LISBON
SCHOOL OF
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UNIVERSIDADE DE LISBOA

MASTER

MONETARY AND FINANCIAL ECONOMICS

MASTER´S FINAL WORK

DISSERTATION

ECONOMICALLY JUSTIFIED EQUITY INVESTMENT STRATEGIES CAPABLE OF WITHSTANDING GROWING INTEREST RATE ENVIRONMENT

CHI NAM YAU

OCTOBER- 2019

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ABSTRACT

This thesis proposes an approach for selection of stocks that could serve as a natural hedge for fixed income portfolios to minimize rising interest rate risk. The developed approach is applied to the case of US equity markets. Based on macroeconomic analysis, vector autoregressive model and Granger causality tests, and financial analysis, it is concluded that US financial sector is the optimal choice among all sectors that have strong correlations with interest rates. The thesis' results could be useful for interest rate risk management of the investment portfolios under the growing interest rate environment, in particular, and for investment industry professionals.

Keywords: Stock returns, interest and inflation rates, interest rate risk, vector autoregressive model, Granger causality test

JEL: G01, G11, G12, C21

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1 INTRODUCTION

Equity investment is generally referred to the buying and holding of stocks by investors in anticipation of receiving dividends and capital gains. It is commonly believed that stocks are not a good investment tool to hedge against rising interest rate risk. Campell (1987) suggests that excess return on 20-year Treasury bond and stock returns move together, and expected standard deviation of stock returns is much larger than that of bonds based on linear regression model.

However, recent studies have shown the possibility of short-term gains from stock investment when interest rates rise. Interest rate is the amount a lender charges a borrower for the borrower's use of lender's assets expressed as a percentage of the principal. Interest rates affect financial cost, income and profitability of businesses because cost of borrowing is determined by interest rates. However, businesses may gain higher profits if the growth of interest income is higher than the growth of interest expense under rising interest rates environment.

Increasing interest rates is a measure of monetary policy by central banks to lower inflation rate. Inflation rate has a considerable impact on the purchasing power of consumers, investors and savers. It also influences business profitability and competitiveness in the international market. Friedman (1970) famously stated that inflation is always a monetary phenomenon and it can be produced only by a more rapid increase in the quantity of money than in output. However, inflation may erode investment returns and thus the consideration of real interest rate and expected inflation rate is important for the formulation of investment strategies.

This thesis follows the approach developed in Ferrer et al. (2016a, 2016b and 2017) in order to construct an optimal equity investment strategy under rising but low interest rates environment. The strategy is supported by macroeconomic analysis, vector autoregressive (VAR) model and financial analysis. The developed approach is applied

to the US economy. Our results show that financial sector stocks represent a natural hedge for investment portfolio against adverse moves in interest rates.

The rest of the thesis is structured as follows. Section 2 presents the literature review. Section 3 explains the methodology. Section 4 describes the employed data set. Section 5 provides the analysis and discussion. Section 6 concludes the thesis.

2 LITERATURE REVIEW

The studies of stock returns could be categorized into eight domains based on the different aspects of the areas of studies. Studies of stock price movements in the 60s focused on efficient market hypothesis and random walk model (Fama 1965 and Samuelson 1965). Their research on the relationship between macroeconomic variables and stock returns became a theoretical framework for the later studies and inspired countless research on the relationship between interest rates, inflation and stock returns (Fama 1981; Flannery and James 1984; Benderly and Zwick 1985). New statistical models shed light on the non-linear relationship between interest rates and stock returns (Martin and Keon 1977; Bartram 2002; Elyasiani and Mansur 1998; Siklos and Kwok 1998; Alaganar and Bhar 2003). Moreover, studies after Global Financial Crisis (GFC) challenge the theoretical framework with empirical evidence (Nissim and Penman 2010; Borio et al. 2015; Tripathi and Kumar 2014). Recent studies illustrate the differences of interest rate sensitivity in various industries, countries and time periods (Ferrer et al. 2016a; Ferrer et al. 2016b; Ferrer et al. 2017; Boothe et al. 2018; Camilleri et al. 2019; Willis and Cao 2019; Hotchkis & Wiley 2017; Koo 2008). Financial ratios such as Cyclically Adjusted Price to Earnings (CAPE), Price to Earnings (PE), Price to Book (PB) and Debt to Equity (D/E) ratios are essential for fundamental analysis and stock selection (Bunn and Shiller 2014; Jivraj and Shiller 2017; Graham 1973). Below we present the description of the above-mentioned eight domains of equity research studies.

2.1 Random walk model and efficient market hypothesis

For more than five decades, there has been numerous research on the relationship between interest rate changes and stock returns. Fama (1965) advocates efficient market

theory and that stock prices follow a random walk model based on empirical evidence between 1897 and 1957. The theory states that stock price fluctuation is explained by the price convergence to fundamental value. Samuelson (1965) argues that the randomness and unpredictability of stock price variations can simply be explained by competitions between investors. Samuelson (1965) believes that the best estimation of tomorrow's stock price is today's price (see also Delcey 2019). Both Fama's and Samuelson's efficient market hypothesis and random walk theory may not be valid because Miller (1979) argues that there is information asymmetry in the US stock market. Furthermore, Alam (2009) shows that stock markets in a total of 15 developed and developing countries do not follow random walk model from January 1998 to March 2003. The results of his research are summarized in Table I below.

TABLE I: Relationship between interest rates and share prices in different countries, 1998-2003

	Relationship between interest rate and share price	Relationship between changes of interest rate and changes of share price
Japan	Positive	Negative
Bangladesh, Colombia, Italy and South Africa	Negative	Negative
Australia, Canada, Chile, Germany, Jamaica, Mexica, Spain and Venezuela	Negative	No relationship
Philippine	No relationship	No relationship
Malaysia	No relationship	Negative

Source: Alam (2009)

Table I illustrates that none of the countries in the study, except Japan, has a positive relationship between changes of interest rates and change of share price. For this reason, it would be interesting to examine this unique phenomenon in Japanese stock market.

2.2 Theoretical relationship between stock returns, interest rate and inflation rate

Fama (1965) suggests that stock returns should be related to economic fundamentals. It was commonly believed that stock returns in US and other countries could be affected by macroeconomic factors such as interest rates, exchange rates,

inflation rates and unemployment rates. This belief inspired a lot of research on the relationship between various macroeconomic variables and equity returns. Fama (1981) illustrates that there is a negative correlation between short-term interest rate (3 month US Treasury bills yield) and stock return. The sample period of his research is from 1953-1971. Flannery and James (1984) expands Fama's research and examine the relationship between interest rate sensitivity of common stock (67 US commercial bank stocks). They also analyze the maturity composition of the firm's holdings of nominal contract with a linear regression model and a data set from 1976 to 1981. Their research supports Fama's theory and suggests that interest rate sensitivity is significantly related to the maturity mismatch of the bank asset and liabilities. This implies that exogenous factors such as interest rate may have a significant impact on the stock returns.

Moreover, Fama (1981) suggests that high maturity composition of net nominal assets reflects high interest rate sensitivity of a firm's common stock in US. He believes that stock market returns should be negatively correlated with expected inflation, which is often reflected by the short-term interest rate. His regression analysis shows the negative effect of unexpected monthly, quarterly and annual inflation on expected real stock returns. He discovered that current and past real activity is important for inflation regressions but not for stock return regressions. Also, he suggests that in an efficient and forward looking market, stock returns are positively related to expected earnings and output growth. Based on Fama's research, Benderly and Zwick (1985) investigate the real balance effect on US stock returns from 1954 to 1981. The real balance effect refers to the direct effect of real money balances on private expenditure, demand for goods and asset price. Their analysis supports Fama's theory of negative relationship between stock returns and output. However, Berderly and Zwick (1985) argue that the direction of effect is from inflation to output, not vice versa. Also, the real balance effect has a delayed impact on the economy.

2.3 Non-linear interest rate sensitivity and lag effect of interest rate changes

Martin and Keon (1977) suggest that there are major differences in interest rate sensitivity among different stocks. Moreover, Bartram (2002) points out that many

previous studies which focus on industry portfolio and indices are problematic because firms have different exposures within the same industry. Bartram (2002) covers the period of 1987-1995. Its samples include 490 non-financial corporations and 67 financial intermediaries in Germany. He concludes that there are more firms that have non-linear interest rate exposure than firms that have linear interest rate exposure. He also illustrates that there is a negative relationship between interest rate exposure and levels of corporate liquidity. However, financial leverage does not have a significant relationship with interest rate exposure for non-financial firms.

Thus, it is justifiable that more and more researchers use sophisticated non-linear statistical models to examine the causal link, lag effect and the impact of interest rate changes on stock returns. Elyasiani and Mansur (1998) investigate the effect of interest rate and interest rate volatility on bank stock's monthly return (including dividend) with a Generalized Autoregressive Conditional Heteroskedasticity in Mean (GARCH-M) and an Autoregressive Conditional Heteroskedasticity (ARCH) model. Their models do not have the restrictive assumption of linearity, independence, and constant conditional variance. The sample of their research consists of 56 commercial bank stocks that have been traded on the New York and American stock exchanges from January 1970 to December 1992. Their result demonstrates that long-term interest rates (10-year Treasury composite yield) has a significant negative impact on bank stock return. Also, interest rate volatility determines bank stock return volatility and stock risk premium except regional bank portfolio. Siklos and Kwok (1998) test Fama's (1981) hypotheses with vector auto-regressions (VAR) and Granger causality test with quarterly US data from 1960 to 1992. Their analysis is consistent with Fama (1981) but shows evidence against Benderly and Zwick's (1985) delayed real balance sheet effect.

Alaganar and Bhar (2003) adopt causality-in-variance test and GARCH (1, 1) model to show the direction and lags in information flow between financial sector returns and interest rates in G7 countries from 1990 to 2000. Their result shows that a short lag of 1 week in causality at the mean level from interest rate to sector returns in the US markets, and long-term yield has significant explanatory power except in Canada's banking and insurance industries, France's and USA's financial sectors. For the financial sectors in Canada, France, Germany and the USA, banking and insurance industries show

two-way causality at the mean level. The sector returns from the industries in the US show both mean and volatility causation from sector returns and to interest rates and has at least 12 weeks lead. They emphasize that in order to model unexpected interest rate, lagged equity return should be used as additional explanatory variables.

2.4 New evidence against the theoretical relationship between stock returns and interest rate changes

After the GFC, more studies have shown evidence against negative correlation between interest rate changes and stock returns. This signals a challenge to Fama's theory and previous studies. Nissim and Penman (2010) illustrate that there is a positive relationship between unexpected change in interest rate and unexpected earnings in the 1st and 2nd year of interest rate change. They explain that operating income rises more than operating expense in short term when interest rate rises. Only when 2 years have passed after the unexpected interest rate change, will the correlation between unexpected interest rate changes and earnings turn negative for 5 years. Their result is based on the data in US stock market from 1964 to 2001 and time-series regression test of cross-sectional mean of unexpected earnings (except financial firms) and unexpected change in interest rate. Borio et al. (2015) illustrate that monetary policy had a positive effect on return on asset ratio (ROA) in 2009 and 2010 but ROA turned negative from 2011 to 2014. Their research supports Nissim and Penman (2010)'s findings. Borio et al. (2015) analyze the effect of monetary policy on 109 international banks in 14 countries over the period of 1995 to 2012 with a non-linear approach. They explain that there is a positive relationship between interest rate structure (3-month rate and 10-year government bond yield) and bank profitability because short term interest rate leads to an increase in interest income and ROA in short term, but also leads to an increase in unfavorable increase in loan loss provisions, debt service costs and default probabilities in the long run.

Tripathi and Kumar (2014) test Fama's theory in BRICS (Brazil, Russia, India, China and South Africa) over the time period of January 2000 to September 2013. Quarterly data is analyzed with Johansen integration test to test the co-integrating relationship between stock index and inflation rate in BRICS. They find positive

relationship between inflation rate and stock returns in China and India but negative relationship in Russia and Brazil. This implies that Fama's theory may not hold up in some countries. Their result also shows that changes in inflation rates lead to stock market movement in the short run, and that equity is not a good hedge against inflation in the long run in BRICS.

2.5 Differences of interest rate sensitivity in various countries and industries

Recent research focus on examining the interest rate exposure of different industries and countries. Ferrer et al. (2016a, 2016b, 2017) cover this area using advanced statistical analysis such as quantile analysis (Ferrer et al. 2016a), wavelets model (Ferrer et al. 2016b), and Granger causality test (Ferrer et al. 2017).

Ferrer et al. (2016a) illustrate that some industries' interest rate sensitivity had changed after the 2008 US financial crisis. They show that energy, health care and information technology stocks become positively sensitive to interest rate changes (10-year treasury yield). Energy sector return has a significant positive relationship with real interest rate changes while utilities sector return has a significant negative correlation in both pre-crisis (2003-2007 August) and post-crisis period (September 2007-2013). Also, health care and information technology have positive significant interest rate sensitivity in the post crisis period. Their findings are supported by empirical evidence by Boothe et al. (2018).

Ferrer et al. (2016b) examine the relationship between interest rate (10-year government bond yield) changes and stock returns (mainly bank stocks) across European countries from January 1993 to December 2012. They demonstrated that the UK is the country with the strongest interdependence between long-term bond yields and equity returns (significant positive linkage of 1 or 2 years since 2000s), followed by Germany, France, the Netherlands and Spain. In contrast, this linkage is much weaker for Portugal, Ireland and Greece. They believe the reason why there is a weak linkage in those

countries is that the trading volume, capitalization and liquidity are low in the stock exchanges of those countries.

Camilleri et al. (2019) show that the link between stock returns and inflation rate is significant in 5 European countries (Belgium, France, Portugal, Netherlands and Germany) over the sample period from 1999 to 2017 with VAR model and Granger causality test. They suggest that stock returns have a lagged positive impact on inflation rate. Their analysis also reveals that inflation rate has a lagged negative impact on stock prices in France and Portugal. It means that policy makers may increase interest rates due to higher inflation rate, which leads to a decrease in stock prices. Moreover, they show that in the case of Germany and Portugal, there are significant contemporaneous relationship between long-term interest rate and stock prices. The relationships are negative in Belgium and Portugal while other countries have positive relationships between the variables. Also, they argue that lagged long-term interest rates do not have a significant explanatory power on stock prices in most of the sample countries.

Ferrer et al. (2017) illustrate that there is a bidirectional Granger causal links between stock returns (daily closing price of S&P500) and 10-year treasury yield. The bidirectional causal links imply that long-term interest rate and stock return is interrelated. Moreover, the research observed that the links became stronger before the beginning of the GFC as stock investors shifted their equity investment to US treasury bonds. This flight to quality phenomenon led to a decrease in stock price and 10-year treasury yield. The positive relationship between stock return and long-term interest rate became more significant before the crisis. The sample period of this research ranges from January 1993 and December 2014.

2.6 Interest rate exposure of US stocks in different time periods

Willis and Cao (2015) show that US stocks become less interest rate sensitive in post 1984 period due to structural changes in financial markets and industries. Their research brings two important discoveries: 1) the transmission of short term interest rate (federal fund rate) to long-term interest rates (10-year treasury yield) has changed. Long-

term interest rates do not move in the same direction as short-term rates. 2) The impact of long-term interest rates on the economy has a longer lag in post 1984 period. The framework used for their analysis is a VAR model with a sample period of January 1960 to December 2007. Data from the post-2007 period are excluded because the federal funds rate has been constrained at the zero lower bound (ZLB) during this period.

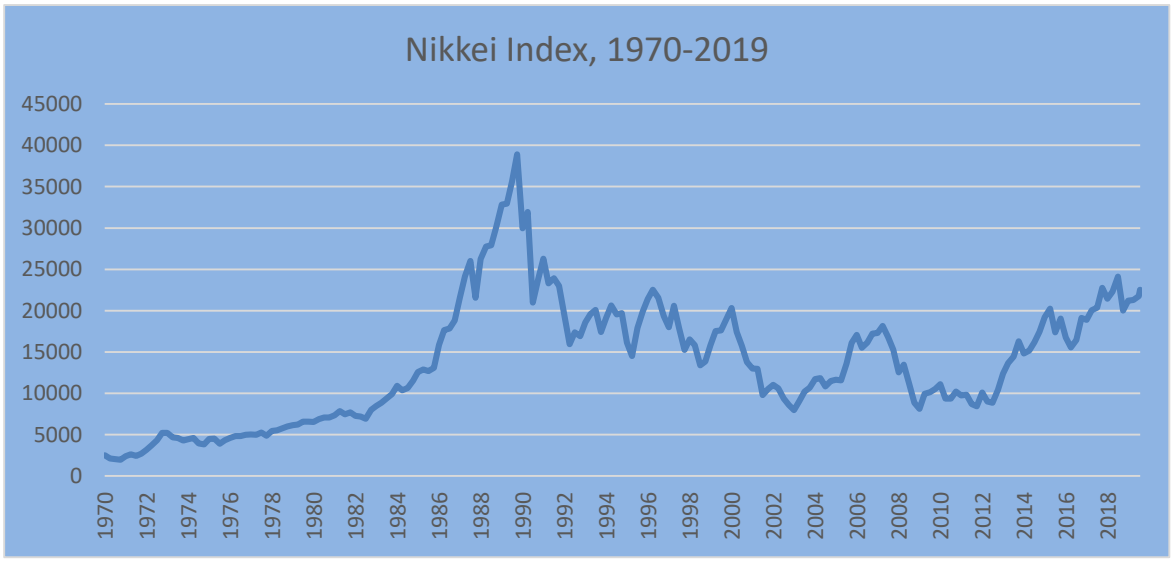
Regression analysis by capital management company Hotchkis & Wiley (2017) support Willis and Cao (2015)'s study. The regression analysis shows that the negative correlation between S&P 500 P/E ratio and 10-year Treasury bill yield is weak between 1963 and 2016. However, the negative relationship is much stronger during rising rates period (1963-1981) and falling rates period (1982-2000). The relationship is positive but weak in low rate period (2001-2017). Hotchkis & Wiley (2017) suggest changes of interest rates have an insignificant impact on share price if interest rates have fallen below a certain threshold. More importantly, the analysis shows that value stocks outperform growth stocks when interest rate rise, and that small value stocks outperform small growth stocks regardless of the changes of interest rates.

Value stocks are appealing because their stock prices are below their fundamental values. Fundamental values of the stocks can be estimated by the firms' financials such as earnings, dividends and sales revenue. Other the other hand, growth stocks are defined as stocks that have higher growth potential than the industry average. Generally, growth companies have significantly high positive cash flow but pay small or no dividends in order to retain funds for reinvestment and company expansion.

2.7 Zero and negative interest rate in Japan

Japan's economy suffered long-term recession between 1990 and 2012, see the respective Nikkei index behavior in Figure 1.

FIGURE 1: Nikkei index from 1970 to 2019



(Source: Bloomberg Terminal)

The Bank of Japan implemented stimulative monetary policy to fight recession. The short term interest rate in Japan fell dramatically from 6% in AUG1990 to nearly zero in FEB1999 (Reuters 2018) and below zero in 2016 and 2019. However, the Japanese stocks returns had a falling trend from 1990 to 2012 under the low and negative interest rates. This phenomenon contradicts Fama (1981)'s theoretical relationship between interest rates and stock returns.

Koo (2008) explains that zero interest rate could not vitalize the economy and the stock market because Japan was suffering from the balance sheet recession. There were not enough borrowers although interest rates were nearly zero. Companies paid down debt at the rate of several tens of trillion yen a year and households were not willing to spend their deposits and savings. This led to a deflationary spiral which dragged down stock market returns. Monetary policy was useless in this scenario and fiscal stimulus was needed to make an economic recovery. This means that in the balance sheet recession, the relationship between interest rate and stock returns is not negative. Stock returns did not rise although interest rates had fallen to zero while higher interest rate would further depress the stock market. Therefore, the relationship between short term

interest rates and stock prices is different from the theoretical relationship under zero interest rates environment.

2.8 Equity investment strategy

To select stocks that hedge against rising interest risk, financial indicators such as CAPE, PE and PB ratios should be considered because it is important to know the potential return and risk of the stocks indicated by the ratios. Bunn and Shiller (2014) investigate the forecasting power of CAPE ratio in industrial, utilities and the railroad sectors in the US from 1872 to 2013. CAPE ratio is a useful tool for market valuation because it is inflation adjusted and is calculated by dividing real S&P500 price index (numerator) by the moving 10-years average of real reported earnings (denominator). The authors suggest that stock price will fall in the long-term if the CAPE ratio is high. In other words, CAPE ratio reflects whether a stock is undervalued or overvalued. Also, the ratio may predict the future inflation adjusted financial performance of the stock. Bunn and Shiller (2014) propose an equity investment strategy that overweights sectors with low relative CAPE ratio and underweighs sectors with high relative CAPE ratio. They also warn investors to be wary of value trap and momentum effect. Their investment strategy generate 1.09% excess real annual return than market benchmark over the period.

Jivraj and Shiller (2017) break the CAPE investment strategy into 4 steps. The first step is to obtain sector data such as sector index and earnings to calculate CAPE and relative CAPE ratios for 10 sectors. The second step is to select 5 most undervalued sectors based on the relative CAPE ratio. The third step is to remove sector with the lowest momentum in the past 12 months as a momentum filter to avoid value trap. The final step is to equally weight the remaining 4 sectors and rebalance the portfolio monthly.

Graham (1973) was considered to be the best book of equity investment by Warren Buffet. Graham (1973) advocate that value stocks with low debt, PE and PB ratios are more attractive because the low ratios indicate healthy financial status of the company. The higher the PE and PB ratios, the more expensive are the stocks. Suppose

stock A's PE and PB ratios are 10 and stock B, which is identical to stock A, has higher PE and PB ratios of 12; stock A is more attractive to stock B because it is relatively cheaper.

In summary, numerous studies have shown that stock returns are influenced by macroeconomic factors. The macroeconomic factors that affect most sectors and stocks are GDP growth, interest rates and inflation rate. Fama (1965) suggests that stock return should be related to macroeconomic factors. Fama (1981) believes that stock returns are negatively correlated to expected inflation and short-term interest rate. Flannery and James (1984) advocates that interest rate sensitivity of US commercial banks are dependent on their debt structures and maturities. Alaganar and Bhar (2003) shows that long-term interest rate has a significant impact on US financial sector. Nissim and Penman (2010) demonstrate that interest rate shock has a short-term positive impact on international banks' profits. However, Koo (2008) argues that Japanese stock market was not sensitive to interest rate changes because firms have high level of financial leverage. Therefore, it is essential to analyze the impact of macroeconomic factors on the stock market.

Studies after the GFC show that equity returns may have positive correlations with interest rates. (Nissim and Penman 2010; Borio et al. 2015 and Ferrer et al. 2016a). Moreover, stock returns may increase under rising interest rate environment because interest rate changes may have a positive impact on stock returns for a short period of 2 years. Also, value stocks outperform growth stocks and should be a good hedging tool against rising interest rate for fixed income portfolio (Graham 1973; Willis and Cao 2015; Hotchkis & Wiley 2017). For international stock markets, there are contradictory results in Asian, European and other stock markets (Alam 2009; Batram 2002; Alaganar and Bhar 2003; Ferrer et al. 2016b). In particular, this thesis will focus on analyzing US sectors in order to formulate an equity investment strategy that benefits from rising interest rate environment.

3. METHODOLOGY

There is no such economic theory that could fully explain why the correlation between interest rate changes and stock returns is different in various countries and sectors. The theoretical negative correlation between interest rates changes and stock returns is often attributed to changes in the discount rate, a denominator effect in equity valuation models such as dividend discount models. The major disadvantages of the prominent discount models are: 1) the unrealistic assumption of constant dividend growth 2) no consideration of other important factors that determine a firm's competitiveness. Therefore, this thesis adopts several distinct approaches to examine the relationship between interest rates and stock prices. Namely, this thesis seeks investment opportunities under rising interest rates environment by the use of macroeconomic analysis, VAR model and Granger causality test, and financial analysis.

3.1 Macroeconomic analysis

The first component of our approach is the macroeconomic analysis, which is based on the economic outlook of US economy and the study on PE ratio versus inflation rate. The economic outlook involves analyses of short-term interest rate (FED fund rate), mid-term interest rate (US 5-year generic Treasury yield), long-term interest rate (US 10-year Treasury yield), inflation rate, equity market (S&P 500 indices), CAPE ratio versus long-term interest rate (US 10-year Treasury constant maturity rate), GDP growth and unemployment rate. The economic outlook is important for creating an equity investment strategy that hedges against rising interest rate risk because studies have shown that macroeconomic factors such as interest rates and inflation rate have significant impacts on stock returns.

3.2 Vector autoregressive model and Granger causality test

The second element of the proposed approaches to construct an investment portfolio resilient to growing interest rate environment is VAR model and Granger causality test. Factors such as interest rates, inflation, crude oil price and S&P 500 indices are analyzed.

The VAR model is employed to test the lead-lag effect of macroeconomic variables such as crude oil price, US 10-year Treasury yield, 5-year Treasury yield, short-term interest rate and inflation rate on stock prices. VAR model is a multivariate linear time series model. According to Brooks (2008), the advantages of VAR model are 1) all variables are endogenous 2) VAR model is more flexible than univariate model as VAR model allows dependent variable to be explained by more variables than just its own lag variables 3) strong predictability of out-of-sample data. However, VAR model is only accurate for analyzing stationary data. Stationary data is defined as the data that has constant statistical properties such as mean, variance and autocorrelation over time. The typical specification of VAR model could be presented as follows:

$$y_{1t} = \beta_{10} + \beta_{11} y_{1t-1} + \cdots + \beta_{1k} y_{1t-k} + \alpha_{11} y_{2t-1} + \cdots + \alpha_{1k} y_{2t-k} + u_{1t}$$
$$y_{2t} = \beta_{20} + \beta_{21} y_{2t-1} + \cdots + \beta_{2k} y_{2t-k} + \alpha_{21} y_{1t-1} + \cdots + \alpha_{2k} y_{1t-k} + u_{2t}$$

$$y_{1t} \text{ and } y_{2t} \text{ are the variable observations}$$
$$u_{1t} \text{ and } u_{2t} \text{ are the residual terms}$$

We also apply Granger causality test on VAR model to test the causal link between the variables. Brooks (2008) states that if y_1 causes y_2, lags of y_1 should be significant in the equation for y_2. If this is the case and not vice versa, there is a unidirectional causality from y_1 to y_2. Granger causality means that the lag of y_1 is capable of predicting y_2. This is important to note that granger causality does not mean that y_1 causes y_2. The null hypothesis of Granger causality test is that the explanatory variables do not 'granger cause' the dependent variable. The null hypothesis will be rejected if the t-statistics exceed the critical t value at a given confidence level.

3.3 Financial analysis

The third dimension of the proposed methodology is related to the financial analysis. We examine the financial indicators such as total return, PE and PB ratios of the sector benchmarks. PE ratio is calculated by dividing current stock price by previous

year's earnings while PB ratio is calculated by dividing stock price by the book value per share. Generally, low PE and PB ratios signify that the stock is undervalued. We also analyzes the percentage change in total liabilities in order to discover the impact of interest rates on firms' debt structure.

4. DATA

According to Ferrer et al. (2016a) and Boothe et al. (2018), US energy and financial sectors have the most significant positive relationships with interest rates. Therefore, this thesis will focus on analyzing US energy and financial sectors.

We analyze the stock performance in US energy and financial sectors over 2009 and 2019. Our samples consist of 3 US stock index benchmarks. Data series of stock prices, crude oil prices, US unemployment, inflation, interest rates are obtained from Bloomberg. , Gross domestic product (GDP) and real GDP US Federal Reserve are publicly available data from Economic Data Bank (FRED) database. Fed fund rate, 5-year US generic bond yield and 10-year US treasury yield represent short term interest rates, mid-term yield and long-term interest rates respectively.

We use the S&P500 energy sector GICS (Global Industry Classification Standard) level 1 index (Bloomberg ticker: S5ENRS) as the proxy for US energy sector performance. The S&P500 financials sector GICS level 1 index (Bloomberg ticker: SPFINL) represents the financial sector returns. The S&P500 index is employed as the proxy of US stock market. All the proxies are employed to measure sector performance and the correlation between interest rates, inflation and stock prices. The list of leading companies in different sectors is based on Fortune 500.

In order to examine the impact of inflation rate changes on US stock performance, we employ the percentage change of consumer price index (CPI). The CPI is a measure of the weighted average price changes of a basket of consumer goods and services. Historical inflation rates are available from Bloomberg Terminal. Stock prices and inflation rate are inter-correlated as rise in stock price may cause higher inflation while

high inflation may undermine future stock returns and leads to an increase in interest rates (Fama 1981; Camilleri et al. 2019). We also examine the historical relationships between inflation and the PE ratios of US stock market, US energy and financial sectors between October 2009 and August 2019. S&P 500 is employed as the proxy for the US stock market. We adopt S&P 500 energy and financial indices as the proxies of US energy sector and financial sector respectively.

GDP is the market value of finished goods and services within a country. Higher GDP growth often signifies better economic condition of a country. The US GDP growth is calculated by the percentage change of real GDP per quarter. Real GDP is adjusted by inflation to account for the impact of inflation on the economic output. The US GDP and real GDP are obtained from FRED database while the growths are calculated by the author.

CAPE ratios are obtained from Shiller (2019)'s database. The database contains useful information such as historical real dividend yield, real S&P500 index and real earnings. CAPE ratio provides an overview of stock market performance and predicts long-term stock returns.

5. ANALYSIS OF RESULTS AND DISCUSSION

This section presents the results of the methodology applied to US equity market and respective discussions.

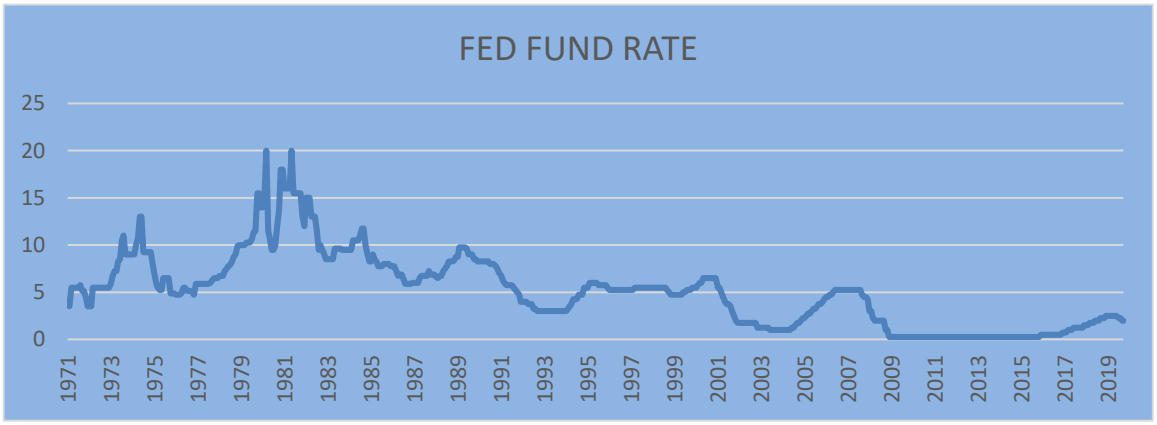
5.1 Macroeconomic analysis

5.1.1 US economic outlook

In the US, federal funds rate serves as anchor for the overnight interest rates of borrowing and lending activities between banks. Hence, federal funds rate is an important benchmark for financial market. It affects the supply of available funds as well as influences inflation rate and long-term interest rate. In accordance with Figure 2, the federal funds rate fell from its peak of around 19% in 1980s to close to zero percent in 2009. The federal funds rate was maintained at around zero percent until 2016.

Afterwards, the fund rate rose to 2.5% in January 2019 but then decreased to 1.75% in October 2019.

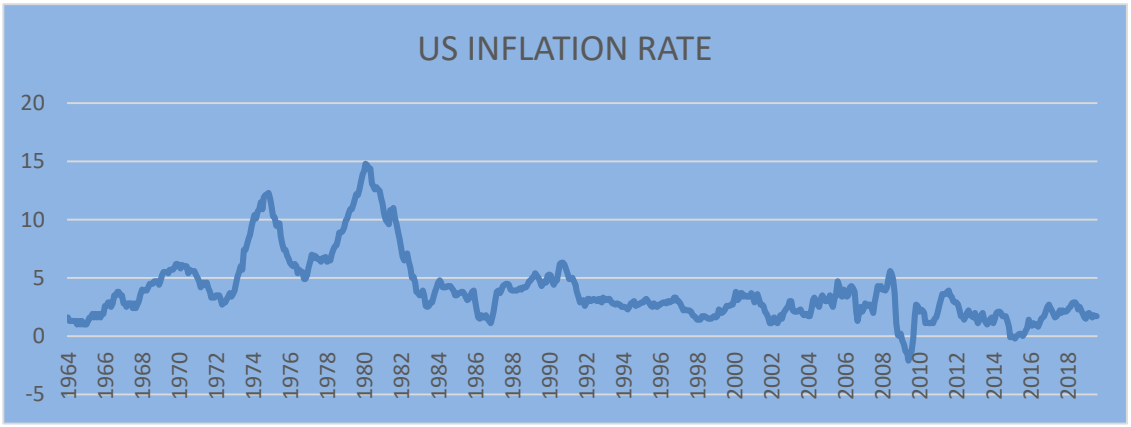
Figure 2 Historical FED fund rate



Source: Bloomberg Terminal

Figure 3 below depicts the US inflation rate over the period of 1960 to 2018. The US Fed implemented monetary policy by adjusting interest rate to inflation in order to fight stagflation (high unemployment and inflation rates). As a result, inflation fell to the target rate of around 2% in 2004 while short term interest rate also fell to a very low level of approximately 1%. However, under the low interest rate environment, real estate bubble started to form. Although Fed increased the short-term interest rate to 5.25% in 2006, the bubble busted and triggered US financial crisis and Global Financial Crisis (GFC) 2007-2008.

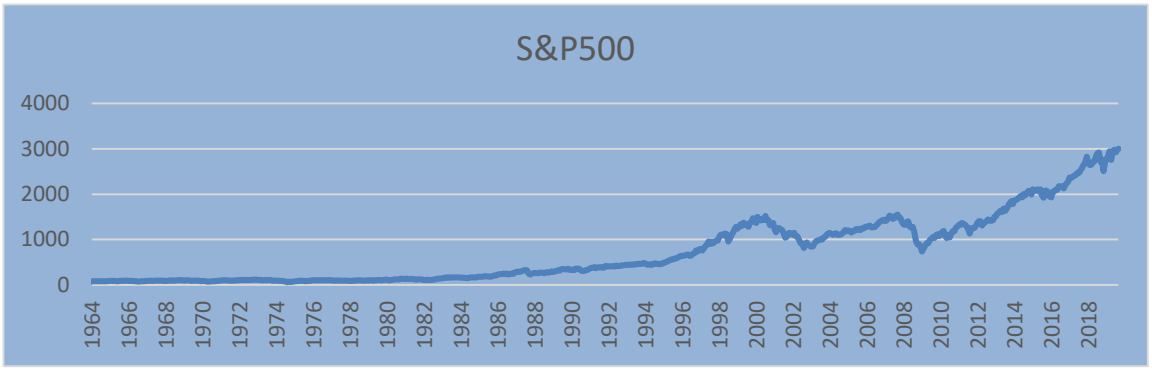
Figure 3 Historical US inflation rate



Source: Bloomberg Terminal

US economy and stock market suffered due to GFC caused by the sub-prime mortgage crisis. S&P 500 index decreased by more than 50% from 1500 to around 700 points between 2007 and 2009 (see Figure 4 below). However, the low interest rate environment between 2008 and 2015 restored investors' confidence in US equity investments. As a result, S&P index exhibits all times high at about 3000 points in 2019, doubling the before GFC index level. Therefore, in general, it would be of interest to investigate how equity valuations depend on interest rate and, in particular, which stocks may benefit most from rising interest rate environment.

Figure 4 Historical S&P 500 index



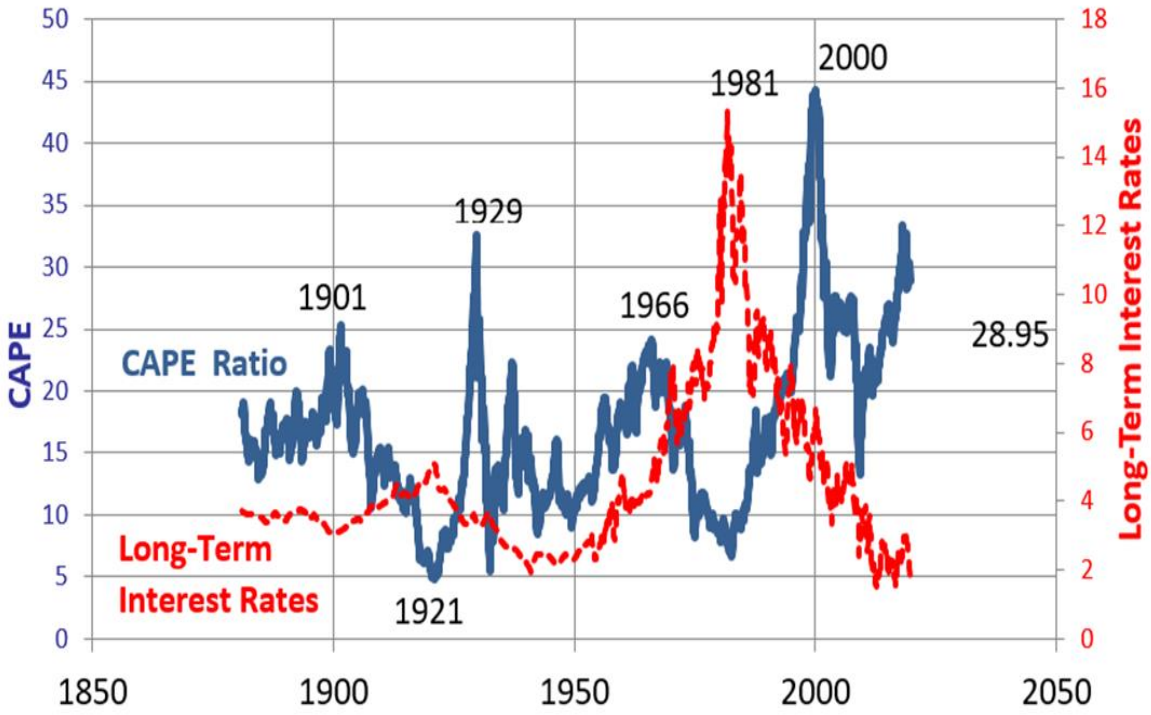
Source: Bloomberg Terminal

Despite the relationship between interest rate and stock return is controversial, there is a consensus that higher stock returns may lead to higher inflation rate and that inflation rate has a lagged negative impact on stock prices (Fama 1981; Camilleri et al. 2019). Generally, central banks increase interest rate if they predict inflation rate will exceed their target in the future. However, increase in interest rate does not effectively prevent US economy and stock market from overheat.

Colombo (2018) warns that financial crises often occur after interest hikes. He also suggests that interest rate hike may cause financial crisis. However, his analysis is not accurate due to several biases. For example, Colombo (2018) is subject to hindsight bias because it is impossible to know when the interest rate reaches the peak and when the financial crisis will occur. Interest rate falls when financial crisis occurs; that is the only moment we know interest rate has reached the climax. Also, Colombo (2018) fails

to understand a simple statistical concept: correlation does not imply causation. Short-term and long-term interest rates and inflation rate are useful signals that reflect the status of economy. However, they are never the only culprit of financial crisis. Market bubbles seem to be a more plausible explanation.

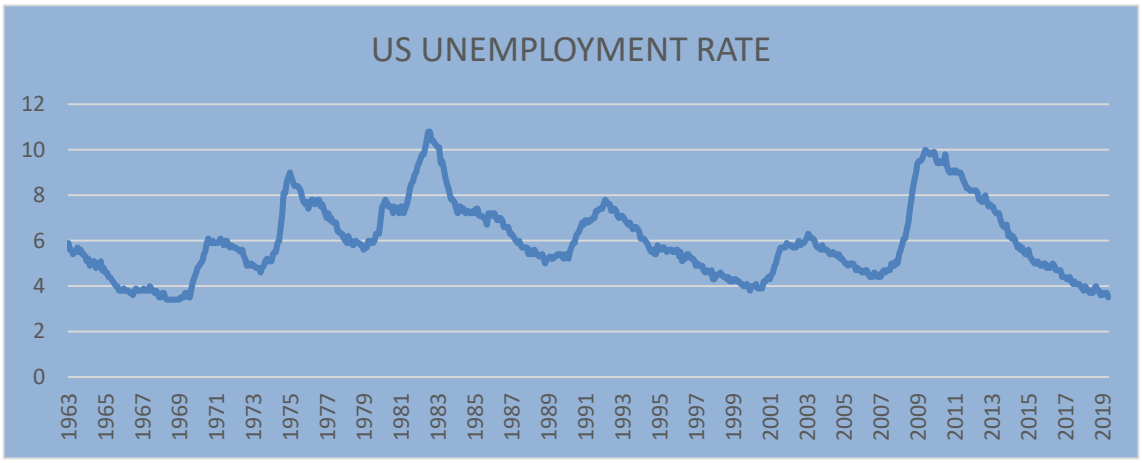
Figure 5 Historical CAPE ratio and US long-term interest rate



Source: online data by Shiller's database (http://www.econ.yale.edu/~shiller/data.htm)

According to Figure 5 above, the long-term interest rate has been experiencing a falling trend since 1981 while there were ups and downs for CAPE ratio. The CAPE ratio increased dramatically from the bottom of 6.64 in 1982 to the historical peak of 43.83 in 2000. The bust of dot com bubble in 2000 led to a staggering fall of CAPE ratio. The CAPE ratio fell to 21.21 in 2003 and recovered to 27.32 in 2007. However, the 2008 US financial crisis led to another significant fall of CAPE ratio. The ratio plummeted to 13.32 in 2009 but picked up a rising trend afterwards and reached 28.95 in 2019. The graph shows that the CAPE ratios move independently from long-term interest rates (US 10-year Treasury constant maturity rate). This implicates that the impact of long-term interest rate on US stock market return could be insignificant.

Figure 6 Historical US unemployment rate



Source: Bloomberg Terminal

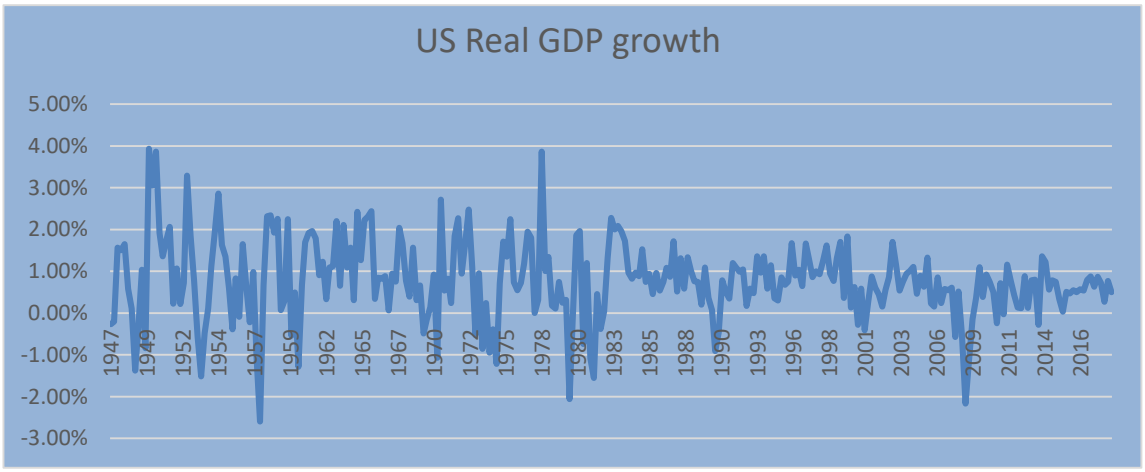
Figure 6 below shows that there is a decreasing trend in US unemployment rate since 2010. This signals a favorable positive economic growth because lower unemployment rate indicates that the working population becomes larger, which lead to higher level of economic output in the future.

Overall, the macroeconomic factors implicate that the US economy is currently at the late expansion phase of the business cycle. Figure 3 illustrates a positive short-term economic outlook as the inflation rate is maintained near the target of 2%. S&P 500 index (see Figure 4) has a dramatic growth since 2010 while short term interest rate (see Figure 2) increased from 0% to 2.5% between 2015 and early 2019 but was recently reduced to approximately 1.75% in October 2019. However, Figure 7 below shows that long-term interest rate has fallen to the rather closed to the zero bottom level. It implies that investors are pessimistic about the US economy in the long run. Moreover, Figure 8 shows that the quarterly US real GDP growth has been below 1% for more than 3 years while Figure 9 depicts that the quarterly nominal US GDP growth has been below 2% for over 13 years. The slow real GDP growth implies that the US economy has already entered a mature phase.

Figure 7 Historical 10-year US Treasury yield

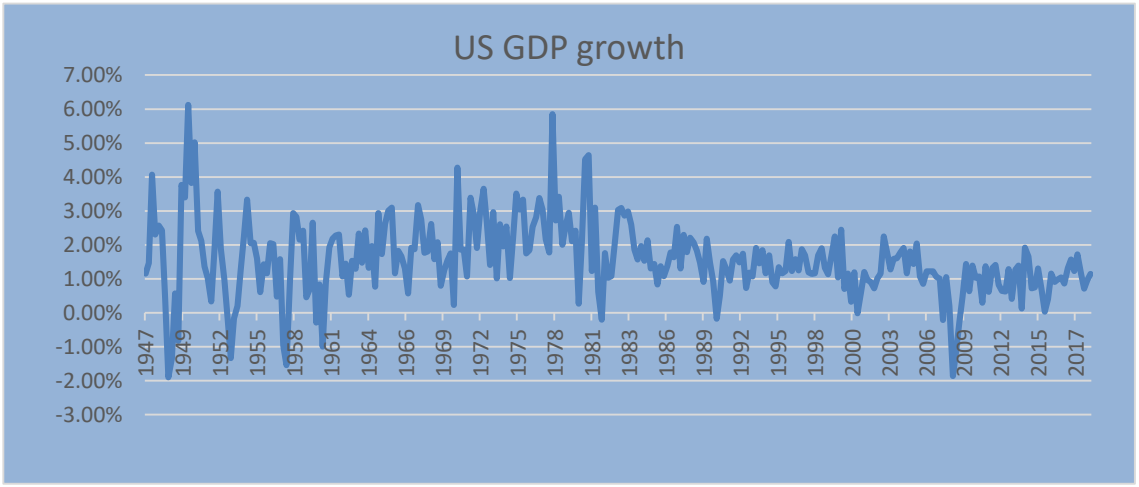
Source: Bloomberg Terminal

Figure 8 Historical US Real GDP growth



Source: FRED database and author's calculation

Figure 9 Historical nominal US GDP growth

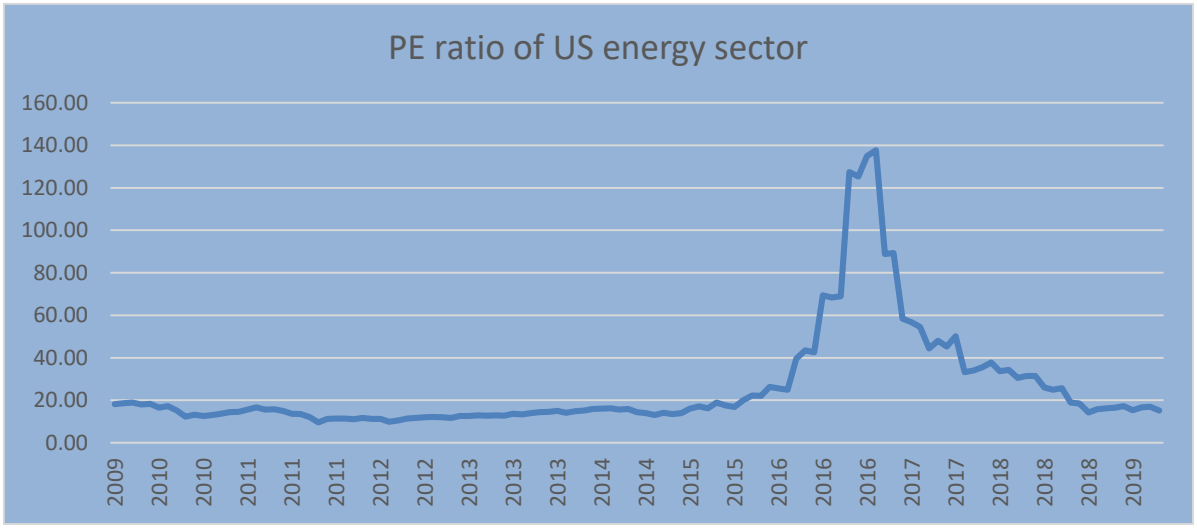


Source: FRED database and author's calculation

5.1.2 PE ratio of US energy sector, crude oil price and inflation rate

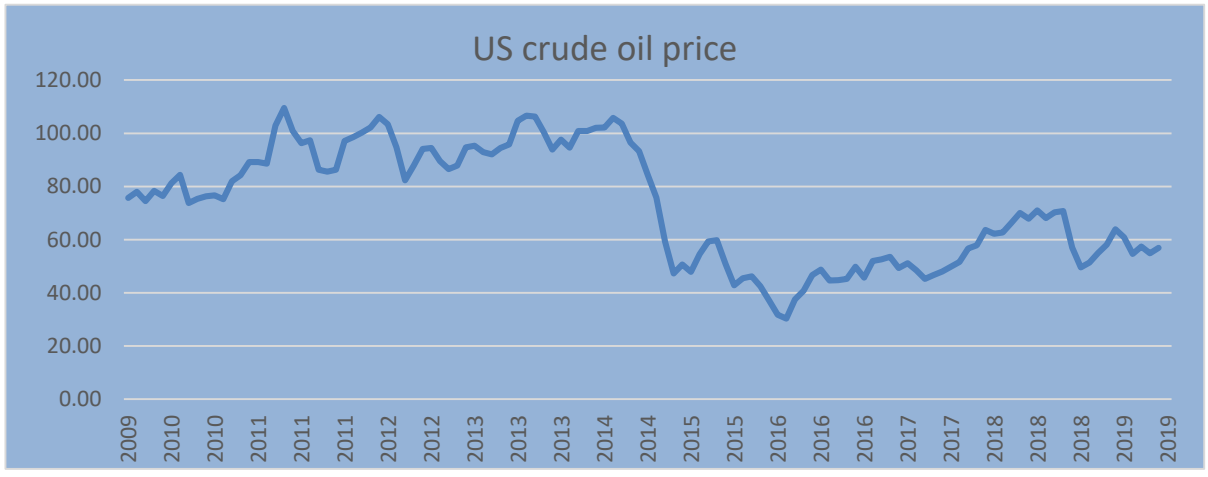
Based on Figure 10, the PE ratio of US energy sector skyrocketed in 2016. The dramatic increase in PE ratio could be explained by the decrease in oil price in 2016 when the oil price fell to the bottom of $30 per barrel (see Figure 11). Thus, changes in oil price may have a considerable impact on US energy stock returns.

Figure 10 PE ratio of US Energy Sector Benchmark S&P 500 Energy index, 2009-2019



Source: Bloomberg Terminal

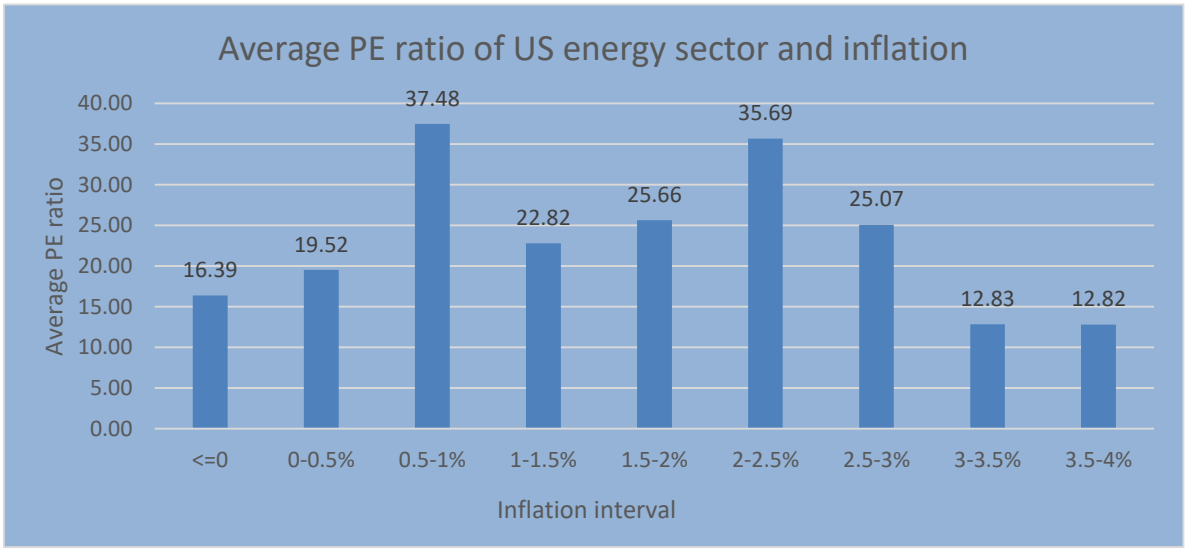
Figure 11 Historical US crude oil price. 2009-2019



Source: FRED database

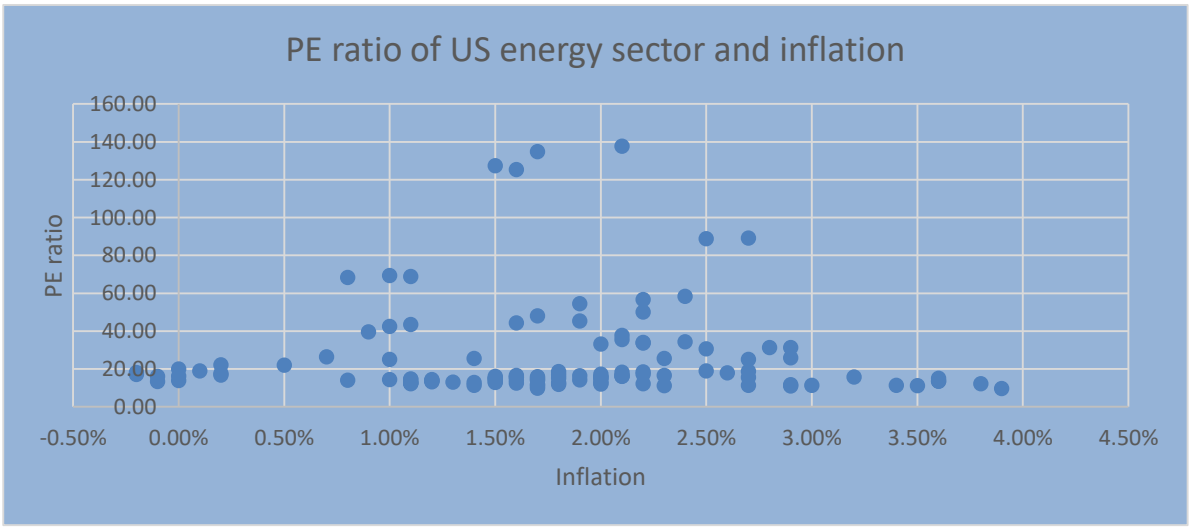
Additionally, changes in inflation rate may significantly influence US energy stock returns. Figure 12 and 13 below illustrate that the highest average monthly PE ratios are observed for inflation rate intervals of 0.5%-1% and 2%-2.5% during the period 2009-2019. On the other hand, the graphs show that lowest PE ratios are observed for inflation higher than 3%. The highest PE ratio observable in Figure 12 and 13 could be explained by the plummeting oil price in 2016. Figure 10 also depicts that the volatility of PE ratio was the highest during the 2016 oil shock and the inflation rate at that time was positive and rather low.

Figure 12 Average PE of S&P 500 energy index versus inflation rate, 2009-2019



Source: Bloomberg Terminal and author's calculation

Figure 13 PE ratio of S&P 500 energy index versus inflation rate, 2009-2019

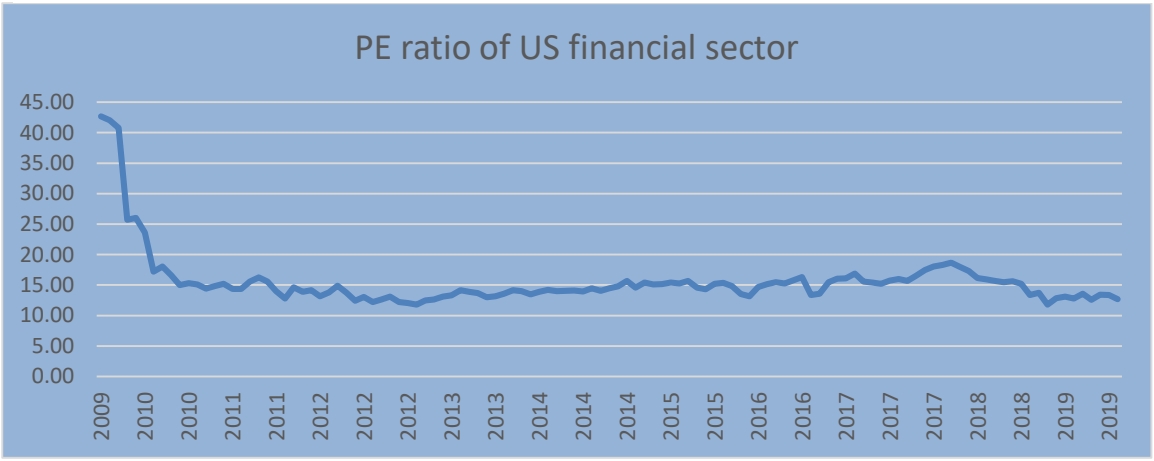


Source: Bloomberg Terminal and author's calculation

5.1.3 PE ratio of US financial sector and inflation rate

Figure 14 below demonstrates that the PE ratio of US financial sector plummeted from the peak of over 40 to less than 15 after the GFC. At first glance, the significant fall of PE ratio is favorable to value stock investors.

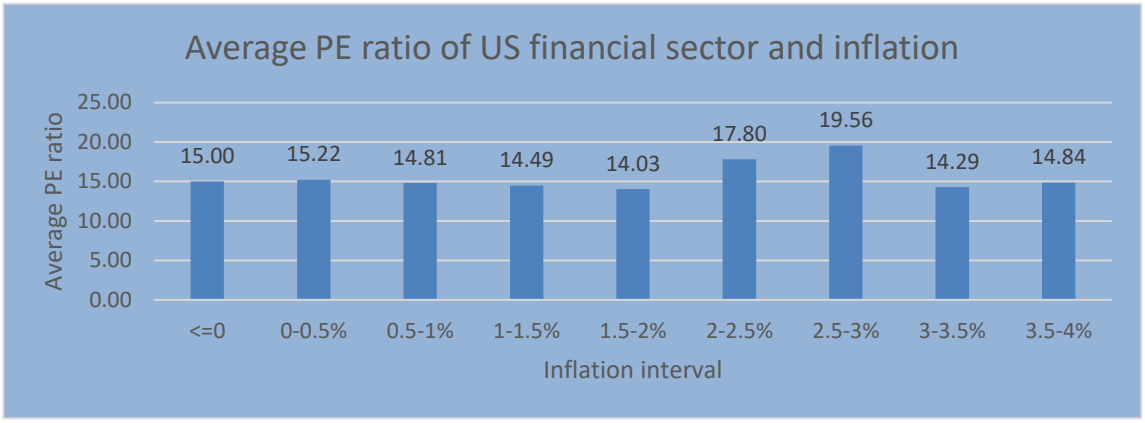
Figure 14 PE ratio of S&P 500 financial index, 2009-2019



Source: Bloomberg Terminal

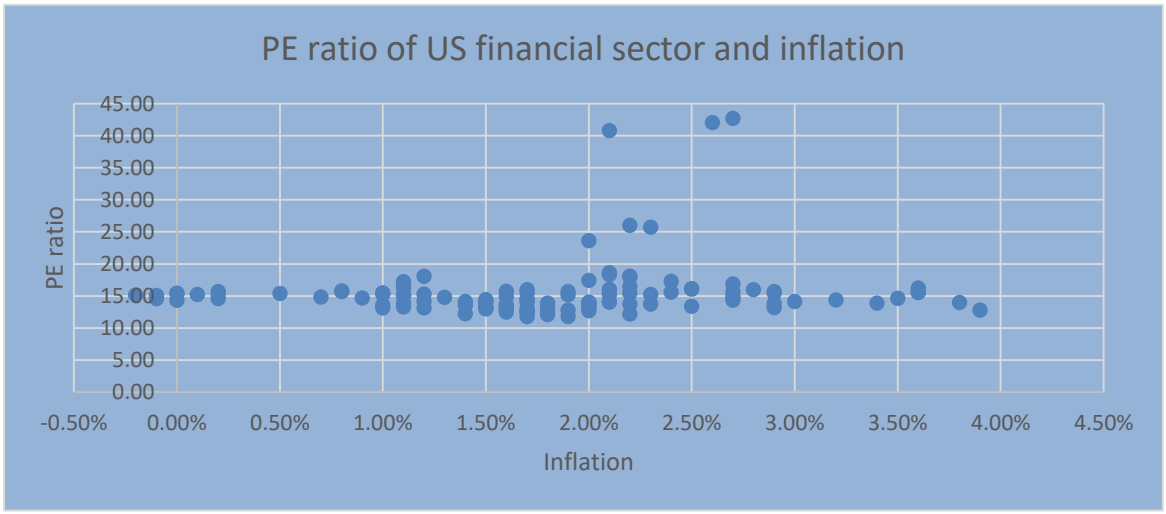
Based on Figure 15, the highest average PE ratio of US financial sector is observed for the inflation interval of 2-3%. Compared with US energy sector, US financial sector has lower average PE ratios for inflation interval of less than zero percent to 3% (see Figure 12 and 15). The highest PE ratio of US financial sector is 19.56 for the inflation interval of 2.5-3%, i.e., for higher inflation rates than those subjacent to the local maxima in Figure 12. In line with it, US financial sector has slightly higher PE ratio than US energy sector for the inflation interval of 3-4%. Figure 13 and 16 also show that the PE ratios of US financial sector are likely to be less volatile than US energy sector's PE ratio.

Figure 15 Histogram chart of average PE of S&P 500 financial index and inflation rate, 2009-2019



Source: Bloomberg Terminal and author's calculation

Figure 16 PE ratio of S&P 500 financial index versus inflation rate, 2009-2019

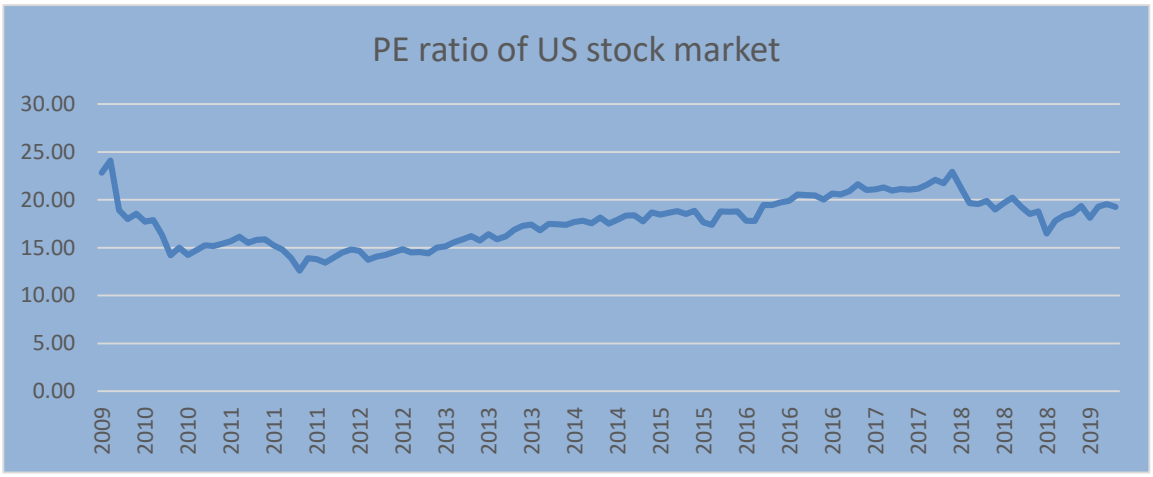


Source: Bloomberg Terminal and author's calculation

5.1.4 PE ratio of US stock market and inflation rate

Figure 17 below illustrates that the PE ratio of US stock market fell to less than 15 after the GFC but started to rise in 2011 until 2018. The PE ratio reached 22.93 in January 2018 but decreased to 16.48 at the end of 2018. Then, the ratio increased to around 20 in 2019. US financial sector had the lowest PE in recent period (2014-2019) (see Figure 10, 14 and 17). Although it is not clearly shown by the graphs, the US energy sector had the lowest PE between May 2011 and July 2013.

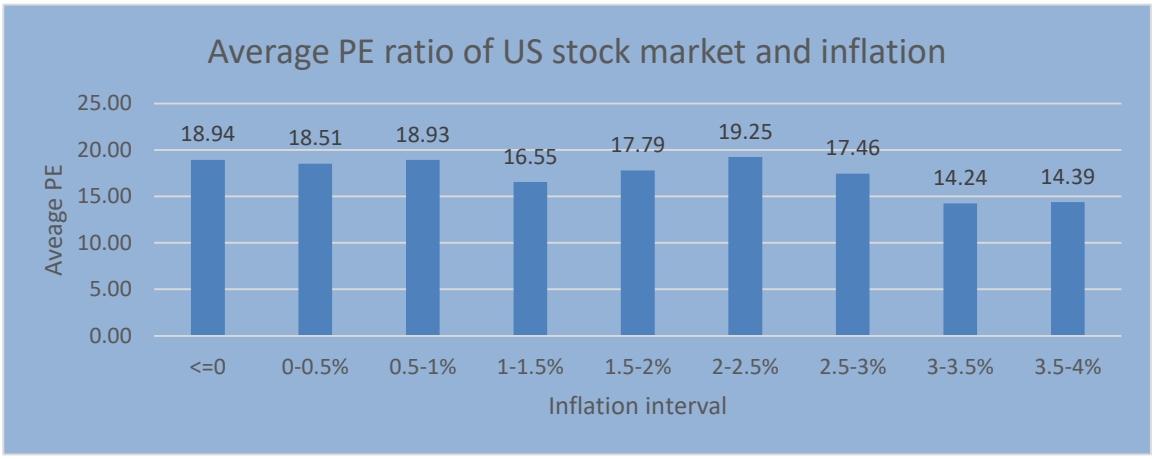
Figure 17 PE ratio of S&P 500 index, 2009-2019



Source: Bloomberg Terminal

In accordance with Figure 18 below, the average PE ratio of US stock market is slightly higher under inflation interval of 2-2.5%. The ratio is the lowest when the inflation rate is around 3-3.5%. It is noteworthy that the second highest average PE ratios of energy and financial sectors are observed for inflation interval of 2-2.5% while the second lowest ratios of the sectors are observed for inflation interval of 3-3.5% (see Figure 12, 15 and 18). This implicates that based on value investment strategy, the US stock market may be the most attractive when the inflation rate is around 3-3.5%, while the entire stock market may become less attractive when the inflation rate is around 2% to 2.5%. However, the inflation rates in 2019 varies within 1.5% to 2%, the range for which US financial sector has the lowest average PE ratios.

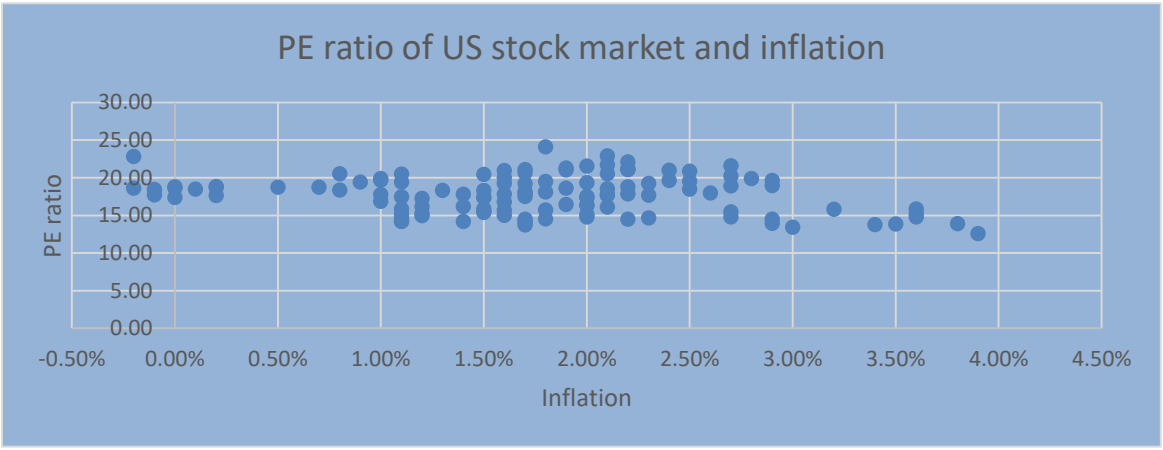
Figure 18 Average PE of S&P 500 index versus inflation rate, 2009-2019



Source: Bloomberg Terminal and author's calculation

According to Figure 19, it appears that the PE ratios of US stock market is not volatile between 2009 and 2019. It is interesting to note that US energy and financial sectors' PE ratios seem to be more volatile than US stock market's PE ratios (see Figure 13, 16 and 19). The US energy sector's PE ratios are more volatile possibly due to the oil shock in 2016.

Figure 19 PE ratio of S&P 500 index versus inflation rate, 2009-2019



Source: Bloomberg Terminal and author's calculation

5.2 Results from VAR model and Granger causality test

5.2.1 VAR model and Granger causality test for US energy sector

Table II below summarizes the result of VAR model and Granger causality test for US energy sector between January 2010 and August 2019. Only the statistically significant variables (stationary data) are reported for Table II and other tables in section 5.2. The variables are considered to be statistically significant if their T-ratios exceed the critical T-ratio of 1.98 with 116 observations at 95% confidence level under a two-tailed test (null hypothesis: coefficient = 0; alternative hypothesis: coefficient ≠ 0). The critical t-value is 1.658 at 90% confidence level. Monthly data of the variables such as 10-year US Treasury yield, 5-year US Treasury yield, inflation rate and fund rate are employed as explanatory variable in order to examine their impact on the returns of US stock market, energy and financial sectors. For US energy sector, crude oil price is adopted as an additional explanatory variable.

TABLE II: Summary of VAR model and Granger causality test for US energy sector, 2010-2019

Dependent variable	Explanatory variable	Coefficient	T-ratio	R^2	Granger causality test
S&P 500 energy index monthly return	US 5-year Treasury yield$_{(t-1)}$	-1.50	-1.69*	0.028	Fail to reject null hypothesis
S&P 500 energy index monthly return	US fund rate $_{(t-2)}$	-18.56	-1.69*	0.043	Fail to reject null hypothesis
S&P 500 energy index monthly return	Crude oil price$_{(t-1)}$	0.0058	5.74	0.23	Reject the null hypothesis
S&P 500 energy index monthly return	Crude oil price$_{(t-2)}$	-0.0056	-5.59	0.23	Reject the null hypothesis
S&P 500 energy index monthly return	Changes in crude oil price$_{(t-1)}$	0.0056	5.63	0.22	Reject the null hypothesis

*significant at 90% confidence level
Source: Bloomberg Terminal and author's calculation

Table II illustrates that 1 month lag of US 5-year Treasury yield, 2 month lag of US fund rate, 1 and 2 month lags of crude oil price and 1 month lag of changes in crude oil price have significant explanatory power on US energy sector returns. The negative coefficients of US 5-year Treasury yield (1 month lag) and US fund rate (2 month lag) indicate that there is an inverse relationship between interest rates and energy sector returns, which supports Fama (1981)'s theoretical framework. It is noteworthy that the crude oil price has a positive 1-month lag effect and a negative 2-month lag effect on US energy stock returns. Moreover, the R squared on Table II demonstrates that the monthly US energy stock return has weak correlations with the lags of US 5-year Treasury yield and fund rate, while lags of crude oil price and changes in crude oil price have considerably stronger correlations with US energy stock returns.

The result from Granger causality test shows that crude oil price and changes in crude oil price 'granger cause' the movements of S&P 500 energy index while US 5 year Treasury yield and fund rate does not. The null hypothesis of Granger causality test is that the explanatory variable does not 'granger cause' the dependent variable.

Table III below presents the summary of statistical test results for US energy sector from 2016 to 2019 (low and rising interest rate period), in the layout similar to Table II. The only difference is that 1 month lag of changes in US 10-year Treasury yield has a significant negative impact on US energy sector returns between 2016 and 2019 but US fund rate and 5-year Treasury yield do not.

TABLE III: Summary of VAR model and Granger causality test for US energy sector, 2016-2019

Dependent variable	Explanatory variable	Coefficient	T-ratio	R^2	Granger Causality Test
S&P 500 energy index monthly return	Changes in US 10-year Treasury $yield_{(t-1)}$	-3.27	-1.69*	0.083	Fail to reject null hypothesis
S&P 500 energy index monthly return	Changes in Crude $oil\ price_{(t-1)}$	0.008318	3.79	0.27	Reject null hypothesis
S&P 500 energy index monthly return	Changes in crude $oil\ price_{(t-2)}$	0.0056	5.63	0.22	Reject null hypothesis
S&P 500 energy index monthly return	Crude $oil\ price_{(t-1)}$	0.008	3.4	0.30	Reject null hypothesis
S&P 500 energy index monthly return	Crude $oil\ price_{(t-2)}$	-0.0086	-3.86	0.30	Reject null hypothesis

*significant at 90% confidence level
Source: Bloomberg Terminal and author's calculation

Therefore, based on our results from VAR model and Granger causality test, crude oil price and changes in crude oil price may have stronger impact on US energy stock returns than macroeconomic factors because monthly returns of S&P 500 energy

index are "Granger caused" by the crude oil price and changes in crude oil price, and not by interest rates, fund rate or inflation.

5.2.2 VAR model and Granger causality test for US financial sector

Tables IV and V below illustrate that US 10-year and 5-year Treasury yield have significant positive lag impact on US financial sector return for 2010-2019 and 2016-2019.

TABLE IV: Summary of VAR model and Granger causality test for US financial sector, 2010-2019

Dependent variable	Explanatory variable	Coefficient	T-ratio	R^2	Granger Causality Test
S&P 500 financial index monthly return	US 10-year Treasury $yield_{(t-1)}$	2.10	2.54	0.067	Reject null hypothesis
S&P 500 financial index monthly return	US 5-year Treasury $yield_{(t-1)}$	1.648	2.20	0.054	Reject null hypothesis
S&P 500 financial index monthly return	Inflation $rate_{(t-1)}$	2.865	1.81*	0.052	Fail to reject null hypothesis

Source: Bloomberg Terminal and author's calculation

TABLE V: Summary of VAR model and Granger causality test for US financial sector, 2016-2019

Dependent variable	Explanatory variable	Coefficient	T-ratio	R^2	Granger Causality Test
S&P 500 financial index monthly return	US 10-year Treasury $yield_{(t-1)}$	3.21	1.98	0.11	Reject null hypothesis
S&P 500 financial index monthly return	US 5-year Treasury $yield_{(t-1)}$	2.42	1.88*	0.10	Reject null hypothesis

Source: Bloomberg Terminal and author's calculation

The long-term and mid-term interest rates 'granger cause' the US financial stock returns over the same time periods. Compared with the results for US energy sector, the results for US financial sector are strikingly different. Interest rates have negative lag impacts on US energy stock prices but have positive lag effect on financial stock returns. Although interest rates do not 'granger cause' US energy stock price movements, they 'granger cause' changes in US financial stocks price.

Furthermore, the R squared on Table V is reasonably higher than the R squared on Table IV. This implicates that the correlations between US financial stock returns and interest rates become stronger in recent years (2016-2019).

5.2.3 VAR model and Granger causality test for US stock market

TABLE VI: Summary of VAR model and Granger causality test for US stock market, 2016-2019

Dependent variable	Explanatory variable	Coefficient	T-ratio	R^2	Granger Causality Test
S&P 500 index monthly return	US 10-year Treasury yield$_{(t-1)}$	-5.357	-1.822*	0.40	Fail to reject null hypothesis
S&P 500 index monthly return	US 10-year Treasury yield$_{(t-5)}$	-6.85	-2.20	0.40	Fail to reject null hypothesis
S&P 500 index monthly return	Changes in US fund rate$_{(t-3)}$	-19.20	-2.41	0.65	Fail to reject null hypothesis
S&P 500 index monthly return	Changes in US fund rate$_{(t-12)}$	-15.91	-2.09	0.65	Fail to reject null hypothesis

Source: Bloomberg Terminal and author's calculation

The tested macroeconomic variables have significant explanatory power on S&P 500 index between 2016 and 2019 but the power is insignificant over 2009-2019. Table VI above demonstrates that US 10-year Treasury yield and changes in fund rate have negative lag effect on the US stock market. However, they do not 'granger cause' the US stock price movements. Nonetheless, the R squared of test for US stock market is

substantially higher than the R squared from the tests for US energy and financial sectors. This indicates that the correlation between interest rates and stock returns become stronger in recent years (2016-2019) under low and rising interest rate environment. Willis and Cao (2015) suggest that US stocks become less interest rate sensitive between 1984 and 2007 based on VAR model. Willis and Cao (2015) do not analyze the data in post-2007 period because they believe that interest rate sensitivity of US stocks may change drastically under low interest rate environment. Therefore, our result from Table VI supports Willis and Cao (2015)'s insight.

It is also worth noting that, interestingly enough, the changes in US fund rates have stronger explanatory power and higher statistical significance than long-run US 10-year Treasury yield. The explanation of this phenomenon does not enter in the scope of the presented research, but further investigation of this subject seems to be highly desirable.

Overall, our results from VAR model and Granger causality test show that interest rates have positive lag impact on US financial sector returns, and have negative lag impact on US energy stock returns and US stock prices. Furthermore, interest rates 'granger cause' the price movements of US financial stocks. Thus, US financial stocks appear to be the optimal choice for our equity investment strategy that hedges against rising interest rate risk. However, financial indicators, which will be discussed in the section below, should also be examined before we reach our conclusion.

5.3 Financial analysis

Table VII: Financial indicators of sector benchmarks

Index	10-years annual total return	5-years annual total return	5-years Annualized risk (Standard Deviation)	10-years Annualized risk (Standard Deviation)	PB	PE	Leading Companies
S&P 500 energy	0.66%	-9.23%	20.15%	19.48%	1.55	15.73	Exxon Mobil , Chevron Corp
S&P 500 financial	8.75%	8.3081 %	16.24%	16.95%	1.43	13.47	Berkshire Hathaway, Bank of America
S&P 500	13.24 %	10.84%	11.93%	12.55%	3.42	19.77	Microsoft Corp, Apple Inc., Facebook Inc.

Source: S&P Dow Jones indices (https://us.spindices.com), Bloomberg Terminal and Fortune 500

Table VII above illustrates that US financial sector is the most favorable based on value investment strategy due to its low PB and PE ratios. However, US financial sector has lower annual total returns and higher annualized risk than the US stock market.

Table VIII: Financial leverage of sector benchmarks

Index		2014	2015	2016	2017	2018	2019
S&P 500 energy	% change in Total Liabilities	5.37%	-10.33%	-1.18%	-8.18%	-5.11%	3.45%
S&P 500 financial		3.08%	-1.65%	27.33%	5.19%	3.15%	3.91%
S&P 500		5.88%	2.09%	6.80%	4.81%	3.17%	4.34%

Source: Bloomberg Terminal and author's calculation

As interest rates determine the borrowing cost, interest income and interest expense of firms, it is important to examine the changes in total liabilities in the US stock market under rising interest rates environment. The rise of total liabilities in US financial

market and US stock market under low and rising interest rate environment from 2016 to 20019 are possibly favorable. The S&P 500 index has reached its pinnacle of over 3,000 points. The Japanese stock market, which is also under the influence of low interest rate environment, has not yet fully recovered from the loss from the bust of asset bubble in 1992. Koo (2008) suggests that Japanese stock prices were stale after the bust because firms' objective switched from profit making to paying down debts. Stock prices moved downward along with the interest rates after the bust. That is possibly the reason why Alam (2009) states that Japanese stock market has a positive relationship with interest rate.

Based on financial analysis, S&P 500 index replication and investment in US financial sector could be optimal for hedging against rising interest rate. Although US financial sector has lower return than the S&P 500 index's benchmark return, it has lower PE and PB ratios.

6. CONCLUSION

This thesis proposes the three-fold methodology to be employed in order to find the optimal investment strategy that withstands growing interest rate environment. This approach is based on macroeconomic analysis, VAR model and Granger causality test, and financial analysis. This methodology is applied to the US equity market.

The performed study illustrates that US financial stocks are the most suitable for hedging risks of rising interest rate. US financial stocks have the lowest average PE ratios for the inflation interval of 1.5-2%, which happens to be the range of inflation rate in 2019. They have a historically verified potential to be resilient to rising interest rates.

Additionally, based on our result from VAR model, interest rates have positive lag impacts on US financial stock returns. Moreover, in accordance with Granger causality test, the interest rates 'granger cause' the US financial stock returns. Furthermore, according to financial analysis, US financial sector has lower PE ratios and PB ratios than energy sector and US stock market benchmark. US financial sector also had a significant growth in total liabilities in 2016 which could be favorable based on the observations from Japan stock market. However, our analyses are dependent on historical data and observations which do not guarantee future performance. Therefore, investors should not neglect the looming threat of tail risks and 'black swan' effect.

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