

The Influence of Environmental Change on Pharmaceutical Companies-- Analysis of Opportunities for Pharmaceutical Companies, Take Roche Inc., Pfizer, and Merck. as an example.

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Abstract. The impact of natural environment change on biological pharmaceutical companies has become a growing concern in recent years. In response, re-searchers have employed various models to analyze the relationship between natural environment changes and the financial performance of these companies. This paper will use the Capital Asset Pricing Model (CAPM) and Fama-French Three-Factor Model (FF3F) to estimate the impact of natural environment changes on biological pharmaceutical companies. Using secondary data from past studies, this paper conducts a literature review to analyze the impact of natural environmental changes on these companies, particularly in terms of their risk and return tradeoffs. Results from previous research indicate that both CAPM and FF3F models can be used to measure the risk and return trade-offs in the context of natural environmental changes. The CAPM model has been used to identify factors such as natural disasters and climate change that influence the risk of these companies, while the FF3F model has been used to measure the effect of regulatory changes on their stock prices. Overall, this paper brings together previous insights and findings, aiming to provide a deeper understanding of the impact of natural environment change on biological pharmaceutical companies. It concludes that further research is needed to investigate other factors that can influence the performance of these companies in the face of natural environmental changes.

1 Introduction

Pharmaceutical and biotech companies have seen significant changes in their operational environment in recent years. With the impact of climate change, the aging population, and various global pandemics, the pharmaceutical industry is becoming increasingly important in the world. The increasing dependency on emerging markets, regulatory constraints, and competition are some of the big challenges that the industry is facing. The biotech players are gradually becoming the preferred choice of investors, pushing into new markets, and extending their product line.

The CAPM model and FF3F model will be chosen to evaluate the opportunities and risks of environmental changes to bio-pharma companies, Pfizer, Merck, and Roche are taken as examples. The Pharmaceutical industry aims to understand the market demand and rely on the scientific research strength of the enterprise to develop drugs, vaccines, food, and other products. The main opportunity discussed in this paper is the rising

demand for medicines based on the impact of environmental changes on human health. However, companies have faced several environmental impacts that have affected their financial performance. For instance, the increasing regulatory demands and legal intervention have caused a slowdown in the product development process, which has resulted in a decline in the operational efficiency of the companies.

2 literature review

The impacts of natural environment change on biological pharmaceutical companies have been studied extensively, with models such as CAPM and FF3F being utilized to analyze these effects. Investment risk has been assessed based on market volatility through CAPM, and it has been found that natural environment changes can affect this. FF3F has been used to analyze risk-adjusted returns using market capitalization, market risk, and value factors. Studies have used these models to analyze the effects of natural disasters, climate change, and regulatory changes on companies. Further research is needed to understand other factors that influence the

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performance of companies amidst natural environmental changes [1].

Several studies have been conducted to analyze the relationship between natural environment changes and biological pharmaceutical companies. For instance, the importance of environmental trends has been emphasized, and their impact on the pharmaceutical industry has been discussed. It has been suggested that companies need to recognize the importance of sustainability and develop strategies to address environmental challenges. A case study of Pfizer Inc. has been presented, and it has been concluded that tighter regulations will force pharmaceutical companies to adopt more environmentally friendly practices [2].

The technological revolution and impact of pharmaceutical medicine have been studied, with differences between current and past drug development processes being illustrated. Difficulties in the field of Drug product design and the complexity of non-oral dosage forms are also clearly discussed [3]. The impact of information asymmetry on the market caused by resource limitations, including natural resources, has been discussed, and it has been found that the market pays more attention to the top pharmaceutical companies [4]. The impact of the outsourcing phenomenon on the statistical results of government departments has been studied, and it has been proposed that the government may underestimate the size of the manufacturing sector, providing a new way of thinking for the strategic decision-making of pharmaceutical enterprises [5].

The impact of the financialization process on corporate innovation and public health has been addressed, specifically focusing on drug pricing [6]. The main outputs from a range of activities specifically related to drug supply risk management have been listed [7]. Reports on the quality of various environmental matrices from around the world have been collected and analyzed, concluding that pharmaceutical products are a global challenge that requires multi-stakeholder efforts to reduce and prevent problematic drugs from entering the market loop [8]. The current situation of pharmaceutical enterprises has been discussed in the background of Brexit, focusing on factors such as corporate contribution, legislative procedures, regulatory procedures, research and achievements, and business risks [9]. The reluctance of various investment sectors in the market to invest in new, less mature technologies and the conciliatory role of government departments between investors and investors have been estimated [10].

3 Data

3.1 Environmental Situation

The impact of environmental change on global pharmaceutical companies is closely tied to the health of people worldwide, as demand for medicines is affected. To assess risks and opportunities, it is important to first examine environmental issues such as global warming,

which is caused by increased levels of greenhouse gases in the atmosphere. Another issue is particulate matter, which is harmful to human health and can come from various sources. The shrinking of the ozone layer over Antarctica is also a concern, as it could lead to increased exposure to harmful solar radiation and various health problems.

3.2 Overview of the Biopharmaceutical Industry

The global biopharmaceutical market was worth \$338.5 billion in 2020 and is projected to experience a CAGR of 9.5% from 2021 to 2028, according to a report by Grand View Research. The market's growth is fueled by several factors, including the growing demand for biologics, the rising prevalence of chronic diseases, the expansion of healthcare spending, and advancements in biopharmaceutical manufacturing technology.

3.3 Introduction of Pfizer Inc., Merck KGaA, and F. Hoffmann-La Roche AG (Roche)

Pfizer, Merck, and Roche are three of the largest biopharmaceutical companies in the world. Pfizer's primary product areas include vaccines, oncology, and rare diseases. Merck's primary products include vaccines, oncology, and infectious diseases. Roche's product line includes oncology, immunology, and ophthalmology. The three companies have a significant presence in the global biopharmaceutical market and are expected to continue to be major players in the industry in the years to come. Additionally, three major biopharmaceutical companies, Pfizer, Merck, and Roche, are introduced along with their main products and their positions in the industry. This information serves as a foundation for the subsequent analysis of the impact of natural environmental changes on biopharmaceutical companies using CAPM and FF3F models, and the countermeasures they can take to respond to these changes.

3.4 Trend Analysis

3.4.1 Pfizer

The financial statements of Pfizer reveal that the company has performed well in recent years. The company's revenue has increased from \$53.647 billion in 2016 to \$51.750 billion in 2020, depicting a growth of 2.85%. Moreover, Pfizer has successfully maintained its working capital at a high level, indicating that the company has been efficient in utilizing its assets to generate revenue. Despite the market's pandemic-driven volatility in 2020, the stock performance of Pfizer has been strong, reaching a 52-week high in December 2020. This can be attributed to the company's successful development of a Covid-19 vaccine.

3.4.2 Merck

Merck's financial statements show that the company's revenue has been on a downward trend, from \$39.81

billion in 2016 to \$39.03 billion in 2020, depicting a decline of 1.96%. However, Merck's net income has seen a high level of growth from \$13.51 billion in 2016 to \$18.75 in 2020, indicating that the company has maintained its profitability despite falling revenues. Merck's stock performance has been more volatile than Pfizer's, reaching a low in March 2020 but rebounding by year-end. This volatility is likely a result of the company's relatively small product roster compared to Pfizer.

3.4.3. Roche

From 2016 to 2020, Roche's financial statements indicate that the company's revenue and net income have a respective growth rate of 5.53% and 5.41%. Furthermore, the company has been able to maintain its working capital level, showing its operational efficiency. Roche's stock performance has been relatively stable compared to the other two companies, reflecting its strong financial performance.

4 Model

We will analyze the market index and some economic indicators based on the CAPM model and FF3F model.

4.1 CAPM Model

The CAPM Model elucidates how the anticipated return of a stock is linked to the overall risk of an investment, commonly referred to as systemic risk. CAPM formula is:

$$ER_i = R_f + \beta_i (ER_m - R_f) \quad (1)$$

Where ER_i is the investments' expected return, R_f is the risk-free rate. (Without risk's income), β_i =beta of the investment which calculated by: $Cov(R_m, R_s) / Var(R_m)$, refers the sensitiveness of market risk. $ER_m - R_f$ is market risk premium.

4.2 Fama-French Three Factor (FF3F) Model

FF3F Model evaluates the impact of external macro factors, including societal, technological, regulatory, and environmental factors, on a company's financial and management performance. The critical indicators that the model employs include market saturation, competitive intensity, the attractiveness of the industry, and industry profitability. Counting by:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1 (R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_{it} \quad (2)$$

where: R_{it} is the return of the i -th asset in a given period, R_{ft} is the risk-free rate of return in the same period, α_{it} is the intercept or constant term, which represents the excess return of the i -th asset when all other variables in the model are zero, β_1 is the coefficient of the market risk premium ($R_{Mt} - R_{ft}$), which measures the sensitivity of the i -th asset's return to changes in the overall market return, R_{Mt} is the return of the market portfolio in the same period, SMB_t is the size premium, which measures the excess return of

small-cap stocks over large-cap stocks and HML_t is the value premium, which measures the excess return of high book-to-market ratio stocks over low book-to-market ratio stocks, ϵ_{it} is the error term, which represents the unexplained variation in the i -th asset's return that is not accounted for by the other variables in the model.

4.3 Data Analysis

We will select a few important companies' financial indexes, combined with the CAPM model and FF3F model to Analyze.

Working Capital equals Current Assets - Current Liabilities.

The Sales Revenue Analysis: Sales revenue data is assessed to understand the impact of environmental changes on the top line of these companies. The formula used: Revenue Growth Rate = (Current Year Revenue - Previous Year Revenue) / Previous Year Revenue * 100

Gross Margin Analysis: Gross margin data is crucial as it can provide insights into the pricing strategies deployed by these companies. The formula used: Gross Margin = (Revenue - Cost of Goods Sold) / Revenue * 100

Operating Expenses Analysis: Operating expenses data would give insights into the management strategies deployed by these companies. The formula is represented as follows: Operating Margin = (Revenue - Operating Expenses) / Revenue * 100

Table 1. Current situation of Working capital, Revenue growth rate, Gross margin, and Operating margin of the three companies

	Working capital	Revenue growth rate	Gross Margin	Operating Margin
Pfizer	22,964,000,000	6.38%	74.09%	67.02%
Merck	10,014,000,000	8.59%	75.90%	67.25%
Roche	10,347,000,000	2.29%	61.81%	60.26%

Source: Annual reports of companies.

"Table 1" above shows the data that discussed four important company indicators; they can provide some reference for the following model analysis.

4.4 CAPM Model

The formula for calculating beta is $Beta = [Covariance \text{ between the stock and market returns}] / [Variance \text{ of market returns}]$. Calculate the expected return of each company using the CAPM model: expected return = risk-free rate + beta x market risk premium. The formulas for calculating expected return and cost of equity are as follows: Expected return = Risk-free rate +

Beta x (Market return - Risk-free rate) Cost of equity =
 Expected return - Dividend yield [11,12].

Table 2. CAPM model analysis of three companies

	MRK	ROG	PFE
Rf	0.00266		
Rm	0.00979		
Equity Risk Premium	0.00713		
Beta(i)	0.4307	0.20827	0.62436
Expected return	0.57%	0.42%	0.17%

“Table 2” above shows the calculation results of the three companies under the CAPM model. We can also compare the actual return of each company to its expected return to identify abnormal performance.

4.5 FF3F Model

The rate of return calculated by FF3F is very different from the CAPM. The coefficients of SMBs are negative because these companies are large enterprises. The HML MRK coefficient of 0.227 is the only positive value among the three companies, indicating that MRK is a value stock [11, 12]

Table 3. FF3F model analysis of three companies

	MRK	ROG	PFE
Rf	0.00266		
Mkt-Rf	0.00673		
SMB	0.00196		
HML	0.00356		
Mkt-Rf coefficient	0.52589	0.145721	0.61488
SMB coefficient	-0.90924	-0.101566	-1.35007
HML coefficient	0.22692	-0.284913	-0.15883
Expected return	0.52%	0.24%	0.36%

“Table 3” above shows the calculation results of the three companies under the FF3F model. We can clearly read the HML coefficient, Expected return, and other indicators.

5 Outcome

The CAPM Model analysis suggests that these companies have a stable liquidity position, as their working capitals remain positive, with Pfizer having a clear advantage over the others. It also highlights that Merck has the highest revenue growth rate, which suggests that the change in environmental conditions has a more significant impact on this company's top line relative to others. However, Roche has the lowest gross margin, and its operating margin suggests that it has a lower propensity to take on business risks. In CAPM, beta MRK, ROG, and PFE were respectively 0.431, 0.208, and 0.624. All three values are positive, showing

that the performance of the three pharmaceutical companies in our example is roughly in line with the trend of the overall market, we can see that ROG has the lowest beta value, which means ROG is less sensitive to market exposure, under CAPM assumptions. ROG growth is smaller when the market is doing well, but when the market falls, ROG doesn't have a negative impact either.

This analysis demonstrates that the pharmaceutical industry is exposed to various environmental challenges with differing levels of impact on companies' performance. The CAMP and FF3F models comprehensively evaluate the opportunities and risks presented by environmental changes. The past five years of financial statements and stock market data for Pfizer, Merck, and Roche indicate that these companies have distinctively different performance situations.

As human industrial activities continue to intensify and greenhouse gas emissions rise, the global average temperature is steadily increasing. This trend is leading to more frequent occurrences of extreme weather and hot temperatures. Cold waves pose a significant risk to public health, increasing the likelihood of arthritis, measles, meningitis, and scarlet fever. Conversely, hotter regions are more prone to outbreaks of cholera, dysentery, and other digestive diseases. Whether the temperature is too high or too low, certain patients are at increased risk of death, such as respiratory disease, heart disease, brain disease, and vascular disease.

Climate change will also have a direct impact on disease transmission. It may facilitate the spread of infectious diseases such as malaria and Schistosomiasis. Studies have predicted that under the condition of doubling carbon dioxide concentration in the future, the area affected by plague in China will increase by about 40% due to the increase of grassland area, and the threatened population will also increase correspondingly. The ongoing rise in global temperatures has created favorable conditions for pests and pathogens to thrive, reproduce, and spread. This has led to an increase in the prevalence and range of these harmful organisms, with some even moving into previously unaffected areas. As a result, there is a growing need for drugs and vaccines to combat tropical infectious diseases, as well as cardiovascular and cerebrovascular diseases. Pharmaceutical companies can capitalize on this demand by increasing their research efforts in these areas and developing new treatments. Additionally, there may be opportunities for pharmaceutical companies to develop medical devices and drugs to treat skin diseases caused by exposure to solar radiation.

6 Conclusion

There is no doubt that environmental changes have an impact on people's physical health. For these effects, pharmaceutical companies can expand their business and use their scientific research resources to develop drugs. The opportunities for pharmaceutical companies are mainly in areas such as lung function diseases, heart disease, infectious diseases, skin diseases caused by

radiation, and rheumatism. At the same time, it is important to beware of damage to ecosystems and biodiversity, even if extreme weather is predicted and reasonable measures are taken to reduce losses, taking countermeasures for Pfizer, Merck, and Roche to respond to natural environmental changes. For example, companies could invest in developing new treatments or diagnostic tools for diseases that may be impacted by natural environmental changes, such as Lyme disease or Zika virus. They could also invest in environmentally friendly or sustainable production processes.

full account of the risk of resistance. Countermeasures for Pfizer, Merck, and Roche to Respond to Natural Environmental Changes Based on the CAPM and FF3F model analysis, we recommend the following

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