4.3 and expressed in equation 8. These results detail the relationships between the quality factor and its dimensions in both sample-wide and economically defined analyses, these findings are reported in Table 3.

Column 1 reports the results of the regression within the full sample universe. The results suggest that the profitability dimension of quality is positively related to the quality factor, evident in the positive coefficient which is robust to the level of 1%. On the other hand, negative coefficients and strong statistical support to the level of 1%, implies that the growth and payout dimension have a negative relationship with the factor. The results pertaining to the safety dimension are also negative, but a lack statistical significance.
Column 2 presents the results of the loading's during periods of economic expansion. The relationship identified between the growth and payout scores, and the quality factor are negative and significant at the level of 1%. The profitability and safety dimensions each exhibit a positive coefficient, which is robust to the level of 1%.
Column 3 displays the results in periods of recession. The safety dimension exhibits a positive relationship with the factor, significant to the level of 1%. In contrast to the prior column, the profitability dimension records a negative relationship with the quality factor, despite the results being statistically insignificant. On the other hand, the growth and payout dimensions are again reported to exhibit negative coefficients that are statistically significant to the 1% level.
Column 4 reports the results in periods of economic depression. In this phase the profitability, growth, payout and safety scores all exhibit negative coefficients that are statistically significant to the level of 1% and backed by t-statistics ranging from 5.38 to 14.84.
Column 5 displays the findings related to each dimension in the recovery stage of the economy. These results hold similarities to those identified in the sample wide analysis in column 1. The profitability dimension exhibits a positive coefficient, significant to the 0.1% level and supported by a t-statistic of 14.52. Meanwhile, the growth, safety and payout dimensions all exhibit negative coefficients that are statistically significant to the 1% level.

These findings suggest that on-average the quality factor is driven by its profitability dimension. Despite this, the results presented throughout the stages of the economy indicate that the drivers of a composite quality factor are dynamic thought the economy, expressed through profitability and safety dimensions both simultaneously and independently.

Table 3: This table reports the results pertaining to the fixed-effects regression analysis, expressed by equation 8 in the methodology. In this model, the quality factor portfolio is regressed on the dimensions of which it consists, namely profitability, growth, safety and payout scores take the role of the independent variables. The definitions of the economic cycle, presented in Section 3.4, are imparted on the regression as indicator variables. This allows the study to identify the relationship between the dependant variable and the independent variables throughout each stage of the economic cycle; expansion, recession, depression and recovery. Column 1 presents the loading's of the dimensions on the quality factor in the full sample universe. Columns 2, 3, 4 and 5 indicate the results of the dimensions loading's on the quality factor during economic expansion, recession, depression and recovery. The relationships are expressed through coefficients, standard errors and t-statistics.

Fixed Effects Regression Analysis

Variables		1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor	5 Quality Factor
Profitability Score	Coef.	6.27e-07***	1.92e-06***	-1.26e-07	-2.19e-06***	1.59e-06***
	Std.Err	6.2e-08	1.08e-07	1.83e-07	1.48e-07	1.09e-07
	Tstat	10.01	17.82	-0.69	-14.84	14.52
Growth Score	Coef.	-8.61e-07***	-8.90e-07***	-9.53e-07***	-9.62e-07***	-9.98e-07***
	Std.Err	3.54e-08	6.14e-08	1.07e-07	8.71e-08	6.00e-08
	Tstat	-24.32	-14.5	-8.88	-11.05	-16.64
Safety Score	Coef.	-1.27e-08	5.94e-07***	4.16e-07***	-6.81e-07***	-4.81e-07***
	Std.Err	5.21e-08	8.84e-08	1.56e-07	1.23e-07	8.8e-08
	Tstat	-0.24	6.72	2.64	-5.38	-5,46

Fixed Effects Regression Analysis Continued

Variables		1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor	5 Quality Factor
Payout Score	Coef.	-8.59e-07***	-7.75e-07***	-1.10e-06***	-1.24e-06***	-6.85e-07***
	Std.Err	4.77e-08	8.21e-08	1.14e-07	1.15e-07	8.16e-o8
	Tstat	-17.99	-9.43	-7.65	-10.82	-8.39
Constant	Coef.	0.008***	0.005***	0.008***	0.015***	0.006***
	Std.Err	1.00e-04	1.00e-04	2.00e-04	2.00e-04	1.00e-04
	Tstat	76.10	30.04	30.75	60.03	35.40
Obs		1,522,773	439,323	286,480	361,941	430,022
Stocks		9,896	9,353	8,734	9,024	9,178
R-squared		0.001	0.002	0.001	0.004	0.001

The dimensions of quality are expressed via the Profitability Score, Growth Score, Safety Score and the Payout Score. The results pertaining to the regression of the quality factor on these dimensions are expressed by the coefficient (Coef), standard error (Std.Err) and the t-statistic (Tstat). The intercept (Constant) is also expressed in this manner. Moreover, the number of observations (Obs) and assets (Stocks), along with the goodness-of-fit (R-squared) are also reported for each regression. The notation on the coefficient implies statistical significance at the following p-value levels; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

5.4 Robustness Checks

5.4.1 07/08 US Financial Crisis Sample

This section of the results identifies the findings that are related to the robustness check involving the analysis of an isolated sub-sample from the data-set. The details of this analysis are provided in Section 4.4.1, and the findings are displayed in Table 4.

Column 1 reports the results for this check in periods of economic expansion. The profitability dimension displays a negative relationship with the quality factor, this is supported by a t-statistic of -63.71. The remaining dimensions exhibit statistically insignificant results in this economic state. Column 2 records the results pertaining to periods of recession. Both the profitability and safety dimensions display positive interaction with the factor, these findings are supported by strong statistical significance. Meanwhile, growth and payout dimensions display insignificant coefficients. Column 3 indicates that profitability, safety and payout dimensions are positively related to the quality factor in economic depressions. These suggestions are all supported by p-values that indicate significance to the level of 1%, meanwhile the loading of the growth dimension is insignificant. Finally, the results pertaining economic recovery are provided in column 4. These results indicate that profitability alone displays a positive interaction with the quality factor, this relationship is statistically significant at the 1% level. On the other hand, the remaining dimensions exhibit statistical negligence in their relationship with the factor.

This robustness check issues empirical support to the findings related to the quality factor being driven by its safety dimension in recession stages and the profitability dimension in recovery stages, while being negatively impacted the growth dimension in economic depression. Moreover, the study recognizes the dynamic loading patterns of the factors dimensions throughout a changing economy. Despite this, the analysis identifies 9 of a possible 16 contradicting relationship to the results presented in Table 3. This could be a product of the short time-frame over which the sample was conducted, or the inherent volatility of financial markets throughout the isolated sample. In review, this robustness check offers small evidence in support of the findings presented in Section 5.3.

Table 4: This table presents the results pertaining to the robustness check in which a single full economic cycle is analyzed. This is carried out in order to determine if the results presented in Section 5.3 are robust to a sample that includes only the time frame of the 07/08 U.S financial crisis. This analysis isolates the time period of March 2007 through March 2010, allowing the analysis to use a 36-month frame in which financial markets were particularly volatile. During this period the expansion phase take place for 8 continuous months, while the recession, depression and recovery phases take place for 10, 8 and 10 continuous months respectively. The quality factor is regressed on its dimensions in a similar fashion to that of Section 4.3. The economic indicator variables are imparted on the fixed-effects model to generate results that detail the loading's of each dimension on quality through each stage of the economic cycle, during only the financial crisis. This analysis is carried out using equation 8 in the sample period identified, and reports the coefficients, standard errors and t-statistics pertaining to each dimension. Column 1 reports the results that relate to times of economic expansion, while columns 2, 3 and 4 detail the findings for economic recession, depression and expansion respectively.

U.S Financial Crisis 07/08

		1	2	3	4
Variables		Quality Factor	Quality Factor	Quality Factor	Quality Factor
Profitability Score	Coef.	-1.70e-04***	4.96e-05***	6.63e-05***	8.17e-06***
	Std.Err	2.66e-05	2.8e-05	3.56e-06	1.42e-06
	Tstat.	-63.71	17.74	18.64	5.77
Growth Score	Coef.	3.28e-07	1.52e06	-5.40e-06***	-5.97e-07
	Std.Err	7.96e-07	1.07e-06	1.22e-06	5.35e-07
	Tstat.	00.41	01.42	-4.41	-1.12
Safety Score	Coef.	-2.33e-07	4.06e-06***	1.68e-05***	-7.69e-07
	Std.Err	3.27e-07	9.91e-07	2.08e-06	8.07e-07
	Tstat.	-0.71	4.09	8.06	-0.95

U.S Financial Crisis 07/08 Continued

Variables		1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor
Payout Score	Coef.	-1.97e-07	-1.78e-07	4.64e-06***	4.02e-07
	Std.Err	4.91e-07	9.61e-07	1.51e-06	5.7e-07
	Tstat.	-0.4	-0.18	3.08	0.71
Constant	Coef.	0.382***	-0.106***	-0.166***	-0.017***
	Std.Err	0.005	0.006	0.008	0.003
	Tstat.	66.61	-17	-20.26	-5.36
Observations		26,578	32,560	26,127	33,288
Stocks		3,364	3,431	3,394	3,475
R Squared		0.152	0.012	0.020	0.001

The dimensions of quality are expressed via the Profitability Score, Growth Score, Safety Score and the Payout Score. The results related to the fixed-effects regression of the quality factor on these dimensions are expressed by the coefficient (Coef), standard error (Std.Err) and the t-statistic (Tstat). The intercept (Constant) is also expressed in this manner. Moreover, the number of observations (Obs) and assets (Stocks), along with the goodness-of-fit (R-squared) is also reported for each regression. The notation on the coefficient implies statistical significance at the following p-value levels; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

5.4.2 Alternative Definition of The Economic Cycle

This section of the results identifies the findings pertaining to the robustness check that involves determining an alternative method of defining each stage of the economic cycle. The results related to this check are displayed in Table 5.

Column 1 reports the results regarding the analysis in periods of economic expansion. The table indicates that the profitability and safety dimensions both exhibit positive relationships with the quality factor, while growth and payout dimensions display negative relationships. These results are all statistically significant to the level of 1%.
Column 2 records the results for periods of economic recession, in which the safety dimension solely loads positively on the factor. On the other hand, the payout and growth dimensions load negatively on quality. These relationships are all significant to the 1% level, while the profitability dimension displays a relationship that is insignificant.
Column 3 displays the findings for periods of economic depression. The results imply that each dimension interacts negatively with the quality factor. These relationships are all statistically significant to the 1% level.
Column 4 presents the results for periods of economic recovery. It is highlighted that the profitability dimension interacts positively with the factor, meanwhile the remaining dimensions display negative loading's on the dependent variable. These relationships are all significant to the level of 1%.

The the matching of 16 out of a possible 16 outcomes implies the findings identified in this analysis are identical to those explored in Section 5.3, specifically with regards to the sign on the coefficient and statistical significance of the relationships between the dimensional factors and the quality factor. The results also confirm the dynamic pattern of dimensional loading's on the factor throughout the economic cycle. This analysis therefore provides an abundance of support for the findings identified in Section 5.3.

Table 5: This table reports the results of the robustness check detailed in Section 4.4.2. The results displayed are derived from a fixed-effects regression of the quality factor on its dimensions throughout the economic cycle, identical to that expressed in equation 8, yet using a different definitions for each stage of the economic cycle. The results in this table correspond to an analysis which defines each economic environment over a 3-month period, rather than the 1-month period assessed in Section 5.3 of the research paper. This is achieved by calculating the GDP ratio-to-trend, and the change in this variable, using 3-month trailing averages. Column 1 details the findings related to periods of economic expansion. Columns 2, 3 and 4 catalogue the findings that pertain to periods of recession, depression and recovery. This analysis allows the study to determine if the findings presented in Section 5.3 of the paper are robust to expanding each economic definition to account for a period of 3-months.

Alternative Definition of Economic Cycle

Variables		1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor
Profitability Score	Coef.	9.03e-07***	-2.14e-08	-3.01e-06***	2.81e-06***
	Std.Err.	1.1e-07	1.8e-07	1.4e-07	1.0e-07
	Tstat.	8.24	0.12	-20.9	26.14
Growth Score	Coef.	-7.99e-07***	-5.47e-07***	-6.50e-07***	-1.44e-06***
	Std.Err.	6.3e-08	1.04e-07	8.3e-08	5.9e-08
	Tstat.	-12.62	-5.25	-7.75	-24.1
Safety Score	Coef.	5.53e-07***	6.06e-07***	-5.91e-07***	-5.71e-07***
	Std.Err.	9.1e-07	1.55e-07	1.22e-07	8.7e-07
	Tstat.	6.08	3.92	-4.85	-6.51

Alternative Definition of the Economic Cycle Continued

Variables		1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor
Payout Score	Coef.	-1.09e-06***	-1.01e-06***	-5.79e-07***	-9.68e-07***
	Std.Err.	8.4e-08	1.41e-07	1.11e-07	8.1e-08
	Tstat.	-12.9	-7.15	-5.22	-11.91
Constant	Coef.	0.008***	0.007***	0.014***	0.005***
	Std.Err.	1.82e-04	2.62e-04	2.45e-04	1.90e-04
	Tstat.	45.01	27.55	58.27	30.23
Observations		431,142	293,718	380,948	416,965
Stocks		9,370	8,628	9,056	9,180
R-squared		0.001	0.000	0.004	0.003

The dimensions of quality are expressed via the Profitability Score, Growth Score, Safety Score and the Payout Score. The results related to these dimensions in the newly defined economy are expressed by the coefficient (Coef), standard error (Std.Err) and the t-statistic (Tstat). The intercept (Constant) is also expressed in this manner. Moreover, the number of observations (Obs) and assets (Stocks), along with the goodness-of-fit (R-squared) is also reported for each regression. The notation on the coefficient implies statistical significance at the following p-value levels; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

5.4.3 Principle Components Analysis

This section of the results explores the findings for the robustness check involving the deployment of the principle components analysis to compute new dimensional factors. These results pertain to a fixed-effects regression model, expressed in equation 9. These results are displayed in Table 6.

Column 1 reports the results of the regression in periods of economic expansion, these figures indicate that the quality factor positively interacts with the first and second safety dimensions, these findings are significant to the 10% and 1% percent levels respectively. The second profitability and the first payout dimensions display negative and significant relationships with the factor, while the remaining dimensional factors are statistically insignificant. Column 2 records the results for equation 9 in periods of economic recession. The results in this column imply that the second profitability dimension is positively related to the quality factor, and significant at the level of 10%. In contrast the second safety dimension displays a negative, and significant to the 1% level, relationship with the dependent variable. Column 3 presents the results pertaining to depression phases in the economy, the findings indicate that the quality factor is positively interacting with the first growth dimension, this result is significant to the 1% level, while the second profitability, first safety and the first payout dimensions exhibit negative coefficients that are statistically significant to the same level. Column 4 details the phase of economic recovery, the results in this portion of the table implies that both profitability dimensions are positively and significantly, at least to the level of 5%, related to the quality factor, while the second safety and first payout dimensions appear to be negatively interacting to the dependent variable. These relationships are statistically significant to the level of 1%.

In review, these findings do not predominantly match with those explored in Section 5.3. This is likely a result of the principle components analysis generating dimensional factors that do not reflect the initial dimensional factors deployed. Specifically, these synthetic factors do not capture stocks that simultaneously display multiple dimensional measures, rather capturing stocks that only display the aspects of the principle components analyses factors. Such discrepancies are highlighted in Table 15 of the Appendix. Despite this, the analysis still confirms 3 of a possible 16 findings in common with those of Section 5.3, and further recognizes the dynamic loading patterns of the quality dimensions throughout the cycle. This robustness check therefore provides small yet ample evidence in support of the findings presented in Section 5.3.

Table 6: This table displays the results of the regression of the quality factor portfolio on a set of synthetic factors, as identified in equation 9. This regression is imparted with the standard economic indicators identified in Section 3.4 in order to determine the relationship between the the quality factor and its dimensions, along with identifying if the results hold similarities with those identified in Section 5.3. A principle components analysis is deployed to create these factors. In this study the analyses generated 2 factors for each dimension, thus producing 8 independent variables. The coefficient, standard error and t-statistic related to each of these factors is presented for each stage of economic cycle. Column 1 displays the results for these factors in periods of economic expansion, while columns 2, 3 and 4 relate these findings to periods of economic recession, depression and recovery respectively.

Principle Components Analysis Regression

Dimensions		Variable	1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor
Profitability:	P1	Coef.	-1.52e04	-9.63e-06	1.17e-04	6.79e-04***
		Std.Err	1.28e-04	1.41e-04	1.9e-04	.64e-04
		Tstat.	-1.18	-0.07	0.61	4.14
	P2	Coef.	-5.59e-04***	7.48e-04**	-4.70e-04*	1.18e-04*
		Std.Err	9.4e-05	3.56e-04	2.61e-04	6.6e-05
		Tstat.	-5.89	2.1	-1.8	1.76
Growth:	G1	Coef.	4.5e-05	-1.14e-04	4.42e-04***	-1.02e-04
		Std.Err	7.27e-05	9.93e-05	1.37e-04	1.21e-04
		Tstat.	0.62	-1.15	3.21	-0.84
	G2	Coef.	-2.07e-04	-2.20e-05	-8.18e-06	-1.08-e04
		Std.Err	2.86e-04	1.77e-04	1.17e-04	1.77e-04
		Tstat.	-0.72	0.12	-0.07	-0.61
Safety:	S1	Coef.	2.3e-04*	-1.66e-04	-6.29e-04***	-2.12e-05
		Std.Err	1.18e-04	1.68e-04	1.61e-04	1.18e-04
		Tstat.	1.95	-0.98	-3.91	-0.18
	S2	Coef.	5.26e-04***	-3.67e-04***	-1.27e-04	-3.44e-04***
		Std.Err	6.51e-05	1.36e-04	1.09e-04	5.98e-05
		Tstat.	8.08	-2.71	-1.17	-5.8

Principle Components Analysis Regression Continued

Dimensions		Variable	1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor
Payout:	PO1	Coef.	-2.98e-04***	-6.12e-05	-3.30e-04***	-2.94e-04***
		Std.Err	4.93e-05	8.98e-05	5.65e-05	5.75e-05
		Tstat.	-6.04	-0.68	-5.85	-5.12
	PO2	Coef.	5.01e-05	6.73e-05	1.86e-04	3.41e-05
		Std.Err	401e-04	8.02e-05	1.16e-04	7.32e-05
		Tstat.	1.22	0.84	1.6	00.47
Constant		Coef.	0.008***	0.004***	0.006***	0.006***
		Std.Err	4.57e-05	7.09e-05	6.45e-05	4.63e-05
		Tstat.	175.18	67.61	104.39	138.14
Observations			210,946	147,994	180,881	215,346
Stocks			5,798	5,546	5,758	5,843
R-squared			0.001	0.000	0.000	0.000

The profitability (P1 and P2), growth (G1 and G2), safety (S1 and S2) and payout (PO1 and PO2) factors generated from the principle components analysis are reported in this table. The loading's for each of these factors on the quality factor are reported through a coefficient (Coef), standard error (Std.Err) and relative t-statistic (Tstat). The intercept (Constant) is also expressed in this manner. Moreover, the number of observations (Obs) and assets (Stocks), along with the goodness-of-fit (R-squared) are also reported for each regression. The notation on the coefficient implies statistical significance at the following p-value levels; *** p<0.01, ** p<0.05, * p<0.1.

5.4.4 Dynamic Re-balancing Portfolio Analysis

This section of the results details the findings related to the robustness check carried out regarding the dynamic re-balancing portfolio and its assessment under the lens of a portfolio analysis, as explored in Section 4.4.4. These results are displayed in Table 7.

Column 1 highlight the results produced from the sample-wide analysis. Across the 684 months present in the sample, the re-balancing portfolio generates a high monthly Sharpe ratio of 0.336. Moreover, a reported monthly Alpha of 0.002 suggests that the portfolio also on-average outperforms the market benchmark. Column 2 displays the results that relate to the re-balancing portfolio in periods of economic expansion, in which the portfolio assumes positions based on the profitability and safety dimensions of quality. In this phase, the portfolio generates a high risk-adjusted measure of return of 0.425, along with a strong Alpha of 0.005. Column 3 represents periods of economic recession, in which the portfolio tilts solely to the safety dimension of quality. The Sharpe measure for the portfolio is 0.34, while also recording an exceptionally high monthly Alpha of 0.011. This measure is a result of the negative performance of the market benchmark in these economic periods. Column 4 represents results during phases of economic depression, during which the portfolio is balanced on the quality score, as identified in Section 3.3. The portfolio again records a high Sharpe ratio of 0.256, along with a similarly positive Alpha of 0.005. These results are of course identical to those of Section 5.3, as the composition of each portfolio in this state is defined by the same quality score. Column 5 highlights the results through periods of economic recovery. In this phase the portfolio is re-balanced to invest solely through the profitability dimension of quality. In this case, the portfolio generates a high Sharpe ratio of 0.348, yet posts a negative Alpha of -0.003. The resulting Alpha is a result of the strong performance of the market portfolio during periods of economic recovery.

These results indicate that on-average, and throughout each stage of the economic cycle, the dynamic re-balancing portfolio generates high risk-adjusted returns, as identified in the strong positive Sharpe ratios displayed in the table. Moreover, the positive alpha recorded on-average, and throughout most stages of the economic cycle, implies the portfolio also tends to outperform its benchmark. The exception to this is the negative Alpha recorded in stages of economic recovery, in which the market benchmark outperforms the re-balancing portfolio. In essence, these findings imply that the dynamic re-balancing portfolio, conditioned on the findings related to the drivers of quality in the cycle, outperforms the quality factor portfolio.

Table 7: This table reports the results pertaining to the performance of the dynamic re-balancing portfolio, explored in Section 4.4.4 of the research paper. The creation of this portfolio is motivated by the findings uncovered in Section 5.3 of the study, which indicates that the drivers of the quality factor are dynamic in their contribution throughout the stages of the economic cycle. In line with these results, the portfolio is designed to balance its positions dependent on the relationships uncovered Table 3. In essence, this portfolio invests through profitability and safety dimensions in periods of economic expansion, solely through the safety dimension in periods of economic recession and only the profitability dimension in stages of economic recovery. The portfolio assumes the quality factor in periods of economic depression, given that the related results imply that none identified dimensions drive the performance of the factor. The portfolio is value weighted and accounts for transaction costs. The results presented indicate the sample-wide performance of this portfolio, along with its performance in each phase of the economic cycle.

Dynamic Re-balancing Portfolio

	Samplewide	Expansion	Recession	Depression	Recovery
Rebalanced Portfolio:					
Mean	0.007	0.008	0.007	0.006	0.008
Std.Dev	0.022	0.019	0.021	0.026	0.023
Sharpe	0.336	0.425	0.340	0.256	0.034
Mktrf.	0.004	0.002	-0.004	0.004	0.011
Alpha	0.002	0.005	0.011	0.001	-0.003
Monthly Obs.	684	190	143	164	184

The mean (Mean) and standard deviation (Std.Dev) of the returns generated by the re-balancing portfolio are recorded. Risk-adjusted performance measures, such as the Sharpe ratio (Sharpe) and Jensen's Alpha (Alpha) are also reported for the portfolio. The average of the return on the market portfolio (Mktrf) over the related period, and the number of monthly observation's (Obs) are also displayed. These results are portrayed for a sample-wide portfolio analysis, along with an identical analysis that details the performance of the portfolio in differing phases of the economic cycle.

6 Discussion and Implications

This section of the research paper is designed to discuss the results presented in Section 5. This allows the study to deduce concise findings from the methodology aiding in hypothesis assessment, detail any relationships relevant to the related literature and highlight the implications that these findings hold.

6.1 Portfolio Analysis

The sample-wide portfolio analysis results reveal that stocks that are of high quality, in essence those that exhibit strong profitability, growth, safety and payout fundamentals, outperform those which are of low quality, essentially those who exhibit weak profitability, growth, safety and payout characteristics. These findings are in line with the research of Asness et al. (2013), Grantham (2004), Daco (2018) and Novy-Marx (2014). A large and significant monthly Sharpe ratio of 0.32 recorded in the long-short quality portfolio implies that such a strategy produces high risk adjusted returns that are incoherent with the Efficient Market Hypothesis. This provides evidence that lends support to the conformation of Hypothesis 1.

The reporting of a positive Alpha in this the quality factor portfolio analysis further indicates that quality style investing, in the manner of this research, outperforms the market benchmark. The robustness of the accompanying t-statistic supports the statistical significance of these findings. Given the stipulations placed on the data-set, such as the implementation of transaction costs, the performance of the factor insinuates that a quality based strategy is an achievable and attractive investment option for prospective investors. This provides evidence for the conformation of Hypothesis 2.

The results pertaining to the portfolio analysis in each phase of the economic cycle posts similar results to those of the sample wide analysis, revealing again that high quality stocks outperform low quality stocks. The results support the research of Asness et al. (2013) and Daco (2018) who indicate strong quality performance in positive economic periods, while also supporting findings that imply such performance holds in periods of economic downturn (Asness et al. 2013; Daco, 2018 and Bazgour et al, 2016). These findings posit that the composite quality measure in this study is a true market anomaly, a market characteristic that exhibits a risk return relationship that is not in line with efficient market beliefs. Moreover, the positive Alphas generated in each stage of the cycle by this portfolio highlights that quality equities consistently outperform the market portfolio. The statistical difference between the performance of these portfolios is also strong, as indicated by Table 16 in the Appendix. These findings provide further support for the confirmation of Hypothesis 1 and 2.

6.2 Asset Pricing Regressions

The results relating to the linear regression model of the quality factor on the Fama-French 3 factor model reveals that the return on the market portfolio and the value factor display negative relationships with the portfolio, while the size factor holds no relation to quality. Similar results hold in the linear regression of the quality factor on the Carhart 4 factor model, implying that these factors hold no explanatory power on the performance of the quality factor. Despite this, it is of interest to note that the momentum factor displays a positive relationship with quality, suggesting that it partly accounts for the performance of the factor. Further inspection of this finding is out of the scope of this paper, and is therefore in the hands of future researchers.

The significant intercepts that remain in these regressions implies that the price of quality stocks does not incorporate information pertaining to the subsequent out-performance of high quality stocks relative to low quality stocks, this is in line with the research of Asness et al. (2013) and Bouchaud et al. (2016). The quality portfolio is therefore not only a market anomaly, but also a pricing anomaly that is in contradiction with the school of efficient markets. These findings lends support to the conformation of Hypothesis 3.

6.3 Fixed Effects Regression Analysis

The sample-wide fixed-effects model reveals that the high quality returns generated by the quality portfolio are driven solely by its profitability dimension, indicating that regardless of the economic environment the profitability fundamentals can explain a large portion of documented performance. This result may indicate that quality is simply a diversified strategy that is incorporated with a profitability factor that significantly drives returns overtime, in essence the finding is an example of over-fitting bias. Such a finding is in line with the research of Novy-Marx (2013), who posits that gross-profits-over-assets can capture a large sum of the cross section of expected returns. On the other hand, the results may imply that an overall quality factor is best captured by its profitability dimension. Regardless of the argument, the findings provide support for confirmation of Hypothesis 4, implying that the quality factor is driven by a single dimension.

The results regarding the drivers of the quality factor in stages of economic expansion, recession, depression and recovery provide contradictions to the thought of a single profitability factor consistently driving the performance of the quality factor. The fixed-effects model highlights that such returns are driven by the profitability and safety dimensions in expansion periods, the safety dimension in recession phases and the profitability dimension in stages of economic recovery. The results also suggest that none of the identified dimensions drive the performance of the quality factor in periods of economic depression. These findings imply that the quality factor is either driven dynamically by its dimensions, or is possibly a product of the over-fitting bias, suggested by Novy-Marx (2014). Determining which of these ideas holds true, and assessing the prominence of profitability and safety dimensions loading individually and simultaneously on the quality factor, is in the hands of future research. Despite this, the findings provides irrevocable evidence that the quality factor is driven dynamically by its dimensions throughout the economic cycle, thus lending support to the rejection of Hypothesis 4 and the conformation of Hypothesis 5. This indicates that The quality factor is driven dynamically by its dimensions throughout the economic environment.

6.4 Robustness Checks

6.4.1 07/08 U.S Financial Crisis

This robustness check was designed to determine the validity of the findings related to the fixed-effects regression analysis investigated in Section 5.3. This alternate fixed-effects model presents 9 of a possible 16 contracting relationships when in comparison to the findings of the original investigation. Such contradictions are likely a result of the short time frame in which the analysis was carried out, or the the prevailing volatility of financial markets during this time. Despite this, the model determines that the quality factor is driven by its safety dimension in recession stages and the profitability dimension in recovery stages, while being negatively impacted the growth dimension in economic depression. These findings are similar to those expressed in Section 5.3. In a similar vein, the analysis highlights the dynamic loading pattern of the dimensions of quality on the factor throughout the economic cycle, an observation also recorded in Section 5.3. These findings therefore issue small support to the conformation of Hypothesis 5, and therefore the rejection of Hypothesis 4.

The results presented for a related portfolio analysis during the sub-sample, displayed in Table 9 in the Appendix, reveals that the quality factor strongly preforms in periods of economic expansion and recession. While the remaining findings of this analysis are statistically insignificant, such discrepancies likely being a result of the sub-sample size, the findings overall issue further solidification to the conformation Hypothesis 1 and 2.

In summary, the findings uncovered by this robustness check issue minor support to the results presented in Section 5.1 and 5.3, thus providing further evidence in favor of Hypothesis 1, 2 and 5. In essence, the study reveals that quality is a robust factor in financial equity markets that generates high risk-adjusted returns and outperforms the market benchmark. This performance is driven dynamically by its dimensions throughout the economic cycle.

6.4.2 Alternative Definition of the Economy

This robustness check was designed to further test the validity of the findings pertaining to the analysis conducted in Section 5.3. In the fixed-effects model that includes an alternative definition of the each economic phase, the results presented strongly correlate to those identified in the initial inquiry.

Considering the status of the coefficient and the statistical significance of the results, this check produces 16 out of a possible 16 matching results with the fixed-effects regression analysis explored in Section 5.3. This finding implies solidarity between the definitions of the economic cycle used in this study. Furthermore, this robustness check also confirms the dynamic loading pattern of quality dimensions, on the quality factor, throughout the economic cycle. These findings are echoed in an alternative robustness check of a similar nature, which is displayed in Table 8 of the Appendix.

In review, the investigation of this robustness check provides vast evidence for the findings presented in Section 5.3. In turn, the conformation of these results lends further support to the acceptance of Hypothesis 5 and the subsequent rejection of Hypothesis 4.

6.4.3 Principle Components Analysis

This robustness check is concerned with determining the accuracy of the findings presented in the fixed-effects regression analysis, as explored in Section 5.3. Simply questioning, are these findings robust to implementing a different method for computing quality dimensional factors.

In considering the sign of the coefficient and the statistical significance of the findings, this robustness check confirms 7 of a possible 16 matches with the results identified in the fixed-effects model of Section 5.3. The factor is confirmed to be positively driven by safety and profitability dimensions in expansion and recovery periods respectively. The model further confirms that the factor is negatively impacted by the payout dimension in expansion, profitability and safety dimensions in depression, and safety and payout dimensions in economic recovery. The mid-level agreement between these results is likely a result of the principle components analysis generating dimensional factors that do not fully reflect the initial dimensional factors. Specifically, these synthetic factors do not capture stocks that simultaneously display multiple dimensional measures, rather capturing stocks that only display the aspects of the factors computed in the principle components analyses. A description of these analyses can be found in Table 15 of the Appendix. The results presented by these factors are therefore not fully in-line with those expressed in Section 3.3.

In synopsis, this robustness check provides mid-level support to the findings uncovered in Section 5.3. This allows for the study to further posit support for the conformation of Hypothesis 5, and therefore the rejection of Hypothesis 4

6.4.4 Dynamic Re-balancing Portfolio

This robustness check is designed to determine if the findings presented in this paper, specifically regarding the drivers of the quality factor identified by the fixed-effects regression analysis of Section 5.3, can be translated into an investment portfolio that yields high risk-adjusted returns and outperforms the benchmark.

The results indicate that on-average, and throughout each stage of the economic cycle, the dynamic re-balancing portfolio generates high risk-adjusted return's, as identified by the strong positive Sharpe ratios displayed in Table 7. Moreover, the positive Alpha recorded on-average, and through each stage of the economic cycle, implies that the portfolio also tends to outperform the market benchmark. The sole exception to this is the negative Alpha recorded by the portfolio in stages of economic recovery, in which the market benchmark outperforms the re-balancing portfolio. Such findings have vast implications for practitioners, who in understanding the drivers of factor performance, can generate efficient and effective investment strategies that outperform traditional vehicles.

Under the assumption that the dynamic re-balancing portfolio represents an efficient quality factor, this study can posit support to Hypothesis 1 and 2. This support is evident in the performance measures discussed. Moreover, given the portfolios composition and outperformance relative to the quality factor portfolio discussed in Section 5.1, the study can further determine that the drivers of quality are indeed dynamic throughout the stages of the economic cycle. This allows the study to issue further support to the conformation of Hypothesis 5, and the rejection of Hypothesis 4.

6.5 Implications

The conformation of the presence of a dynamic and robust composite quality factor in U.S equity markets could subject researchers to a deeper investigation of quality, and its explanatory power on expected returns. Continuous conformation of quality based factors would likely dispel previous beliefs regarding individual dimensional factors, such as profitability, driving the factor. Perhaps it is instead profitability measures that captures part of an overall quality measure, that in-turn has a greater explanatory power on returns. The behavior of the factor also possibly calls for a more abstract approach to identifying factors within academic research. In-line with the details uncovered in the asset pricing regression, as explored in Section 5.3, it could be expected that future research may attempt to define composite quality as an independent right-hand variable in the development of future asset pricing models.

On the other hand, these findings would likely also impact practitioners, specifically regarding the composition of future portfolios. It could be expected that the conformation of a quality factor would result in a tilt in the market toward quality based investment strategies. Such strategies may not be implementable, restricted by limits to arbitrage, or the inability to secure a short position due to investors refusing to shun quality (Shleifer & Vishny, 1997). Saturation of such strategies in financial markets could dampen the the persistence of the quality factors strong performance. Finally, the dynamic loading pattern of the profitability and safety dimensions on the quality factor in phases of the economy, as expressed in Section 5.3, holds further ramifications for investors. The implementation of an economically conditioned re-balancing portfolio is detailed in Section 4.4.4. This analysis implies that by taking the findings of this study into account, an investor can improve the efficiency and performance of a quality-style portfolio, thus presenting a new attractive investment vehicle for prospective investors.

7 Conclusion

This section of the research paper summarizes and implicates the findings presented in this study, discusses the limitations that were present throughout the process of conducting the research, while finally bringing the paper to an close with the conclusion.

7.1 Findings

The study highlights that high quality stocks seem to outperform low quality stocks when considering the multidimensional measure of quality explored in Section 3.3. This finding implies that the risk-return relationship inherent to these stocks cannot be reconciled with a theory of efficient markets. This indicates the existence of a quality factor in U.S financial equity markets. This finding is robust to analyses of differing surrounding economic environments, a sample-wide analysis, a sub-sample analysis and a Sharpe ratio hypothesis test. These investigations led to the conformation of Hypothesis 1; A robust quality factor is present in financial equity markets.

Moreover, the performance of this factor relative to the market benchmark reveals that not only does the quality factor generate high risk-adjusted returns, but it also exhibits consistent out-performance when in comparison to a highly stable investment vehicle, such as the return on the market portfolio. These findings are robust to sample-wide and economically defined analyses, along with a sub-sample analysis and a hypothesis testing analyses. Such findings allow for the acceptance of Hypothesis 2; A quality based investment strategy consistently outperforms the market benchmark.

The findings presented in Section 5.2 insinuate that the deployed asset pricing models do not capture the information regarding high risk-adjusted returns in quality market prices, thus positioning the quality factor as a pricing anomaly present in the U.S sample. This finding allows for the conformation of Hypothesis 3; The quality factor is a pricing anomaly in U.S financial markets.

The results explored in Section 5.3 finalize the main methodology in this research paper.

These results initially indicate that in a sample-wide analysis, the profitability dimension tends to drive the performance of the quality factor, lending support to the research of Novy-Marx (2013) and of Hypothesis 4; The quality factor is driven by an individual dimension.

However, the results generated in each phase of the economic cycle indicate that the dimensions which drive the quality factor are dynamic throughout this cycle. For instance, the performance of the quality factor seems to be driven by profitability and safety characteristics across stages of economic expansion, recession and recovery. Interestingly, the dimensions also tend to alternate relative to the relationship they hold with the factor. This implies that the factor is not driven by a single dimension through the sample, rather the quality factor must be composed of features that are dynamic in their loading on the factor. These findings are reinforced in the sub-sample, alternate economic definition, principle components and dynamic re-balancing portfolio analyses. These findings lie in contradiction with Hypothesis 4, which is therefore rejected. These results provide irrevocable support for the conformation of Hypothesis 5, which is henceforth accepted.

In summary, research paper posits that a robust quality factor, that generates high risk-adjusted returns and consistently outperforms the benchmark, is in existence in U.S equity markets across all market environments. Moreover, asset pricing models seem to lack explanatory power on the quality factor, thus positioning quality as a pricing anomaly. The investigation finally determines that the drivers of the quality factor are dynamic throughout the economic cycle, specifically profitability and safety dimensions both display, simultaneous and independent, positive interaction with the factor.

7.2 Limitations

While this study uncovers a variety of findings pertaining to the quality factor, a number of limitations have been encountered throughout the course of the study. These limitations will be explored in this section of the conclusion.

With regards to the sample universe used in this study a vast analysis of the quality factor is carried out. Despite this, the nature of the multidimensional aspect of computing quality and dimensional scores presents data mining and availability concerns. The over-fitting bias explored in Section 2.3.1 indicates that a multidimensional model may not effectively capture the performance of a single multidimensional factor, rather the model may capture the performance of a single dimension that holds explanatory power on the quality factor, therefore corrupting the findings of an individual quality factor.

Availability concerns arise due to the lack of accounting fundamental data present of the databases used prior to 1962. As these fundamentals are central to the construction of the quality and dimensional measures, the ability of this study to conduct its analysis over a greater time frame is restricted. Without this impediment, the data would allow for a more comprehensive analysis of the of the methodologies discussed in Section 4.

Moreover, global differences in accounting standards and requirements implies that the availability of identical fundamental measures in various geographical markets is weak. This limits the ability of the study to expand its research into multiple financial markets across the globe, therefore impacting the extent to which this study can confirm a quality factor. With final regards to the limitations presented by the data-set, the definition of quality and its dimensions are borne out of accounting fundamentals that relate directly to equity markets. Finding a substitution for such measures in other assets classes, for instance commodities and bonds, proves a difficult task without prior literature to reference. This aspect of the data impedes the ability of the study to expand the analysis of a quality factor into multiple asset classes. Achieving such an analysis would further solidifying the presence of a quality factor.

Another limitation that was encountered in the study relates to the definition of the economic cycle. The literature review revealed a variety of methods deployed to indicate the state of the economy, while also presenting a multitude of varying definitions for such states. This study eschews simple indicators, such as defining the economy by growth or contraction alone, in search of a more expansive definition of the economy. The four-stage indicator used in this study achieves a detailed analysis, yet the lack of representation for other indicators in the study may limit the significance of the results presented in Section 5.1 and 5.3. Including a variety of definitions, and economic variables, would allow the study to determine if the methods used to capture the state of the economy holds for a variety of other economic definitions.

In a similar vein, a number of other asset pricing models could be deployed in Section 5.2 of this study. While the goal of this sub-analysis is simply to reconcile with the literature review and confirm Hypothesis 3, the inclusion of modern pricing models may produce contradicting results to those found in Table 2. For instance, it could be expected that the profitability factor present in the Fama-French 5 factor model would likely exhibit a strong positive relationship with the quality factor, given that a quarter of its composition coincides with a profitability dimension. Therefore, the critiquing of the factor under a variety of asset pricing models would add significant power to the assessment of Hypothesis 3.

Lastly, while the goal of this research paper is to assess the relationship between the quality factor and its dimensions, an expansion in the number of quality definitions used in the paper could allow the study to make further observations regarding the factor. The assumption that the composite quality score acts as an individual measure of a stock's quality ignores the possibility that other measures may similarly, or more effectively, capture the quality of a stock Such quality definitions, individual or multidimensional, may also exhibit factor-like traits. Identifying similarities in the performance, behavior and correlation of multiple quality definitions would enhance the study's ability to identify a true quality factor.

7.3 Conclusion

This research paper explored the topic of the quality factor, a market characteristic that is related to the cross section of expected returns. Specifically the study assessed the presence, performance and drivers of this factor. The findings imply that the quality is a robust financial factor, whose unexplained risk-return relationship allows for the generation of high risk adjusted returns. This factor is indeed a market and pricing anomaly, thus far foreign to theories in-line with efficient markets. Moreover, the study identifies that the dimensions of quality do not consistently drive the performance of the factor. While implying that the profitability and safety dimensions are strong contributors to this phenomenon, these dimensions also exhibit negative interaction with the factor in certain stages of the economy, thus indicating that quality is a dynamic factor that displays various quality characteristics in differing market environments.

The study adds value to the existing literature in a number of ways. The research paper lends support to studies that posit the existence of a quality factor in financial equity markets (Asness et al. 2013, Daco, 2018, Novy-Marx, 2014 and Grantham, 2004). Moreover, while many papers posit the performance of the factor under various definitions of the economy (Asness et al. 2013 and Daco, 2018), these investigations fail to break down the economic environment in a detailed manner. This study eschews such failures by implementing a

4-stage economic cycle, thus creating a new set of findings for the related literature. Furthermore, while many studies analyze the nature of pricing related to such financial factors, this study focuses on the dimensional drivers of the performance of the multidimensional quality factor. This allows for the presentation of results that indicate what exactly drives the high risk-adjusted returns associated with the factor. Such an investigation has yet to been identified in the literature regarding the factor at hand in this research. The findings in this paper thus hold obvious implications for researchers working on the frontier of factor investing, while also providing valuable evidence for practitioners from which they can use these discoveries of this paper to model investment strategies.

This research opens the door for further inspection of a quality factor, and the dimensions of which it consists. Such studies could investigate the presence, performance and drivers of any financial factor present in markets using a similar methodology to the one explored in this paper. Moreover, future papers could look to expand upon the comprehension of quality, thus working toward a universal definition and measurement of the factor. While this study generates a plausible and significant set of findings that create value for those interested, much work is still left to be completed under the topic of the quality factor, thus a large portion of the quality puzzle remains unsolved.

8 References

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, *23*(4), 589-609.

Ang, A. (2013). Factor investing. *Columbia Business School Research Paper*, 13-42.

Ang, A., Hodrick, R., Xing, J., Xing, Y., , & Zhang, X. (2009). High idiosyncratic volatility and low returns: International and further us evidence. *Journal of Financial Economics*, *97*(1), 1-23.

Asness, C., Frazzini, A., & Pedersen, L. (2013). Quality minus junk. *Review of Accounting Studies*, *24*(1), 1-80.

Baker, M., & Wurgler, J. (2002). Market timing and capital structure. *Springer*, *57*(1), 1-32.

Ball, R., Gerakos, J., Linnainmaa, J. T., & Nikolaev, V. V. (2015). Deflating profitability. *Journal of Financial Economics*, *117*(2), 225-248.

Banz, R. W. (1981). The relationship between return and market value of common stocks. *The Journal of Financial Economics*, *9*(1), 3-18.

Bazgour, T., Heuchenne, C., & Sougné, D. (2016). Conditional portfolio allocation: Does aggregate market liquidity matter? *Journal of Empirical Finance*, *35*, 110-135.

Bender, J., Briand, R., Melas, D., & Subramanian, R. A. (2013). Foundations of factor investing. *SSRN 2543990*.

Black, F. (1993). Estimating expected return. *Financial analysts journal*, *49*(5), 36-38.

Blitz, D. (2016). The value of low volatility. *The Journal of Portfolio Management*, 94-100.

Bouchaud, J., Ciliberti, S., Landier, A., Simon, G., & Thesmar, D. (2016). The excess returns of "quality" stocks: A behavioural anomaly. *The Journal of Investment Strategies*, 51-61.

Bouchaud, J. P., Krueger, P., Landier, A., & Thesmar, D. (2019). Sticky expectations and the profitability anomaly. *The Journal of Finance*, *74*(2), 639-674.

Burns, A. F. (1946). Measuring business cycles.

Campbell, J. Y. (2008). Estimating the equity premium. *Canadian Journal of Economics/Revue canadienne d'économique*, *41*(1), 1-22.

Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of finance*, *52*(1), 57-82.

Cochrane, J. H. (2011). Presidential address: Discount rates. *The Journal of Finance*, *66*(4), 1047-1108.

Daco, J. (2018). Quality investing : design of a quality definition from a practitioners' perspective.

Damodaran, A. (2016). Damodaran on valuation: security analysis for investment and corporate finance. *John Wiley Sons.*, *324*.

Daniel, K., & Titman, S. (2006). Market reactions to tangible and intangible information. *The Journal of Finance*, *61*(4), 1605-1643.

de Groot, B. E. (2006). Essays on economic cycles. *Columbia Business School Research Paper*, *45*(3).

Emsbo-Mattingly, L., Hofschire, D., Litvak, A., & Lund-Wilde, J. (2017). The business cycle approach to equity sector investing. *Fidelity Investments*.

Fama, & French, K. (1992). The cross section of expected stock returns. *The Journal of Finance*, *47*(2), 427–465.

Fama, E., & French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3-56.

Fama, E. F., & French, K. R. (2005). Financing decisions: who issues stock? *The Journal of Financial Economics*, *76*(3), 549-582.

Frazzini, A., & Pedersen, L. H. (2014). Betting against beta. *Journal of Financial Economics*, *111*(1), 1-25.

George, T. J., & Hwang, C. Y. (2010). A resolution of the distress risk and leverage puzzles in the cross section of stock returns. *Journal of Financial Economics*, *96*(1), 56-79.

Graham, B. (1965). The intelligent investor. , 1-28.

Grantham, G. (2004). The case for quality—the danger of junk. *GMO White Paper*.

Greenblatt, J. (2006). The little book that beats the market. *John Wiley Sons.*.

Hamilton, M., & Longis, A. d. (2015). Dynamic asset allocation through the business cycle: A macro regime approach. *Columbia Business School Research Paper*, Oppenheimer Funds.

Hanauer, M. X., & Huber, D. (2018). Constructing a powerful profitability factor: International evidence. *The Journal of finance*.

Harvey, C. R., Liu, Y., & Zhu, H. (2016). . . . and the cross-section of expected returns. *The Journal of Finance*, *29*(1), 5-68.

Haugen, ., R. A, & Heins, A. J. (1972). On the evidence supporting the existence of risk premiums in the capital market.

Hong, H., & Sraer, D. (2012). Speculative betas. *Working Paper No.w18548*.

Hou, K., Xue, C., & Zhang, L. (2015). Digesting anomalies: An investment approach. *The Review of Financial Studies*, *28*(3), 650-705.

Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance*, *48*(1), 65-91.

Joyce, C., & Mayer, K. (2012). Profits for the long run, affirming the case for quality. *GMO White Paper*.

Kahneman, D., & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. , 263-292.

Kondratiev, N. D. (1925). The major economic cycles.

Kuczynski, T. (1987). Marx and engels on long waves. in the long-wave debate. *Springer*, 35-45.

Kumar, A. (1979). Who gambles in the stock market? *The Journal of Finance*, *64*(4), 1889-1933.

Lintner, J. (1965). Security prices, risk, and maximal gains from diversification. *The Journal of Finance*, *20*(4), 587-615.

Lo, A. W., & MacKinlay, A. C. (1990). Data-snooping biases in tests of financial asset pricing models. *The Review of Financial Studies*, *3*(3), 431-467.

Mohanram, P. S. (2005). Separating winners from losers among lowbook-to-market stocks using financial statement analysis. *Review of accounting studies*, *10*(3), 133-170.

Mossin, J. (1966). Equilibrium in a capital asset market. *Econometrica: Journal of the econometric society*, 425-442.

Novy-Marx, R. (2013). The other side of value: The gross profitability premium. , *108*, 1-28.

Novy-Marx, R. (2014). Quality investing.

Ohlson, J. A. (1980). Financial ratios and the probabilistic prediction of bankruptcy. *Journal of Accounting Research*, 109-131.

Penman, S. H. (2007). Financial statement analysis and security valuation. *New York: McGraw-Hill.*, *3*.

Piotroski, J. D. (2000). Value investing: The use of historical financial statement information to separate winners from losers. *Journal of Accounting Research*, *38*, 1-52.

Ross, S. (1976). The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, *13*(3), 341-360.

Schumpeter, J. A. (1939). Business cycles. *New York: McGraw-Hill*, *1*, 74-161.

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, *19*(3), 425-442.

Shleifer, A., & Vishny, R. W. (1997). The limits of arbitrage. *The Journal of finance*, *52*(1), 35-55.

Sloan, R. G. (1996). Do stock prices fully reflect information in accruals and cash flows about future earnings. *Accounting Review*, 289-315.

Stattman, D. (1980). Book values and stock returns. *The Chicago MBA: A journal of selected papers*, *4*(1), 25-45.

Treynor, J. L. (1961). Market value, time, and risk. *Time, and Risk*.

Van Gelderen, E., & Huij, J. (2014). Academic knowledge dissemination in the mutualfund industry: Can mutual funds successfully adopt factor investing strategies? *The Journal of Portfolio Management*, *40*(4), 157-167.

Zhang, L. (2005). The value premium. *The Journal of Finance*, *69*(1), 67-103.

9 Appendix

9.1 Quality and Dimension Scores

This section details dimension and quality z-scores that are used in the methodology. The definitions of these variables used correspond to CRSP and Compustat i.d. codes. Returns are quoted monthly, while accounting variables are quoted annually. In this section the time subscript (t) refers to years. The construction of these variables are based on the findings of Altman (1968), Ohlson (1980), Ang et al. (2009), Daniel & Titman (2006), Penman (2007), Campbell (2008), Novy-Marx (2013), Frazzini & Pedersen (2014), and Asness et al. (2013). The process for calculating each z-score of variable (x) at time (t) involves ranking x cross-sectionally in ascending order of each variable. Expressed as; rx=rank(x). These ranks are re-scaled to have a cross-sectional means of 0 and standard deviations of 1, expressed as; z(x)=zx=((rx-r(x))/(std*rx)). Dimensional z-scores are computed by averaging five z-score measures related to each dimension. The quality z-score is the computed by averaging the z-scores of each dimension, the equations through which each score is expressed are detailed in Section 3 of the research paper.

9.1.1 Profitability Score

Profitability is computed with return on equity (ROE), return on assets (ROA), cash flow over assets (CFOA), gross profits over assets (GPOA) and gross margin (GMAR). ROE is net income divided by book-equity (IB/BE). ROA is net income divided by total assets (IB/AT). CFOA is net income plus depreciation minus changes in working capital and capital expenditures divided by total assets ((NB+DP-WCC-CAPX)/AT). GPOA is equal to revenue minus costs of goods sold divided by total assets ((REVT-COGS)/AT), and GMAR is revenue minus costs of goods sold divided by total sales ((REVT-COGS)/SALE). Working capital WC is defined as current assets minus current liabilities minus cash and short-term instruments plus short-term debt and income taxes payable (ACT-LCT-CHE+DLC+TXP). Book equity BE is defined as shareholders' equity minus preferred stock (SEQ-PSTK) .

9.1.2 Growth Score

The growth score is computed using the five-year growth in residual profitability measures. In each measure the lowercase components indicate quantities per share. For instance, for all growth accounting measures X, we let x X/S, with S representing the split-adjusted number of shares outstanding. Growth in residual return on equity is computed by; ((ib(t)-rfbe(t-

1))(ib(t-5)-rfbe(t-6)/be(t-5)) and the growth in residual return over assets is ((ib(t)-rfa(t-1)-(ib(t-5)-rfa(t-6)/a(t-5)). Growth in residual cash flow over assets is; ((cf(t)-rfa(t-1)-(cf(t-5)-rfa(t-6)/at(t-5)) where CF = IB+DP-WCC-CAPX. Growth in residual gross profits over assets is calculated by; ((gp(t)-rfat(t-1)-(gp(t-5)-rfat(t-6)/at(t-5)) and the five-year growth in gross margin is; ((gp(t)-gp(t-5))/sale(t-5)).

9.1.3 Safety Score

The safety score is computed averaging the z-scores of low beta (BAB), low leverage (LEV), low bankruptcy risk (O-score and Z-score), and low earnings volatility (EVOL). BAB is equal to minus market beta. LEV is minus total debt over total assets -((DLTT+DLC+MIBT+ PSTK)/AT). Altman's Z-Score is a weighted average of working capital, retained earnings, earnings before interest and taxes, market equity, and sales, divided by total assets; Z=(1.2WC+1.4RE+3.3EBIT +.6ME+SALE)/AT. EVOL is the standard deviation of annual ROE over the past 5 years. Ohlson's O-Score is computed as; O = -(-1.32-0.407*log (ADJAST/CPI)+6.03*TLTA-1.43*WCTA+0.076* CLCA-1.72*OENEG-2.37* NITA-1.83* FUTL+0.285*INTWO-0.521*CHIN). ADJAST is (AT+.1(MEBE)). CPI is the consumer price index. TLTA is equal to book value of debt ((DLC+DLTT)/ADJAST). WCTA is current assets minus current liabilities scaled by adjusted assets; ((ACT-LCT)/ADJAST). CLCA is (LCT/ACT). OENEG is a dummy equal to 1 if total liabilities exceed total assets (LT>AT). NITA is net income over assets (IB/AT). FUTL is pre-tax income over total liabilities (PT/LT). INTWO is a dummy equal to one if net income is negative for the current and prior year ((MAX(IB(t)-IB(t-1))<0). CHIN is changes in net income ((IB(t)-IB(t-1)/(ABSIB(t)+ABSIB(t-1)), where ABSIB is the absolute value of IB

9.1.4 Payout Score

The payout score is computed by averaging the z-scores of net equity issuance (EISS), net debt issuance (DISS), and total net payout over profits (NPOP), low accruals (ACC) and a payout ratio (PAY). EISS is the minus one-year percentage change in split-adjusted number of shares (-log(SHROUTADJ(t)/SHROUTADJ(t-1)). SHROUTADJ corresponds to split-adjusted shares outstanding. DISS is the minus one-year percentage change in total debt (-log(TOTD(t)/TOTD(t-1)). NPOP is equal the sum of total net payout over 5 years (IB-BE)/(RETV-COGS). ACC is depreciation minus changes in working capital; (-(WCC-DP)/AT), while PAY is equal to dividends divided by net income (DIV/IB).

9.1.5 Quality Score

The quality z-score is computed by averaging each of the dimensional z-scores to create an overall quality score. The quality measure thus simultaneously combines profitability, growth, safety and payout measures of the firms present in the sample universe.

9.2 Economic Indicators

The indicator variable used in this study is the gdp ratio to trend (GDP), sourced from the OECD Statistics Database and reported monthly. GDP can define the state of the economy in the following ways; positive (GDP>100), negative (GDP<100) and neutral (GDP=100). Determining the change in monthly GDP (CGDP=GDP(t)/GDP(t-1)) allows the study to define if the economy is expanding of contracting. By imparting CGDP on GDP this study can create a set of final indicator variables that define the economy in 4 states, similar to the model of Schumpeter (1939). In this case, economic expansion corresponds to; positive GDP and CGDP>1, recession is defined by a positive GDP and CGDP<1, depression is assumed with a negative GDP and CGDP<1 and recovery is affirmed with a negative GDP and CGDP>1. The indicator variables therefore identify the state of the economy over the course of 1-month. These definitions are in line with the National Bureau of Economic Research (NBER) definitions of the economic cycle, where recovery and expansion are deemed as early and late pure expansion periods between the trough and peak, and recession and depression are regarded as early and late phases of a recession recession between peak and trough (Moore, 1983).

This variable is altered in the robustness check of Section 4.4.2, and in Table 8 of the Appendix. The alterations are incorporated in order to calculate the economic environment over a 3-month and 6-month period. These alterations are assumed by calculating the average GDP and CGDP over 3-months and 6-months respectively.

9.3 Research Paper Resources

The analyses conducted in this research paper was carried out on Stata 15.1MP, including the formation of all variables, sub-variables and econometric models. The formatting of tables and figures in the study was conducted through Microsoft Excel and LaTeX coding. The literature upon which the research paper was built was sourced form a variety of financial journals, books and reports. The final version of this document is presented in LaTex typesetting form.

Table 8: This table reports the results of an expansion on the robustness check in Section 4.4.2. The results displayed are derived from a regression of the quality factor on its dimensions in the economic cycle, as expressed in equation 8. These results correspond to an analysis which defines each economic phase over a 6-month period, rather than a 1-month or 3-month period, as previously explored in the research paper. Column 1 details the findings in periods of economic expansion, while columns 2, 3 and 4 catalogue the findings that pertain to periods of recession, depression and recovery. The analysis allows the study to determine if the finding presented earlier in the study are robust to an alternative 6-month measurement of the economic environment.

Alternate Definition of the Economic Cycle II

Dimensions		1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor
Profitability Score	Coef.	1.82e-06***	-2.60e-06***	-1.17e-06***	2.06e-06***
	Std.Err	1.15e-07	1.88e-07	1.48e-07	1.01e-07
	Tstat.	15.88	-13.38	-7.19	20.45
Growth Score	Coef.	-9.85e-07***	-2.01e-07*	-7.67e-07***	-1.35e-06***
	Std.Err	6.58e-08	1.07e-07	8.54e-07	5.73e-08
	Tstat.	-14.95	-1.88	-8.99	-23.57
Safety Score	Coef.	3.15e-07***	7.87e-07***	-9.73e-08	-5.88e-07***
	Std.Err	9.51e-08	1.59e-07	1.24e-07	8.34e-08
	Tstat.	3.31	4.95	-0.78	-7.05

Alternate Definitions of the Economic Cycle II Continued

Dimensions		1 Quality Factor	2 Quality Factor	3 Quality Factor	4 Quality Factor
Payout Score	Coef.	-1.18e-06***	-9.48e-07***	-4.39e-07***	-1.04e-06***
	Std.Err	8.8e-08	1.45e-07	1.13e-07	7.72e-08
	Tstat.	-13.45	-6.53	-3.88	-13.43
Constant	Coef.	0.006***	0.011***	0.009***	0.007***
	Std.Err	1.87e-04	2.68e-04	2.56e-04	1.78e-04
	Tstat.	36.4	42.51	35.51	44.16
Obs		432,313	284,999	363,946	441,515
Stocks		9,230	8,664	9,030	9,245
R-squared		0.001	0.002	0.001	0.002

The dimensions of quality are expressed via the Profitability Score, Growth Score, Safety Score and the Payout Score. The loading's for each of the dimensions on the quality factor are reported for the newly defined economy through a coefficient (Coef), standard error (Std.Err) and relative t-statistic (Tstat). The intercept (Constant) is also expressed in this manner. Moreover, the number of observations (Obs) and assets (Stocks), along with the goodness-of-fit (R-squared) is also reported for each regression. The notation on the coefficient implies statistical significance at the following p-value levels; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 9: This table reports the results of a portfolio analysis carried out during an isolated sub-sample period during the U.S financial crisis. The methodology used for conducting this analysis is in line with that of the in Section 4.1. The results allow an insight to the performance of the quality factor during each stage of the economic cycle throughout a particularly volatile time-frame for U.S financial markets. The period under which this analysis was conducted is in-line with the time period explored in Section 5.4.1

U.S Financial Crisis 07/08 Portfolio Analysis

Variable		Expansion	Recession	Depression	Recovery
Quality Portfolio 4:	Mean	0.016	0.009	0.005	-0.002
	Std.Dev	0.010	0.035	0.063	0.025
	Sharpe	1.541	0.268	0.082	-0.083
	Mktrf	0.002	-0.021	-0.021	0.027
	Alpha	0.013	0.0311	0.026	-0.029
	Tstat	5.22	2.25	-0.83	1.68

The mean (Mean) and standard deviation (Std.Dev) of the returns generated by the quality factor portfolio are reported. Also recorded are risk-adjusted performance measures, such as the Sharpe ratio (Sharpe) and Jensen's Alpha (Alpha). The average of the return on the market portfolio (Mktrf) is also provided as a reasonable benchmark. Finally, the results are supported by a relevant t-statistic (Tstat) to provide an insight to the significance of the findings. These measures are computed for the quality factor in the period of economic expansion, recession, depression and recovery throughout the U.S financial crisis.

Table 10: This table records the correlations among the dimensional variables present in this study. The variables PR, GR, SR and POR represent the dimensional score computed in Section 3.2 of the research paper, while the variables P1, P2, G1, G2, S1, S2, PO1 and PO2 reflect the dimensional measures computed via the principle components analysis in Section 8.3. This table provides an important insight into how such dimensions relate to one-another. Moreover, the table allows the study to assess the accuracy of the principle components analysis, specifically with regards to its generation of synthetic factors and their subsequent correlation with the factors upon which they are based.

Dimensional Factors Correlation Matrix

	PR	GR	SR	POR	P1	P2	G1	S1	S2	PO1	PO2	
PR	1											
GR	0.398*	1										
SR	0.541*	0.230*	1									
POR	0.559*	0.316*	0.502*	1								
P1	0.074*	0.152*	-0.034*	0.099*	1							
P2	-0.015*	-0.018*	-0.002*	-0.021*	-0.061*	1						
G1	0.029*	0.154*	0.004*	0.011*	0.106*	0.001	1					
G2	-0.009*	0.0005	-0.004*	-0.009*	-0.027*	0.051*	0.009*	1				
S1	0.095*	0.156*	0.070*	0.075*	0.518*	-0.030*	0.039*	-0.043*	1			
S2	-0.035*	-0.062*	0.045*	-0.020*	0.042*	0.396*	-0.006*	0.001	0.011*	1		
PO1	0.037*	-0.029*	0.057*	0.134*	0.064*	-0.007*	0.012*	-0.004*	0.092*	0.026*	1	
PO2	0.001	0.010*	-0.029*	0.068*	0.063*	-0.002*	0.004*	0.001	0.026*	0.014*	0.055*	

The initial profitability (PR), growth (GR), safety (SR) and payout (POR) dimensions identified in Section 3.3 of the paper are included in the matrix. Moreover, the related profitability (P1 and P2), growth (G1 and G2), safety (S1 and S2) and payout (PO1 and PO2) factors, generated from the principle components analysis in Section 8.3, are also incorporated into the matrix.

Table 11: This table reports correlation matrix's that are of relevance to the research. Slide A represents the correlation of Portfolio 1, 2, 3 and 4, previously identified in Section 5.1 of the paper. These correlations provide an insight to the relationships displayed among these investment vehicles, and is thus important for the comprehension of the quality factor. Slide B of the table identifies the correlation matrix pertaining to quality, size, value and momentum factors. These factors are initially identified in Section 5.2 of the study. This slide demonstrates how prominent factors present in financial literature correlate with one another.

Portfolio and Factor Correlation Matrix

Slide A	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4
Portfolio 1	1			
Portfolio 2	.	1		
Portfolio 3	.	.	1	
Portfolio 4	-0.341*	-0.070*	0.160*	1

Slide B	Quality	Size	Value	Momentum
Quality	1			
Size	0.022*	1		
Value	-0.224*	-0.230*	1	
Momentum	0.305*	0.025*	-0.192*	1

Slide A captures the correlation matrix produced between low quality (Portfolio 1), mid quality (Portfolio 2), high quality (Portfolio 3) and the quality factor (Portfolio 4) portfolios in the U.S sample 1962-2018. Slide B captures the correlation Matrix between the quality factor (Quality) and the factors identified in Section 5.2 of the research paper (Size, Value and Momentum) in the same sample. This table allows one to asses the interrelationships held amongst portfolios and factors respectively.

Table 12: This table reports the summary statistics that are related to the sample-wide portfolio analysis deployed in Section 5.1 of the research paper. The table provides an indication of the average statistics and relevant measures for Portfolio 1, 2, 3 and 4. Portfolio 4 represent the quality factor computed in this study, and is thus used throughout the papers methodology. The tables provides information pertaining to the performance aspects of each portfolio, while also displaying information that relates to the portfolios composition and the data-set. This allows the study to quickly asses the profile of the portfolios defined above, with portfolio 4 being of specific importance through the whole research endeavour.

Portfolio Summary Statistics

Statistical Measure	Quality Portfolio 1	Quality Portfolio 2	Quality Portfolio 3	Quality Portfolio 4
Mean	0.001	0.004	0.008	0.007
Std.Dev	0.044	0.044	0.045	0.023
Sharpe	0.021	0.101	0.187	0.321
Alpha	-0.004	-0.001	0.003	0.002
Tstat	-6.102	-0.578	4.80	7.74
Min	-.204	-.224	-.216	-.091
Max	.176	.208	.207	.111
Mktrf	0.004	0.004	0.004	0.004
Obs	684	684	684	684
Dec	2	5.5	9	-

Quality Portfolios 1, 2 and 3 represent allotments of quality stocks in ascending order. Portfolio 4 represents the long-short quality factor investment. The statistics pertaining to these portfolios include the mean (Mean), minimum (Min), maximum (Max) and standard deviation (Std.Dev) of portfolio returns. Risk-adjusted performance measures such as the Sharpe ratio (Sharpe) and Jensen's Alpha (Alpha) are also recorded for these portfolios. Moreover, the average of the return on the market portfolio (Mktrf), the number of relevant observations (Obs) and the average decile (Dec) selected for each portfolio are also reported.

Table 13: This table presents the summary statistics pertaining to each dimension of quality, along with overall quality, as expressed in Section 3.2 and 3.3. Column 1 records these descriptive statistics for the profitability score, while columns 2, 3, 4 and 5 details the statistics for growth, safety, payout and quality scores respectively. These statistics are useful to profile the variables that were used in the central methodology of the research paper.

Summary Statistics: Quality and Quality Dimensions

	1 Profitability	2 Growth	3 Safety	4 Payout	5 Quality
Statistic:					
Mean	1859.50	1262.05	1920.57	1699.33	1808.34
Std.Dev	620.55	722.81	983.63	825.72	800.18
Min	1	1	1	1	1
Max	5158	3625	6030	5441	6024
Obs	2,314,785	1,526,770	2,663,817	2,530,827	2,695,149
Skew	-.20	.43	1.22	.66	1.16
Kurt	2.66	2.49	4.98	3.77	5.59

This table displays the mean (Mean) standard deviation (Std.Dev), minimum (Min), maximum (Max), number of observations (Obs), skewness (Skew) and kurtosis (Kurt) for the quality score, along with for the score of each quality dimension.

Table 14: This table presents the correlation matrix's for each dimension of quality, as identified in Section 3.2. This table provides an insight to the relationships that exist among fundamental measures of similar dimensions. Slide A presents the matrix relating to the profitability dimensions measures, while Slide B, C and D represent the matrix's of the growth, safety and payout dimensions respectively.

Dimensional Correlation Matrix

Slide A	roa	roe	gmar	cfoa	gpoa
roa	1				
roe	(0.02)	1			
gmar	0.01	(0.00)	1		
cfoa	(0.92)	0.01	(0.03)	1	
gpoa	(0.84)	0.02	(0.01)	0.12	1

Slide B	roag	roeg	gmarg	cfoag	gpoag
roag	1				
roeg	0.01	1			
gmarg	0.04	0.00	1		
cfoag	0.98	0.00	0.03	1	
gpoag	0.96	0.00	0.07	0.96	1

Slide C	lev	evol	alt	ohl	beta
lev	1				
evol	(0.01)	1			
alt	0.005	(0.00)	1		
ohl	(0.07)	0.00	(0.36)	1	
beta	(0.00)	(0.00)	0.00	(0.00)	1

Slide D	eiss	diss	npop	acc	pay
eiss	1				
diss	0.02	1			
npop	(0.00)	(0.00)	1		
acc	(0.00)	(0.05)	(0.00)	1	
pay	0.00	(0.00)	(0.00)	0.000	1

Reported are the correlation coefficients for each variable in relation to another, clustered by dimension. Positive coefficients are presented in standard form, while negative coefficients are displayed in parentheses. The diagonal figure represents a measures own correlation with itself.

Table 15: This table reports the statistical findings that were present in each principle components analysis, as explored in Section 4.4.3. The table documents these statistics for each individual analysis of the dimensions of quality. Slide A records the statistics inherent to the analysis of profitability. Slide B, C and D record the statistics for the growth, safety and payout dimensions respectively.

Principle Components Analysis

Slide A			**Slide B**		
P1	Eigenvalue	2,041	G1	Eigenvalue	2,181
	Cum.Prop	0,408		Cum.Prop	0,436
	Variance	2,039		Rotate.Var	2,181
P1	Eigenvalue	1	G2	Eigenvalue	1,009
	Cum.Prop	0,608		Cum.Prop	0,638
	Rotate.Var	1,013		Rotate.Var	1,009
	Obs	1.701.294		Obs	1.044.029
	KMO	0,7		KMO	0,58
	Uniqueness	0.13–0.74		Uniqueness	0.09–0.51

Slide C			**Slide D**		
S1	Eigenvalue	1,482	PO1	Eigenvalue	1,056
	Cum.Prop	0,296		Cum.Prop	0,211
	Rotate.Var	1,482		Rotate.Var	1,055
S2	Eigenvalue	1,002	PO2	Eigenvalue	1,002
	Cum.Prop	0,497		Cum.Prop	0,4117
	Rotate.Var	1,002		Rotate.Var	1,003
	Obs	1.048.268		Obs	897.991
	KMO	0,55		KMO	0,5
	Uniqueness	0.36–0.60		Uniqueness	0.44–0.74

The table displays the average variance captured by the principle components (Eigenvalue), the cumulative proportion of variance captured amongst the measures used (Cum.Prop) and the rotated factor variance (Variance) for each factor generated in the principle components analysis. Moreover, the number of observations (Obs), range of remaining uniqueness amongst the variables (Uniqueness) and the sampling adequacy of the data, and the Kaiser-Meyer-Olkin test (KMO) are also recorded. These statistics are reported for each dimension of quality, each generating two factors; profitability (P1 and P2), Growth (G1 and G2), Safety (S1 and S2) and Payout (PO1 and PO2).

Table 16: This table catalogues the results pertaining to the hypothesis testing of the Sharpe ratios across investment portfolios explored in Section 5.1. The table displays the differences recorded in the performance measures across multiple portfolio combinations, which are supported by statistics indicating significance.

Sharpe Ratio Hypothesis Test

Sharpe Ratio	Stat	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4
Portfolio 1	Diff	-			
	Tstat	-			
	Deg.Free	-			
	Std.Err	-			
	P-Value	-			
Portfolio 2	Diff	-.081	-		
	Tstat	-4.98	-		
	Deg.Free	683	-		
	Std.Err	.016	-		
	P-Value	1	-		
Portfolio 3	Diff	-.166	-.085	-	
	Tstat	-8.74	-5.72	-	
	Deg.Free	683	683	-	
	Std.Err	.019	.014	-	
	P-Value	1	1	-	
Portfolio 4	Diff	-.301	-.220	-.134	-
	Tstat	-4.92	-4.06	-2.81	-
	Deg.Free	683	683	683	-
	Std.Err	.061	.054	.047	-
	P-Value	1	1	1	-

Reported are the differences between average Sharpe ratios (Diff), the t-statistic (Tstat), degrees of freedom (Deg.Free), the standard error (Std.Err) and the P-value (P-Value) that result from the comparison of portfolio performance between two quality-based portfolios.