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Corporate Culture's Impacts

On Companies' Asset Prices

By

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Abstract

This paper explores the quantitative impacts that corporate cultures have on US publicly-traded firms' rate of return on stocks. By studying companies contained in the 2019-launched MIT SMR/Glassdoor Culture 500 index, I employ both the Carhart four-factor model and the Carhart four-factor model with the Culture Factor, a self-generated long-short strategy, to study the excess returns on asset prices associated with differences in corporate cultures. The analysis shows that there is no statistically-significant difference in companies' excess returns on asset prices for those with the best (top 20%) and the worst (bottom 20%) corporate cultures. In addition, the inclusion of the additional risk factor (i.e., the Culture Factor) fails to add explanatory powers to the Carhart four-factor model. Therefore, according to this analysis, company cultures do not offer additional information on asset prices for investors, and they shall not be major factors in investment decisions.

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1. Introduction

Corporate culture has been one of the main evaluative characteristics of companies in contemporary society, both for investors and employees. For investors, good corporate culture may imply favorable management and stable financial performances; for employees, companies with favorable culture are more likely to provide them with satisfying work environments. In many cases, people tend to link corporate culture considerations with job or investment decisions – they believe that companies with favorable cultures are more inclined to adhere to valued business ethics and consequently are more likely to be profitable.

Previous literature has shed light on the relationship between the two. Theoretically, favorable corporate culture can benefit corporate performance through three channels: "enhanced coordination and control within the firm, improved goal alignment between the firm and its members, and increased employee effort" (Sørensen 2002). Hence, favorable corporate culture positively contributes to a business's operation. We see a similar emphasis on corporate culture in the real world. An MIT Sloan's study found that more than 80% of nearly 700 large companies published their official sets of corporate values on websites (Sull 2020). Empirical examples similarly show that corporate culture matters for a company's financial performance. In February 2018, Wells Fargo lost $30 billion in its market capitalization in a single day, led by the detection of its fraudulent sales practices, the root cause of which was the distortion of its sales culture (Fargo 2017). Therefore, we consistently see examples of investors' and employees' intuitive favoring of firms with good culture, or punishment of unfavorable business practices associated with distorted cultures.

1.1 Research Question

While most evidence of the significance of corporate culture on a company's financial performance is anecdotal or empirical, is the impact of culture on firms statistically significant or quantitatively proven? Thus, the overarching theme of my research is whether and how corporate culture impacts firms' financial performance. To have a more targeted study, I mainly focus on firms publicly traded in the US, whose measurements of cultures and financial performances are more established. Fitting tangible metrics, my research question is what quantitative impacts do corporate cultures have on US publicly-traded firms' rate of return on stocks? In particular, corporate culture is measured and calculated from Glassdoor reviews, which provide information from current and former employees that can be operationalized consistently to examine corporate culture; and a study of culture's impacts on companies' asset prices provide practical insights for investors.

The research contributes to the existing literature by bridging the gap between an intuitive favoring of good corporate culture and its actual quantitative impacts on company performance. Instead of relying on small sample surveys to gauge company culture, this study employs the company culture scores calculated from a large sample of Glassdoor reviews to study corporate cultures. Specifically, if I were to find statistically-significant excess returns attributable to company cultures, I may inform investors' decisions of the risk premium associated with corporate cultures. Otherwise, I would argue that culture's impacts on firms' asset prices are inconsequential, thus less of a concern in investment decisions.

The paper has the following structure: Section 2 presents the theoretical and empirical literature reviews; Section 3 introduces the data sampling and selection processes; Section 4 shows the theories, models, and results of my analysis; and Section 5 concludes my study.

2. Literature Review

2.1 Theoretical Literature

The main constructs in my research are corporate culture and company financial performance. According to O'Reilly and Chatman (1996), culture is defined as "a set of norms and values that are widely shared and strongly held throughout the organization." Notably, culture provides a shared purpose for work, representing an unspoken code of communication among employees (Guiso, Sapienza, and Zingales 2013). Given the definition, culture strongly influences employees' practices. Theoretically, with favorable company cultures and working environments, employees are more inclined to pursue positive social impacts, as they feel more connected to the beneficiaries of their work (Michaelson et al. 2014). Previous research shows that meaningful work provides a variety of benefits to employees, including "job satisfaction, work motivation, ... performance, citizenship behaviors, and attachment to occupations and organizations" (Michaelson et al. 2014). Organizations that promote working with a goal thus drive employees internally when the work can "afford people the opportunity to feel part of something greater" and help "an individual feel that she is living up to one's potential" (Michaelson et al. 2014). Such theoretical arguments argue for positive correlations between favorable firm culture and stronger company financial performances, as they have workers who own control over their productions and truly produce. Therefore, the theoretical literature contributes in a direction that explains a positive relationship between favorable corporate culture and better financial performance.

Nonetheless, to practically understand whether culture contributes to company financial performances in significant ways, it is meaningful to look into how culture influences companies' asset prices. Compared to other metrics of financial performances, including market capitalization, return on assets, etc., asset prices and their movement patterns most directly inform investment decisions. We therefore start with the classical asset pricing models, including the Capital Asset Pricing Model (CAPM), Fama-French three-factor model, and the Carhart four-factor model, to explore the potential impacts of culture on asset prices.

According to the CAPM, if one diversifies his portfolio, he is able to attain any desired point along a capital market line (Sharpe 1964). Hence, one may obtain a higher expected rate of return on his holdings only by incurring additional risk. Though Eugene Fama and Kenneth French later show that, due to the simplicity of CAPM, the empirical record of the model is poor enough to invalidate the way it is used in applications (Fama and French 2004), they extend the CAPM with the Fama-French three-factor model by identifying the three common risk factors that have reliable power to explain the cross-sectional asset average returns (Fama and French 1993). Such variables included in the proposed Fama-French three-factor model are 1) small minus big (SMB), which mimics the risk factor in returns related to size of firms; 2) high minus low (HML), which mimics the risk factor in returns related to book-to-market equity of companies; and 3) the market factor, which is the excess market return (Fama and French 1993). The three factors, mimicking differences of the return behaviors of different stocks, are shown to capture most of the variations in cross-sectional stock returns. Mark Carhart further builds on the Fama-French three-factor model by adding a momentum factor in his Carhart four-factor model, where the momentum factor mimics returns on value-weighted, zero-investment, factor-mimicking portfolios for size, book-to-market equity, and one-year momentum in stock

returns, and are shown to complement the three factors in the Fama-French model and capture additional variations in asset returns.

Therefore, the classical asset pricing models outline a few risk factors that are shown to explain asset prices, and all have the critical assumption of an equity risk premium – an investor shall be compensated for taking an increased level of risk. Following this line of argument, in our context, culture can influence a company's asset prices in two ways. Firstly, culture may contribute to a firm's fundamentals, captured by the explanatory common risk factors in the Fama-French or the Carhart models, including the company's earnings base (such as earnings per share) and its valuation multiple (such as the price-to-earnings ratio). Thus, different types of cultures contribute to companies' asset prices, mainly fundamentals, differently for those in different functional industries: companies in innovation-heavy industries perform better if they emphasize norms and values that promote creativity and implementation, while manufacturing firms may have stronger financial performances when they emphasize efficiency and speed (Tushman and O'Reilly 1996). Hence, culture, which encompasses norms, values, rituals, and climate, is a multidimensional construct (Tushman and O'Reilly 1996), whose different dimensions and content may impact firms' fundamentals in distinct ways.

Additionally, culture can be understood as a risk factor, which aligns with assumptions of the equity risk premium. Specifically, if the improvement of a culture, for example, decreases a company's idiosyncratic risk, such culture negatively contributes to a company's excess stock returns. On the other hand, if the improvement of a culture increases a company's idiosyncratic risk by influencing its operations, such culture positively increases a company's excess stock returns – a compensation for the increased risks. Notably, a few pieces have looked into extensions of the classical asset pricing models to explore additional factors that may impact

asset prices, including corporate social performance. In *The Eco-Efficiency Premium Puzzl*e, the authors find that a company's performance differential resulting from its corporate social performance cannot be explained by differences in market sensitivity, investment style, or industry-specific components (Derwall and Bauer 2017). In concrete terms, the researchers find a stock portfolio consisting of companies labeled "most eco-efficient" sizably outperformed its "less eco-efficient" counterpart over the period from 1995 to 2003, implying that the market fails to price eco-efficiency in an efficient manner (Derwall and Bauer 2017). While no studies of an analysis of asset prices have been done specifically with a focus on corporate culture, corporate culture may perform similarly as the eco-efficiency premium, which generates excess asset returns that are not explainable by common risk factors outlined in the Fama-French or the Carhart factor models.

2.2 Empirical Literature

The concept of corporate culture became popular in the 20th century (Sull, Sull, and Chamberlain 2019), however, many empirical studies on the subject present mixed findings. A 2013 piece, *The Value of Corporate Culture* (Guiso, Sapienza, and Zingales 2013), provides a fundamental examination of corporate culture. In the article, Guiso, Sapienza, and Zingales analyzed the relationship between the entire S&P 500's performances and their advertised social values as of June 2011. The authors classified company cultures into nine categories – Integrity, Teamwork, Innovation, Respect, Quality, Safety, Community, Communication, and Hard Work (Guiso, Sapienza, and Zingales 2013). With one exception, the research finds little evidence that advertised values are correlated with performance measured by Tobin's Q (market value of a company divided by its assets' replacement cost) (Guiso, Sapienza, and Zingales 2013). The

approach, looking at the advertised cultures on websites as opposed to sampling from employee reviews, can be problematic. Notably, the true corporate culture fostered in the working environment can be noticeably different from those advertised: as an MIT Sloan's research piece shows, the correlations between the values a company emphasizes officially and how well the company lives up to those same values in the eyes of employees either hover near zero or are negative (Sull 2020).

Nonetheless, many later studies are constructed upon the nine corporate values proposed in *The Value of Corporate Culture* (Guiso, Sapienza, and Zingales 2013). In *Employee Satisfaction and Corporate Performance: Mining Employee Reviews on Glassdoor.com*, Luo, Zhou, and Shon (2016) examined the relationship between employee satisfaction of company cultures and financial performances, by conducting textual analysis on anonymous employee reviews from Glassdoor. The study looks into both the quarterly overall employee satisfaction score found on Glassdoor, and the employee satisfaction over company's advertised nine cultures proposed in *The Value of Corporate Culture* (Guiso, Sapienza, and Zingales 2013). This study reveals a significant positive correlation between overall employee satisfaction calculated from Glassdoor review texts and corporate performances measured by Tobin's Q (N. Luo, Zhou, and Shon 2016). However, using Tobin's Q to determine corporate performance has its limitations: though the market value may be ascertained, it can be hard to gauge the exact replacement cost for a firm's all assets.

Hence, we may look at other studies on the subject that adopt more dynamic and accessible metrics to evaluate company performance. In the article *Does the stock market fully value intangibles? Employee satisfaction and equity prices*, Edmans analyzed the relationship between employee satisfaction on corporate culture and companies' stock returns (Edmans

2011). In the study, Edmans tracked a value-weighted portfolio of the *100 Best Companies to Work For in America* and found that these companies earned an annual four-factor alpha of 3.5% from 1984 to 2009 after regressions on the Carhart four factors, 2.1% above industry benchmarks (Edmans 2011). The companies featured in *100 Best Companies to Work for in America* have employees that have the most positive attitudes toward management, job satisfaction, fairness, and camaraderie (Edmans 2011). Thus, the analysis shows that the stock market does not fully reflect value intangibles (Edmans 2011). Furthermore, with alphas found, the paper demonstrates that employee satisfaction is beneficial to firm value but not immediately capitalized by the market (Edmans 2011).

A meta-analysis reveals similar positive relationships between favorable corporate social performance and financial performances. Notably, Margolis, Elfenbein, and Walsh find a positive but weak relationship between corporate social performance (CSP) and corporate financial performance (CFP), the former defined as a company's efforts to fulfill its economic, legal, ethical, and discretionary responsibilities, and the latter measured by both the accounting-based measures of financial returns (e.g., return on assets, return on equity) and market-based measures of financial value (e.g., stock returns, market/book value ratio) (Margolis, Elfenbein, and Walsh 2009).

3. Data

3.1 Definition of the Population

As defined in Section 1.1, my research question is what quantitative impacts do Glassdoor-review implied corporate cultures have on US publicly-traded firms' rate of returns on stocks? I aim to understand the relationship between companies' culture and their financial performances measured by stock returns. In particular, the population that I am interested in is the companies that have been actively traded in the past 10 years (from 2011 to 2021) on major US stock exchanges, whose cultures are measured quantitatively over the period as well. The choice of a 10-year time frame is both because 10-year marks a decently long and reliable study timeframe in most of the financial studies, and our culture measurements from Glassdoor are recorded over the past 13 years – so it is reasonable to juxtapose the 10-year financial performance analysis with a quantitatively measured cultural index based on around past 13 years of employee reviews. The two conditions, traded on major US stock exchanges and quantitatively measured cultures, are key to addressing my research question.

The first condition ensures that such companies' stock movements are only impacted by the US stock market. By excluding companies that trade on non-US stock exchanges, we avoid confounding variables attributable to being traded on foreign exchanges, foreign countries, and currencies other than the US dollar. The latter condition empowers my analysis of the quantitative impacts that cultures have, which allows me to juxtapose companies' culture score (in numerical terms) with their stock returns. Therefore, with this analysis, I'd be able to translate

the relationship between corporate cultures and US publicly-traded firms' financial performances into quantitative measurements.

3.2 Sample Selection

3.2.1 Description of the Sample

I use the list of companies contained in the 2019-launched MIT SMR/Glassdoor Culture 500 index ("MIT SMR's Culture 500" 2021) as the raw sample. The MIT SMR/Glassdoor Culture 500 index ("MIT SMR's Culture 500" 2021) is formed from analyzing 1.2 million employee reviews from Glassdoor using a natural language processing methodology that classifies texts into more than ninety culture-related topics, designed by MIT (Sull, Sull, and Chamberlain 2019). Since its launch in 2008, Glassdoor has collected more than 49 million employee reviews from approximately 900 thousand organizations (Sull, Sull, and Chamberlain 2019). On Glassdoor, employees rate their company's culture on a five-point scale: though the quantitative scores alone shed limited insight on the specifics of a company's culture, the mining of the free text responses – with which employees describe the pros and cons of working at a particular company and advice to management in their own words – allows for a measuring of corporate culture of various dimensions in the eyes of employees (Sull, Sull, and Chamberlain 2019).

Specifically, the Culture 500 index is composed of companies from 33 clearly defined industries, with an average of 18 companies per industry (Sull, Sull, and Chamberlain 2019). On average, a company in the Culture 500 sample has over 2000 reviews, which represent about 4% of its total employment and are equivalent to three full-length books' worth of textual data (Sull,

Sull, and Chamberlain 2019). The sample of companies contained in Culture 500 collectively employ 34 million people – the equivalent of one-quarter of private sector employment in the US (Sull, Sull, and Chamberlain 2019). Therefore, the Culture 500 index captures a decently comprehensive list of companies across industries, whose cultures can be rigorously studied with machine learning tools designed by MIT.

By analyzing employee reviews, the Culture 500 index further categorizes such reviews to the so-called *Big Nine cultures*: agility, collaboration, customer, diversity, execution, innovation, integrity, performance, and respect, the descriptions of which are shown in Table 1. Given that culture is the common belief and value shared within a company, employer reviews, which collect a diversified and randomized sample of views that describe and discuss corporate culture, provide a useful portrayal and measurement of corporate culture.

Table 1: Big Nine Cultures ("MIT SMR's Culture 500" 2021)

Culture	Definition	Also Known As
Agility	Employees can respond quickly and effectively to changes in the marketplace and seize new opportunities.	flexible, nimble, fast-moving
Collaboration	Employees work well together within their team and across different parts of the organization.	demonstrate teamwork, identify with the company, join forces
Customer	Employees put customers at the center of everything they do, listening to them and prioritizing their needs.	have a customer focus, deliver for clients, customer-driven
Diversity	The company promotes a diverse and inclusive workplace where no one is disadvantaged because of their gender, race, ethnicity, sexual orientation, religion, or nationality.	inclusive, welcomes everyone, celebrates difference

Culture	Definition	Also Known As
Execution	Employees are empowered to act, have the resources they need, adhere to process discipline, and are held accountable for results.	demonstrate operational excellence, manage projects well, take ownership
Innovation	The company pioneers novel products, services, technologies, or ways of working.	cutting edge, leads change, technologically advanced
Integrity	Employees consistently act in an honest and ethical manner.	do the right thing, behave ethically, play by the rules
Performance	The company rewards results through compensation, informal recognition, and promotions, and deals effectively with underperforming employees.	meritocratic, recognizes achievement, results-driven
Respect	Employees demonstrate consideration and courtesy for others, and treat each other with dignity.	treat others with dignity, courteous, show appreciation for one another

3.2.2 Data Selection

Given the nature of my study, I focus on firms that are publicly-traded. From the big nine cultures, I obtain a total of nine raw lists of companies contained within each culture – the further selection of my sample from each culture portfolio is done with the following steps:

1) delete companies from the list whose stocks are traded outside of the US (i.e., traded on exchanges other than the American Stock Exchange (AMEX), the New York Stock Exchange (NYSE) and the National Association of Securities Dealers (NASDAQ));

2) delete companies from the list whose stocks are traded on OTC markets;

3) delete companies from the list whose stock trading histories are outside of (mainly shorter than) the defined time frame for this study (Nov 2011 to Nov 2021).

After the data cleaning, the selected list of companies in the sample constitute a good representation of major companies publicly-traded in the US across eleven industries, from aerospace to consumer goods, who are actively traded from 2011 to 2021 and have measurable cultures. Table 2 shows the summary statistics of the data set used for analysis.

Table 2: Summary Statistics[2]

Culture	Initial Number	Post-Cleaned Number	Most Common Industries
Agility	425	203	Insurance, Internet, Health Systems
Collaboration	599	270	Specialty Retail, Apparel Retail, Fast Food
Customer	520	227	Specialty Retail, Fast Food, Insurance
Diversity	577	246	Specialty Retail, Fast Food, General Retail
Execution	598	264	Specialty Retail, Fast Food, Apparel Retail
Innovation	392	166	Insurance, Enterprise Software, Internet
Integrity	593	258	Specialty Retail, Fast Food, Insurance
Performance	411	184	Insurance, Internet, Enterprise Software
Respect	579	248	Specialty Retail, Fast Food, Apparel Retail

[2] This table shows a summary statistics of the data sample. **Initial Number** is the original number of companies contained in the corresponding culture portfolios. **Post-Cleaned** Number is the number of companies contained in respective culture portfolios after our data selection with the three steps outlined above. **Most Common Industries** indicates the industries that are most shared by the companies in the post-cleaned culture portfolio, i.e. the three highest-frequency industries of the post-cleaned list of companies.

Here, the companies are selected across industries, and different cultures have different most common industries. From Table 2, we see that different industries value different corporate cultures, i.e. social values. For example, I see that while Agility and Performance are mostly valued by insurance companies, retail companies and their employees tend to emphasize Collaboration, Customer, and Integrity more. Therefore, different cultures may exert distinctive impacts on company performances. In particular, a systematically higher cultural practice of Agility and Performance may positively contribute to insurance companies' business performance; however, if such companies overemphasize, for example, Innovation, their idiosyncratic risks may increase with a misallocation of resources to fields and social values that are not particularly relevant to their industry. What it means, most importantly, is that an improvement in culture has the potential to either positively or negatively contribute to a firm's financial performance, which informs our analysis to both respectively and collectively understand cultures' significance.

From there, I obtain the summary statistics of the financial performances of the best- and worst-ranked companies across the nine cultures. In my analysis, I partition the list of companies in each culture portfolio into five quintiles. Across the culture portfolios, six out of nine – Agility, Customer, Execution, Innovation, Performance, and Respect – have higher first quintile mean of returns, meaning that on average, sub-portfolios of better these cultures have higher average returns. On the other hand, Collaboration, Diversity, and Integrity have lower first quintile mean of returns, implying that better such cultures are negatively associated with the expected asset returns over my studied 10-year period.

Besides, with a mean return of the market portfolio of 0.0633, all cultural sub-portfolios underperform the market portfolio, which explains the negative Sharpe ratios. In addition, all

first quintile sub-portfolios have noticeably smaller standard deviations, implying less volatilities associated with better-culture companies' rate of return on stocks. This aligns with previous literature that shows that better corporate social performance lowers firm-idiosyncratic volatility (X. Luo and Bhattacharya 2009).

Table 3: Summary Statistics of Culture Quintiles[3]

Culture	Quintile	Mean	Standard Deviation	Sharpe Ratio	Maximum	Minimum
Agility	1st	0.3276	0.2651	-0.0514	0.1100	-0.0850
	5th	0.1260	67.5460	-0.0004	0.0857	-0.0843
Collaboration	1st	0.2016	0.1460	-0.1469	0.0922	-0.0881
	5th	0.2772	1321.3893	0.0000	0.0965	-0.0708
Customer	1st	0.2772	0.2445	-0.0671	0.1050	-0.0817
	5th	0.2520	223.2496	-0.0001	0.1029	-0.0882
Diversity	1st	0.1512	0.1556	-0.1611	0.0954	-0.0868
	5th	0.2016	58.2579	-0.0004	0.0530	-0.0741
Execution	1st	0.2772	0.2540	-0.0611	0.1065	-0.0841
	5th	0.1512	78.7725	-0.0003	0.0655	-0.0838
Innovation	1st	0.2520	0.1873	-0.0940	0.0928	-0.0970
	5th	0.0756	26.6231	-0.0011	0.0675	-0.0777

[3] This table shows a descriptive statistic of the data. **Quintile** denotes the data is either of the first quintile (companies with the top 20% culture scores), or of the fifth quintile (companies with the bottom 20% culture scores). **Mean** refers to the annualized mean (expectation) of returns on the market-cap weighted sum of asset returns of the companies contained in the quintile. **Standard Deviation** refers to the annualized standard deviation of returns on the market-cap weighted sum of asset returns of the companies contained in the quintile. **Sharpe Ratio** is calculated from the mean and standard deviation of the referred quintile for each quintile of portfolios. **Maximum** is the maximum value of individual firms' returns on assets of the referred quintile. **Minimum** is the minimum value of individual firms' returns on assets of the referred quintile.

Culture	Quintile	Mean	Standard Deviation	Sharpe Ratio	Maximum	Minimum
Integrity	1st	0.1512	0.1381	-0.1706	0.0696	-0.0786
	5th	0.1512	23.6895	-0.0010	0.0934	-0.0869
Performance	1st	0.2016	0.1556	-0.1338	0.0708	-0.0746
	5th	0.1008	29.8965	-0.0009	0.1135	-0.1249
Respect	1st	0.2016	0.1524	-0.1361	0.0579	-0.0730
	5th	0.1260	32.3792	-0.0008	0.0585	-0.0890

4. Models and Results

4.1 Overview of the Theories and Models

In Section 4, I will introduce the main theory, models and results of my analysis. Collectively, the theory and models allow for an understanding of whether and how corporate culture contributes to asset prices, in statistically significant or insignificant ways. In Section 4.2, I would firstly introduce the Carhart four-factor model (Carhart 1997) and examine whether the model is able to capture variations of portfolios constituted of companies with different qualities of the nine cultures respectively – in other words, I would explore how the Carhart four factors are able to either explain or reveal differences in companies' asset returns given different qualities of the nine corporate cultures.

Then, with an understanding of how these nine cultures may contribute to asset prices differently, I would introduce the model that allows for the creation of a single culture score (rank) in Section 4.3, which aims to mimic the overall and combined effect of the nine cultures on the group of companies shared by the nine cultures contained in the study. Using this optimally-generated culture rank, I would introduce the ways in which we may generate an additional risk factor – Culture Factor – in Section 4.3, a long-short strategy constructed by subtracting the low-ranked quintile of the combined culture portfolio returns from those on the high-ranked quintile of the combined culture stock portfolio, aligning with Carhart's approach and complementing the Carhart four factors, with the intention to capture the additional risks (i.e. returns) associated with corporate cultures.

Finally, I would introduce the approach to assess the explanatory power of the additional culture risk premium in Section 4.5 by comparing the Carhart four-factor model and the Carhart four-factor model with the Culture factor, followed by my results.

4.2 Carhart Four-Factor Model

4.2.1 Theory of the Carhart Four-Factor Model

The baseline asset pricing model that I employ for my analysis is the Carhart four-factor model. In *On Persistence in Mutual Fund Performance* (Carhart 1997), Carhart introduces the Carhart four-factor model, which is a model of market equilibrium with four risk factors. The four factors in the model represent four trading strategies – high versus low beta stocks, large versus small market capitalization stocks, value versus growth stocks, and one-year return momentum versus contrarian stocks. Carhart (Carhart 1997) demonstrates that the four factors collectively explain considerable variation in returns. The coefficients on the factors of the model allows for a mimicking portfolio that indicates the proportion of mean return attributable to the four elementary strategies. Below is the model from *On Persistence in Mutual Fund Performance* (Carhart 1997):

$$r_{it} = \alpha_{iT} + b_{iT}RMRF_t + s_{iT}SMB_t + h_{iT}HML_t + p_{iT}PR1YR_t + e_{it} \quad (1),$$

$$e_{it} \sim N(0, \Sigma)$$

where:

- $r_{it} = r_t - r_{ft}$ [excess asset return] represents the per-period return on a portfolio in excess of the one-month T-bill return;

- $RMRF_t = r_{mt} - r_{ft}$ [excess market return] represents the per-period excess return on a value-weighted aggregate market proxy;
- SMB_t [size factor] represents the per-period difference between the return of small capitalization and big capitalization (B) portfolios;
- HML_t [value factor] represents the per-period difference between the return of High book-to-market (H) and the Low book-to-market (L) portfolios;
- $PR1YR_t$ [momentum factor] represents the per-period return on value-weighted, zero-investment, factor-mimicking portfolios for size, book-to-market equity, and one-year momentum in stock returns;
- Index i denotes portfolio and index t denotes point in time;
- The error terms e_{it} are assumed to be normal, independent, and homoscedastic.

The factors SMB_t, HML_t, and $PR1YR_t$ are estimated according to the methodology proposed by Fama and French (Fama and French 1993) and Carhart (Carhart 1997). In this model, the market portfolio is value-weighted, while portfolios of SMB_t, HML_t, and $PR1YR_t$ are equal-weighted. I obtain the data for the market portfolio, SMB_t portfolio , HML_t portfolio, and $PR1YR_t$ portfolio from Kenneth R. French Data Library ("Kenneth R. French - Data Library" n.d.). Table 4 shows the summary statistics of the four factors during the timeframe November 2011 to November 2022, and Table 5 shows the correlations among the four factors.

Table 4: Summary Statistics[4]

Summary Statistics	Mkt-RF	SMB	HML	Momentum
Mean	15.5484	0.2268	-2.4444	96.9948
Standard Deviation	16.8651	9.2279	11.9948	4.3321

Table 5: Correlation Table

Correlations	Mkt-RF	SMB	HML	Momentum
Mkt-RF	1	0.1833	0.0995	-0.0056
SMB	0.1833	1	0.0617	-0.0017
HML	0.0995	0.0617	1	0.0004
Momentum	-0.0056	-0.0017	0.0004	1

From Table 4, we see that over the period of November 2011 to November 2021, three of the four strategies – large versus small market capitalization stocks, value versus growth stocks, and one-year return momentum versus contrarian stocks – have positive means of daily returns (expected returns), while that of the high versus low beta stocks strategy is negative. Therefore, portfolios that favor small capitalization and low book-to-market companies outperform those that favor big capitalization and high book-to-market companies. In addition, the mean of daily returns for excess market return is greater than that of SMB and HML strategies, so that both strategies

[4] This table shows a descriptive statistic of the data. **Mkt-RF** refers to the excess market return, **SMB** refers to the size factor, **HML** refers to the value factor, and **Momentum** refers to the momentum factor. **Mean** refers to the annualized mean (expectation) of returns on assets for respective strategies. **Standard Deviation** refers to the annualized standard deviation of returns on assets for respective strategies.

underperform the market portfolio. With respect to the standard deviations of the returns, the standard deviations of Mkt-RF, i.e. excess market return, and the HML strategy are the highest across the four factors, hence the most volatile.

The correlations among the four factors, shown in Table 5, are rather low, with the highest correlation between the excess market portfolio and the SMB strategy at 0.18, and the paired correlations among the other factors are all below 0.1. Therefore, the correlations among the four factors are very low, implying independence among them.

All factors except for r_{it} are tracked according to the methodology proposed by Fama and French (Fama and French 1993) and Carhart (Carhart 1997) and readily downloadable from the Kenneth R. French open data library ("Kenneth R. French - Data Library"). r_{it} , excess portfolio return, is derived by subtracting the one-month T-bill rate from the portfolio returns r_t.

The r_ts in my research study are calculated as the following. For each cultural portfolio (a total of nine from the Big Nine Cultures), I divide the list of culturally-ranked companies into five quintiles, aligning with the Fama-French's and the Carhart's approach, to form five sub-portfolios. For each sub-portfolio, I create a return series r_{tp} by weighted-summing companies' daily stock rate of return according to their market capitalizations, where p is the index for sub-portfolios. Hence, I would have five value-weighted sub-portfolio return series per cultural portfolio, r_{t1}, r_{t2}, …, r_{t5}, where:

$$r_{tp} = \Sigma_i r_{it} \times Company_i\ Market\ Capitalization\ / \Sigma_i Company_i\ Market\ Capitalization$$

For each cultural portfolio, I run linear regressions of excess portfolio returns r_{tp} on the four factors for each sub-portfolio. The coefficients on the independent variables indicate the returns attributable to these factors; the Intercept, i.e. alphas, represents the additional risks (or abnormal excess returns) not efficiently captured by the Carhart four factors.

Therefore, the main analysis is on the sets of alpha and coefficients across the sub-portfolios subordinated to the Big Nine culture portfolios. I would compare my regression results with what to be expected given the efficient markets hypothesis (Fama 1970), which argues that asset prices reflect all public information so that constantly generating alpha is impossible – in other words, the intercepts, i.e. alphas, from the above linear regressions should be close to zero when we regress a well-diversified portfolio on the Carhart four factors. If I were to find non-zero alphas at statistically significant levels for some sub-portfolios, the strategy represented by such sub-portfolios generates abnormal returns not captured by the Carhart four factors. Consequently, non-zero and statistically-significant alphas may inform risk premiums associated with the quality cultures, besides the fundamental trading strategies represented by the Carhart four factors.

4.2.2 Methodology for the Analysis of Results from the Carhart Four-Factor Model

The main analysis of this part is on the sets of intercepts and coefficients derived from regressions introduced in Section 4.2.1. In particular, there are two steps that I'd employ to gain insights from such results.

Step One: For each culture portfolio (a total of nine from the Big Nine Cultures), I would examine whether there are non-zero intercepts (alphas) exhibited across the five sets of regression coefficients from the five quintiles, which are the returns not captured by the Carhart four factors. In particular, I'd focus on the alphas of the first and the fifth quintiles. If the first quintile alpha is greater than the fifth quintile alpha, it implies that, on average, companies that perform the best (top 20%) in that culture have higher excess returns on asset prices, as compared to those that perform the worst (bottom 20%) culturally, over the studied 10-year period. Otherwise, it implies that better such cultures instilled within firms are negatively correlated with asset excess returns over the studied 10-year period.

Step Two: Since the comparison is mainly on companies with the best and worst culture performance, I would then employ an additional regression that looks only at the first and the fifth quintiles, to examine whether the difference between the first and the fifth quintiles are statistically significant. If so, I may argue that there is a difference in the company's financial performance depending on whether they have the best or the worst of a particular culture. To do so, I create a dummy variable to indicate whether the analysis is on the first or the fifth quintile. The new regression looks like the following:

$$r_{it}' = \beta_0 + \delta_0 Quintile + b_{iT} RMRF_t + s_{iT} SMB_t + h_{iT} HML_t + p_{iT} PR1YR_t + b'_{iT} RMRF_t \, Quintile \ldots$$

$$\ldots + s'_{iT} SMB_t \, Quintile + h'_{iT} HML_t \, Quintile + p_{iT}' PR1YR_t \, Quintile + e_{it} \quad (2)$$

, where $Quintile$ is a dummy variable that equals 1 when the company is in the first quintile or 0 when it is in the fifth quintile, and all other variables are the same as those defined in Equation (1) – the additional variables for Equation (2) include the dummy variable $Quintile$ and the interaction terms between $Quintile$ and the Carhart four factors. The regression is now of r_{it}' on a total of nine factors, where r_{it}' is the two series of excess returns (per-period returns in excess of the risk-free returns) from the first and the fifth quintiles. This thus can be seen as a combination of two regressions – a regression of the excess returns of the first quintile on a total of nine factors, and a regression of the excess returns of the fifth quintile on the Carhart four factors when the dummy variable $Quintile$ equals to 0 for such returns.

For the purpose of this second step of alpha analysis, I would look at the coefficient and p-value for $Quintile$, the size of which equals the alpha difference between the first and the fifth quintile as we've derived in Step One and the p-value of which indicates whether the difference is statistically significant. This is because by taking on values of 0 or 1, $Quintile$ is able to capture the differences in portfolio excess returns (per-period returns in excess of the returns captured by the Carhart four factors) given whether the companies are in the first (best ranked) and the fifth (worse ranked) quintiles. Therefore, the coefficient of $Quintile$ refers to, on average, how much more or less excess return a company is able to have if it is in the first quintile, as compared to a company that is in the fifth quintile. If the p-value of the coefficient of $Quintile$ is less than 0.05, this difference is statistically significant at an alpha level of 0.05. Therefore, if we have a non-zero coefficient for $Quintile$ at a statistically significant level, I

reject the null hypothesis and argue that there is a difference of excess stock returns for the companies in the first and fifth quintiles. Otherwise, I fail to reject the null hypothesis.

4.2.3 Analysis of Results from the Carhart Four-Factor Model

With the model proposed in Section 4.2.1, we run nine sets of regressions across the nine culture portfolios – results are shown in Table 6.

Table 6: Regression Results[5][6]

Culture	1st Alpha	5th Alpha	Consistent Change	Absolute Change	P-Value
Agility	-0.0021*	-0.0016*	No	-0.0005	0.3969
Collaboration	-0.0018*	-0.0021*	No	0.0003	0.5361
Customer	-0.0021*	-0.0018*	No	-0.0003	0.5252
Diversity	-0.0018*	-0.0019*	No	0.0001	0.9239
Execution	-0.0021*	-0.0016*	No	-0.0005	0.2729
Innovation	-0.0018*	-0.0019*	No	0.0001	0.4275
Integrity	-0.0017*	-0.0017*	No	0.0000	0.9560
Performance	-0.0017*	-0.0016*	No	-0.0001	0.8428
Respect	-0.0017*	-0.0017*	No	0.0000	0.9888

[5] This table shows a descriptive statistic of the data. **1st Alpha** is the coefficient of Intercept from the regression on the first quintile sub-portfolio. **5th Alpha** is the coefficient of Intercept from the regression on the fifth quintile sub-portfolio. **Consistent Change** refers to whether the Intercepts from the first to the fifth quintile sub-portfolios exhibit a consistent change in size (monotonically increasing or decreasing). **Absolute Change** is the difference of the coefficients of Intercept between the first and fifth quintile sub-portfolio. **P-Value** is the p-value for the coefficients of the Quintile variable (whose size is the difference between the first and the fifth quintile sub-portfolios).

[6] * indicates that the result is significant at an alpha-level of 0.05. Levels of significance are determined using heteroskedasticity-robust standard errors.

Across the nine culture factors, alphas from all regressions are negative and statistically significant. Given all statistically-significant non-zero alphas at an alpha level of 0.05, we conclude that there are additional excess returns not captured by the Carhart four factors in our portfolios. Notably, some of the additional excess returns increase in the direction of better culture and some decrease as culture improves. To understand the negative alphas, we propose that it can be because of the heavy emphasis of the Retail industry that distorts our cultural portfolios from a diversified market portfolio, as Retail is one of the most common industries shared by six out of nine culture portfolios shown in Table 2. To test the hypothesis, I run two regressions, respectively of the S&P and S&P Retail Select Industry Index on the Carhart four factors.

Table 7 shows the result of the regression of the excess return from the S&P over the Carhart four factors. The alpha found is 0.0003, statistically insignificant at 0.05 level. Thus, it implies that the Carhart Four-Factor model is valid for a well-diversified passive market portfolio over the period of 2011 to 2021 and captures most variations in the S&P portfolio.

Table 7: S&P Regression Result[7]

Regression Statistics	
Multiple R	0.1629
R Square	0.0265
Adjusted R Square	0.0250
Standard Error	0.0103
Observations	2492

[7] Levels of significance are determined using heteroskedasticity-robust standard errors.

ANOVA

	df	SS	MS	F	Significance F
Regression	4	0.0072	0.0018	16.9482	0.0000
Residual	2487	0.2643	0.0001		
Total	2491	0.2715			

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.0003	0.0004	0.7306	0.4651
Mkt-RF	0.0010	0.0008	1.2817	0.2001
SMB	-0.0015	0.0002	-7.5028	0.0000
HML	0.0012	0.0004	3.2639	0.0011
RF	-0.0005	0.0003	-1.8670	0.0620

Table 8 shows the regression result of the excess return from S&P Retail Select Industry Index on the Carhart four factors. The alpha from the regression is -0.0002 and statistically significant at 0.05 level, indicating that the Retail industry over the period of 2011 to 2021 negatively contributes to excess stock returns.

Table 8: S&P Retail Select Industry Index Regression Result[8]

Regression Statistics	
Multiple R	0.7888
R Square	0.6223
Adjusted R Square	0.6216
Standard Error	0.0092
Observations	2492

[8] Levels of significance are determined using heteroskedasticity-robust standard errors.

ANOVA

	df	SS	MS	F
Regression	4	0.3470	0.0868	1024.1918
Residual	2487	0.2107	0.0001	
Total	2491	0.5577		

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.0020	0.0003	-6.3515	0.0000
Mkt-RF	-0.0001	0.0007	-0.1954	0.8451
SMB	0.0091	0.0002	51.3564	0.0000
HML	0.0077	0.0003	23.9169	0.0000
RF	0.0028	0.0002	11.3492	0.0000

Therefore, the negative alpha may be explained by the large proportion of companies that are in the Retail industry in our sample. Hence, instead of focusing on the sign of the coefficients for Intercept, we shall look at the difference between the first and the fifth quintile alphas to understand the impact of cultures. If the difference between the first and the fifth quintile alphas are positive, it means that firms with better such cultures tend to have higher excess stock returns than those with worse cultures. Otherwise, such cultures negatively contribute to companies' excess stock returns.

Across the nine cultural portfolios, four of them have greater alphas of the best culture sub-portfolio to the worst culture sub-portfolio, which are Collaboration, Diversity, Innovation, and Respect. On the other hand, Agility, Customer, Execution, Integrity, and Performance have greater alphas of the worst culture sub-portfolio. Suppose such differences between the first and the fifth quintile alphas are statistically significant, we may interpret the result as the

improvement of the four cultures, Collaboration, Diversity, Innovation, and Respect, lead to greater excess asset returns of firms, while the improvement of Agility, Customer, Execution, Integrity, and Performance results in smaller asset risk premium.

However, as shown in Table 6, though the intercepts (alphas) of the first and the fifth quintile are statistically significant, the differences between the first- and fifth-quintile alphas are statistically insignificant at an alpha level of 0.05. Therefore, we fail to reject the null hypothesis that there is no difference between the first and fifth cultural quintiles' intercepts at a significant level of 0.05. Nonetheless, the results that are at statistically-insignificant levels do not mean that these cultures have no impact on asset prices at all – it only means that differences as large as the observed differences would be expected to occur at the probability indicated by the p-value, assuming the truth of the null hypothesis. In other words, the directions and magnitudes of how these cultures contribute to the asset excess returns are likely to occur by chance with the large p-values that I find.

4.3 Carhart Four-Factor Model With A Culture Factor

4.3.1 Model to Derive a Combined Culture Rank

With the Carhart four-factor model in Section 4.2.1, we run regressions with each of the nine culture portfolios. The alphas derived can be negative, zero, or positive, at statistically significant or insignificant levels, with the difference between the first- and fifth-quintile alphas also statistically significant or insignificant at zero or non-zero values. The underlying null hypothesis is that the alphas shall be zero, according to the efficient market hypothesis (Fama 1970). If the alphas are statistically distinguishable from zero, we reject the null hypothesis and

propose that such cultures provide additional information to explain asset prices. Thus, the focus is on the cultures that provide additional information on asset prices, by identifying the cultures that generate statistically significant non-zero differences between the first- and fifth-quintiles.

From there, I would create a new, optimal culture portfolio, which is to be formed with these lists of companies from the so-called meaningful culture portfolios. In particular, the companies to be contained in the new culture portfolio should have received culture scores across all cultures that are shown to be meaningful, so those that are contained in only a few but not all meaningful culture portfolios would be removed. These companies would then be ranked according to the weighted sums of their original culture scores (ranks). Specifically, the weights for original culture scores are determined by the signs and sizes of the absolute difference between the first and fifth quintile regression intercepts (alphas). With this approach, this diversified list of companies shared by all meaningful cultural portfolios are ranked in a way that reflects each meaningful culture's impacts given their implications on company asset prices. If the alpha difference of a culture is positive, for example, then this culture positively contributes to excess asset returns of the diversified list of companies that we use for the analysis. We thus look at the signs and sizes of the absolute alpha differences to create the above mentioned new weighted culture rank for companies. The weight of culture is determined by:

$$Weight\ of\ Culture_i = Absolute\ Alpha\ Change_i \,/\, \Sigma_i\ Absolute\ Alpha\ Change_i$$

The re-weighted culture score (rank) for each company is calculated as:

$$Culture\ Rank\ for\ Company_c = \Sigma_i\ Rank\ of\ Culture_{ic} \times Weight\ of\ Culture_i$$

, where index i denotes specific cultures and c refers to individual companies that have been scored across the nine cultures.

This calculated new culture rank can be understood as where the company stands when we combine the impacts of all meaningful cultures. For example, if the absolute difference between the first and fifth quintile alphas are positive, it means that with the improvement of that culture, firms exhibit positive excess returns in asset prices. On the other hand, if the absolute difference between the first and fifth quintile alphas are negative, it means that with the enhancement of that culture, firms exhibit positive excess returns in asset prices. When we create the new culture rank by weighted-summing companies' culture scores with each culture's absolute alpha change as mentioned above, the newly created culture rank presents the collective impacts generated by the meaningful cultures on our diversified portfolio. Therefore, this new, optimal culture portfolio is based on the additional information I learn about excess returns due to culture.

4.3.2 Creation of the Alpha-Weighted Portfolio

With the approach proposed in Section 4.3.1, we create the new culture ranks for firms according to the sizes of their absolute alpha change. Notably, all such differences across culture sub-portfolios are statistically insignificant at an alpha level of 0.05 as shown in Section 4.2.3. As mentioned, results at statistically-insignificant levels do not mean that these cultures have no impact on asset prices – it only means that differences as large as the observed difference would be expected to occur by more than the probability indicated by the p-value, assuming the truth of the null hypothesis.

In this section, all calculations are based on the differences between the first- and fifth-quintile alphas shown in Table 6, with an assumption that such differences exist (i.e. not by chance), meaning that differences in cultures do contribute to differences in asset returns. This

section thus serves more as an illustration of how the model may be applied to understand the impacts generated collectively by the nine cultures, if such differences exist and cultures contribute to asset excess prices in the directions and magnitudes as suggested in our regressions above. The reason that we retain all nine cultures is because all p-values of the first- and fifth-quintile alpha differences are greater than 0.05, so there is no reason for ruling out any of them.

With the approach outlined in Section 4.3.1, the weights for the nine cultural portfolios are calculated as that shown in Table 9. In particular, the weights are positive for cultures that exhibit negative absolute alpha differences between the first and the fifth quintiles and positive otherwise. This is because a positive weight of a culture implies that the improvement of this culture increases companies' excess asset returns, and the negative weight allows the company to move up in ranks in the newly created culture portfolio. On the other hand, a positive weight of a culture implies that the improvement of this culture decreases companies' excess asset returns, thus negatively contributing to its financial performance – the positive weight also moves companies down in ranks in the newly created culture portfolio.

Table 9: Weights to Re-rank Culture

Culture	Weight
Agility	0.4194
Collaboration	-0.2773
Customer	0.3169
Diversity	-0.0375

Culture	Weight
Execution	0.5112
Innovation	-0.0405
Integrity	0.0228
Performance	0.0900
Respect	-0.0051
Total	1

After re-ranking the companies, the newly derived culture scores range from -66.21 to 555.93 (the smaller the culture score, the better the culture performance), with 275 companies receiving negative culture scores and 7 companies receiving positive culture scores. We run the alpha-weighted culture portfolio on the Carhart four factors.

Table 10 A: Regression Results of the Alpha-Weighted Portfolio[9]

Portfolio	1st Alpha	5th Alpha	Consistent Change	Absolute Change	P-Value
Alpha-Weighted	-0.0017*	-0.0015*	No	-0.0002	0.7275

[9] This table shows a descriptive statistic of the data. **1st Alpha** is the coefficient of Intercept from the regression on the first quintile sub-portfolio. **5th Alpha** is the coefficient of Intercept from the regression on the fifth quintile sub-portfolio. **Consistent Change** refers to whether the Intercepts from the first to the fifth quintile sub-portfolios exhibit a consistent change in size (monotonically increasing or decreasing). **Absolute Change** is the difference of the coefficients of Intercept between the first and fifth quintile sub-portfolio. **P-Value** is the p-value for the coefficients of the Quintile variable (whose size is the difference between the first and the fifth quintile sub-portfolios).

Table 10 B: Regression Summary of the Alpha-Weighted Portfolio[10]

Regression Statistics	
Multiple R	0.4524
R Square	0.2047
Adjusted R Square	0.2032
Standard Error	0.0117
Observations	4984

ANOVA

	df	SS	MS	F	Significance F
Regression	9	0.1742	0.0194	142.2344	0.0000
Residual	4974	0.6767	0.0001		
Total	4983	0.8509			

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.0015	0.0004	-3.8807	0.0001 ***
Quintile	-0.0002	0.0006	-0.3573	0.7209
Momentum	-0.0004	0.0008	-0.4369	0.6622
Mkt-RF	0.0005	0.0007	0.6480	0.5170
SMB	0.0017	0.0009	1.9095	0.0563
HML	0.0002	0.0006	0.3058	0.7597
Inter_Momentum	0.0009	0.0012	0.7008	0.4835
Inter_(Mkt-RF)	0.0065	0.0008	7.7107	0.0000 ***
Inter_SMB	0.0011	0.0011	0.9927	0.3209
Inter_HML	-0.0047	0.0008	-5.8456	0.0000 ***

[10] Levels of significance are determined using heteroskedasticity-robust standard errors. Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

From the regression result shown in Table 10 A, we see that the alpha-weighted portfolio exhibits a negative absolute alpha difference between the first and the fifth quintiles. The difference between the first and the fifth quintiles is -0.0002 and statistically insignificant at an alpha level of 0.05 with a p-value of 0.7275. Therefore, even with an assumption of statistically significant differences between the best and worst culture quintiles, a better combined culture does not provide additional information to asset prices at an alpha level of 0.05. In other words, according to our analysis, considerations related to company cultures are already priced in asset prices that are explainable by the Carhart four factors.

4.3.3 Model to Generate the Culture Factor

With the re-ranked list of companies, we derive the sub-portfolio returns from the first to the fifth quintiles following steps above. Aligning with the Fama-French's and Carhart's approach, we create a long-short strategy that represents a risk factor, here named the Culture Factor $Culture_t$, by taking the difference between the top and the bottom quintiles of the daily returns of the newly created value-weighted culture portfolio. We add the Culture Factor as a risk premium on top of the Carhart four-factor model. Developed from Equation (1), the new model that we propose is thus:

$$r_{it} = \alpha_{iT} + b_{iT}RMRF_t + s_{iT}SMB_t + h_{iT}HML_t + p_{iT}PR1YR_t + c_{iT}Culture_t + e_{it} \quad (3),$$

$$e_{it} \sim N(0, \Sigma)$$

where:

- r_{it}, $RMRF_t$, SMB_t, HML_t, $PR1YR_t$, and e_{it}, are the same as in Equation (1);

- $Culture_t$ [culture factor] represents the per-period difference between the return of the top- and bottom-quintile culture portfolios.

Therefore, in the second model, we aim to explore whether the inclusion of the Culture Factor, a long-short strategy based on differences in culture, may capture additional risks or add explanatory powers to understanding portfolio returns. In particular, I would run a regression of the alpha-weighted portfolio on the five factors in Equation (3), and explore the size and p-value of the newly derived alpha and coefficients across the five quintiles of the alpha-weighted portfolio.

4.3.4 Analysis of Results of the Carhart Four-Factor Model With A Culture Factor

We add in Culture as the additional risk factor, calculated as a series of per-period (daily) differences between the first and fifth quintile stock returns. Now, the difference from the new regression with five factors, the Carhart four factors and the Culture factor, between the first and fifth quintile alpha is -0.0003, statistically insignificant at an alpha level of 0.05, as shown in Table 11. With the addition of the culture risk factor, the difference between the best and worst culture sub-portfolios becomes more pronounced, with an increased magnitude of the coefficient for Quintile and a decreased p-value from the Carhart four-factor model with a culture factor.

Table 11: Regression Using the Carhart Four-Factor Model With A Culture Factor [11]

Regression Statistics	
Multiple R	0.4564
R Square	0.2083

[11] Levels of significance are determined using heteroskedasticity-robust standard errors. Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Regression Statistics	
Adjusted R Square	0.2066
Standard Error	0.0116
Observations	4984

ANOVA

	df	SS	MS	F	Significance F
Regression	11	0.1772	0.0161	118.9250	0.0000
Residual	4972	0.6736	0.0001		
Total	4983	0.8509			

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.0017	0.0003	-4.5267	0.0000 ***
Quintile	-0.0003	0.0006	-0.6190	0.5360
Culture Factor	0.0000	0.0001	3.2615	0.0000 ***
Momentum	-0.0005	0.0008	-0.6659	0.5055
Mkt-RF	0.0005	0.0007	0.6496	0.5160
SMB	0.0017	0.0009	1.8812	0.0600
HML	0.0001	0.0006	0.2637	0.7920
Inter_Culture	0.0000	0.0000	0.8748	0.3817
Inter_Momentum	0.0008	0.0012	0.6155	0.5382
Inter_(Mkt-RF)	0.0065	0.0008	7.7108	0.0000 ***
Inter_SMB	0.0011	0.0012	0.9798	0.3272
Inter_HML	-0.0047	0.0008	-5.8725	0.0000 ***

4.4 Model Comparison

4.4.1 Theory for Model Comparison

To compare the Carhart four-factor model (standard model) and the Carhart four-factor model with an additional Culture Factor (enhanced model) as established in Section 4.3, I would perform a standard F-test to examine whether the inclusion of the culture risk factor adds additional explanatory power to our model. If the p-value from the F-test is less than 0.05, the null hypothesis is rejected at an alpha level of 0.05. In addition, I would also compare the AIC values of the two models to explore whether the full model improves upon the reduced model.

4.4.2 Analysis of Results of Model Comparison

To further understand the explanatory power of the Culture factor, I firstly look at the correlations between the Culture Factor and the Carhart four factors, shown in Table 12. The result shows that the correlations between the Culture factor and the Carhart four factors are all very low and close to 0. Therefore, correlations among the variables in our created Carhart Four-Factor Model With A Culture Factor are low, and we are safe to assume independence among the regressors. In other words, multicollinearity is not a problem with this regression.

Table 12: Correlation Table

	Culture Factor	**Momentum**	**Mkt-RF**	**SMB**	**HML**
Culture Factor	1	0.0845	0.0058	0.0274	0.0319

	Culture Factor	Momentum	Mkt-RF	SMB	HML
Momentum	0.0844	1	-0.0055	-0.0017	0.0004
Mkt-RF	0.0058	-0.0056	1	0.1833	0.0995
SMB	0.0274	-0.0017	0.1833	1	0.0617
HML	0.0319	0.0004	0.0995	0.0616	1

To compare the Carhart Four-Factor Model and the Carhart Four-Factor Model With A Culture Factor, we conduct an F-test. In particular, we run regressions with the re-ranked culture portfolio with the two models and look at the summary statistics of the models. The p-value for the coefficients of Intercept are both non-zero at statistically insignificant levels from the two models, so that both models are able to efficiently capture the cross-sectional variations in the alpha-weighted culture portfolio. The F-statistic is calculated as 0.0484. In addition, the AIC value of model 1 is less than that of model 2. Therefore, we fail to reject the null hypothesis and conclude that the addition of the Culture factor does not add explanatory power to the Carhart Four-Factor model.

Table 13 A: Model Comparison

	Model 1 (4-Factor)	Model 2 (4-Factor + Culture Factor)
R Square	0.0012	0.0012
Adjusted R Square	-0.0005	-0.0008
Observations	2492	2492
AIC	6875.4890	6877.4410

Table 13 B: Model Comparison[12]

Models	Residual df	RSS	df	Sum of Sq	F	Pr(>F)
Model 1	2487	2292				
Model 2	2486	2291	1	0.0446	0.0484	0.8258

[12] Levels of significance are determined using heteroskedasticity-robust standard errors.

4.5 Discussion

4.5.1 Discussion of Theories

In Section 4, I introduce two asset pricing models to analyze culture's impacts on stock returns – the Carhart four-factor model and the Carhart four-factor model with a Culture Factor. I've also identified the two steps used for an alpha analysis, and an F-test to compare the two models. One of the major limitations of this analysis is the assumption of normal, independent, and homoscedastic error terms ϵ_t with the two linear asset pricing models.

In fact, Zhou and Li show in their 2016 paper (Zhou and Li 2016, 20) that recent studies have observed non-normal distributions of financial data, producing more kurtosis, higher peak, and non-normal error terms, contradicting the fundamental assumption of a Carhart Four-Factor Model. Zhou and Li thus utilize a generalized autoregressive conditional heteroskedasticity (GARCH) model, a generalized statistical model of time series data that determines the variance of the current error term as a function of the previous periods' error terms. Instead of independent and normally distributed, the error terms in GARCH are conditional and dependent. Using GARCH, we allow for time-varying volatility and error clustering, which are commonly seen when stock prices may move together with business cycles or world economics for periods of ups and downs.

According to the paper, Zhou and Li incorporate the GARCH-type volatilities (error terms) into the Fama-French model and employ non-normal errors proposed by Standardized Standard Asymmetric Exponential Power Distribution to correct the Fama-French model (Zhou and Li 2016, 20). The employment of the GARCH model accounts for heteroskedasticity, the

irregular pattern of variations in the error term, while still preserving the explanatory power of the Carhart four factors. By adopting a GARCH model, as demonstrated by Zhou and Li, the updated model can successfully capture the skewness, fat-tailedness and asymmetric kurtosis of the data and the error terms (Zhou and Li 2016, 20).

However, the validity of an addition of the GARCH model on top of the Carhart four-factor model is often used to analyze stocks traded in emerging markets, such as for analysis of Southeast Asian stock markets (Aziz and Sulistyo Wibowo 2020). Little evidence suggests that an employment of the GARCH model outperforms the standard Carhart four-factor model that assumes normal and independent errors, specifically for the US stock market. Nonetheless, to increase the robustness of my study, the linear regressions are conducted with heteroskedasticity-robust standard errors, also called robust standard errors, to obtain unbiased standard errors of linear regression coefficients that hold under heteroscedastic error terms. In particular, robust standard errors are used to allow the fitting of a model that does contain heteroskedastic residuals, proposed by Huber (Huber 1967). Thus, even if the error terms of my data are heteroscedastic, which violates the key assumptions of a linear regression underlying my models, the employment of robust standard errors still grants the validity of my results.

4.5.2 Discussion of Results

Internally, empirical evidence consistently demonstrates that the four factors together explain considerable variation in returns: for a well-diversified portfolio, α_{iT} should be zero (Carhart 1997). In other words, when we regress a well-diversified portfolio on the Carhart four factors, the derived α_{iT} should be close to 0. Otherwise, there are additional risks associated with

the portfolio not captured by the four factors. As we have seen, there are negative alphas derived from all regressions, signaling returns not captured by the four factors, which are found to be industry effects from an underperformance of the Retail industry over the period of 2011 and 2021 as we've demonstrated. Therefore, the focus is on the difference between the alphas from the best and worst culture quintiles of the culture portfolios.

We then narrow our focus to the cultures that may have an effect on portfolio excess returns by creating an alpha-weighted portfolio, by re-ranking companies given the alphas from the nine regressions of culture portfolios. However, though the best- and worst-culture quintiles of the alpha-weighted portfolio exhibit a negative difference, meaning that an improvement of culture overall reduces the companies' idiosyncratic risks that lowers their excess returns, the difference is statistically insignificant at an alpha level of 0.05. In other words, we fail to reject the null hypothesis that Glassdoor-review implied corporate culture does not impact a firm's stock returns at an alpha level of 0.05.

However, two major limitations face this research. Firstly, the intensity and the homogeneity of the company's culture may impact the degree to which culture impacts a firm's financial performance, which are not indicated by the company's culture score. In *Corporate Culture and Economic Performance: A French Study* (Calori and Sarnin 1991), it shows that the intensity and the homogeneity of a positive company's culture are positively correlated with its relative growth. Here, intensity and homogeneity refers to the degree and extent to which a culture is influential within a firm. However, the data that we have access to, the MIT Sloan Cultural Index, does not provide us with insights into the intensity and the homogeneity of corporate culture. For example, when a company receives a high score for Diversity, it can be because of the positive reviews available on Glassdoor that contributes to its high cultural score,

instead of implying how intense the culture is in the firm. In other words, even when two companies receive the same culture scores for Diversity, it can be the case where one firm has a small group of employees that feel strongly positive about the Diversity within their firm and the other firm that has a majority of employees who feel moderately positive about the Diversity within their firm – the impacts of which are different on firm performance and asset prices, which, unfortunately, are not captured by our analysis with the MIT Sloan Cultural scores.

In addition, the companies' cultures are scored cross-sectionally, while their stock prices are tracked over the past 10 years. Though corporate culture is calculated based on more than 10 years of Glassdoor reviews, there can be major changes in a firm's corporate culture at a point in time that drastically impacts its stock returns, leading to noticeable outliers that we fail to capture with our stock returns. Therefore, though the results from our research shows that corporate culture is not a major influencer on a company's stock performance, there are caveats that we fail to capture with our model. For example, in a related study, Margolis, Elfenbein, and Walsh find that companies do not seem to be well rewarded for engaging in corporate social performances, and penalties accrue to firms that do wrong only if they are caught (Margolis, Elfenbein, and Walsh 2009). Hence, our result only implies that over a 10-year time period, an improvement of corporate culture does not contribute to asset excess returns in statistically significant ways, but does not offer any insights into the asset price movements resulting from an event related to corporate culture changes.

5. Conclusion

Corporate culture has become an increasingly important characteristic to investors and employees alike. A wide variety of studies have been dedicated to studies of factors that influence firms' financial performances, including their stocks' rate of return. However, very few studies have considered corporate culture as a risk factor to companies' asset prices. In our study, we try to link the two constructs, corporate culture and financial performance, with a quantitative approach. We find that Glassdoor-review implied corporate culture does not impact a company's stock rate of return in statistically significant ways. However, this conclusion may result in a paradox, notably, where a risk is present but not compensated for. In other words, if a company with a particularly good corporate culture performs the same as that with a noticeably worse corporate culture, why is an emphasis on corporate culture so prevalent in the contemporary investment space? Therefore, future research is needed to understand the impacts of corporate culture, and whether such impacts are seen financially and in what ways.

Additional efforts may be dedicated to an improvement of the culture measurement as well, in our case, the MIT Sloan Corporate Culture Index. For example, in *Parsing organizational culture* (Chatman et al. 2014), the authors study whether a strong culture that aligns members' behavior with organizational values improves its financial performance. They suggest that the relationship between culture and performance can be reconciled by recognizing that culture embraces three components: (1) "the content of norms (norm content)"; (2) "how widely members agree about norms (culture consensus)"; and (3) "how intensely organizational members hold particular norms (norm intensity)." By testing the hypothesis with a sample of

large firms in the high-technology industry, the authors find that firms characterized by stronger culture consensus and intensity of adaptability performed better three years later than did those with lower consensus, lower intensity of adaptability, or both. Therefore, the intensity of the culture is also important, other than the content of norms and how widely members agree about norms. Therefore, a combinational analysis of culture's content and extent may yield the MIT Sloan Corporate Culture Index more meaningful and might change the result of our analysis.

Future research may also work in the direction of analyzing the impacts of particular corporate culture's events on a firm's financial performance. As mentioned in the introduction, fraudulent firm conduct may drastically drag down a firm's stock prices, hence market capitalization, once revealed. Thus, instead of looking at cross-sectional cultural scores as we have in this analysis, future research may look at cultural events' impacts on the rate of return on stocks moving forward.

Nonetheless, this paper presents a quantitative analysis of corporate culture that bridges the gap in the existing literature. Notably, this research examines corporate culture's impacts on asset prices, which offer practical insights particularly to investors. The study shows that over 10 years (from 2011 to 2022), corporate culture does not function as a common risk factor for companies, and its impacts on asset prices are statistically insignificant at an alpha level of 0.05. Therefore, unless foreseeing an imminent event related to a revelation of a company's cultural practice, corporate culture shall not be a significant consideration in investors' business decisions.

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