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Relationship between stock returns of different sectors within the U.S. stock market and inflation rates

Seyedhamidreza Hosseini, MScBA
TIAS School for Business and Society
Utrecht, Netherlands

***Abstract* -Based on previous studies, responses of different sectors within U.S stock market to inflation rates have not been studies in detail. On the other hand, there are some contradictory studies, which was a motivation for author to study on this topic. This study investigates the relationship between stock returns of different sectors within the U.S. stock market and inflation rates over a period of 21 years. Due to undeniable effects of real activity and interest rate on inflation, author has included these two macroeconomic variables into the regression models. The linear regression demonstrates that past rates of inflation influence the current stock returns, while the responses of stock returns to inflation rates vary from one sector to another. Moreover, real activity is discovered to have a positive effect on the expected stock returns of all sectors. Conversely, most of the sectors do not have a significant relationship with previous values of interest rates.**

Keywords—Stock, Inflation, stock return

I. Introduction

In competitive markets these days, investors are trying to build a portfolio that could earn more with minimal risk. Investors diversify their portfolio with assets like real estate in order to minimize the rsik associated with that. Stocks, as a vehicle of investment, have drawn a substantial amount of attention since firms began issuing shares so as to increase the capital available for their projects and investors purchase stocks to create wealth.

However, stocks have their own risk in the market. The relationship between inflation (as a kind of systematic risk) and stock returns is extremely important, and the reason is because in order to have profitable investment, stock should preserve its value. In this regard, several hypotheses have attempted to explain the extent to which the values of stocks change as the inflation rate increases.

Fisher (1930) has studied on the relationship between stock return and inflation rate, which he concluded that there is a positive relationship between these two. On the other hand, some researchers such as Bodie (1976) and Fama and Schwert (1977) did not find any relationship between these two parameters. Fama (1981) has proposed the hypothesis, which says that this negative stock returns-inflation relationship is due to the connection to real economic activity. Geske and Roll (1983) have discovered the role of monetary policies in stock price in the inflation rate. Based on these studies, several researchers investigated this relation based on the other factors, which there is no definite answer yet.

The relationship between inflation rate and stock returns has been around for a while and it has been always trending among economists. The first economist that proposed the logical solution was Fisher (1930). There were numerous studies back in 1970s, which were showing negative relationship between stock return and inflation rate. However, among those studies, the first empirical analysis was conducted by Fama (1981). He explained the relationship through the connection between aforementioned variables and real activity. It has been observed that causal relations are time variant (Narayan & Thuraisamy, 2013; Antonakakis et al., 2016) and differ from country to country (Caldas & Terra, 2011; Anyiwe & Igbinedion, 2015). The existing differences could be because of factors such as behavior of investors, current state of the economy, and shocks to the system over specific period.

Author has been inspired by the study of Geske and Roll (1983) who have found a negative relationship between stock returns and inflation.

The result of this study will be useful for decision makers in order to develop models or optimization of existing predicting models. The result also could be effective in business excellence model and strategic decision making process. Since there are variety of sectors in this study, the outcome could contribute to their managerial decisions and their operations. Since day to day operation could be affected, the result could have influence on best practice or operational excellence of that specific sector (Leonard & McAdm 2002). Operational excellence has been defined by studies as doing the best thing in every single time (Liu et al. 2015; Liu et al. 2017), which act as best practice for sectors.

II. Research Methodology

There are no previous studies regarding to response of different sectors within U.S. stock market to inflation rate, which in this study will be thoroughly investigated. Therefore, the question still remains then, of whether or not this relationship is similar for different sectors of a stock market. Therefore, this study explores the relationship between stock return of different sectors within united states, real activity, and interest rate altogether. These relationships are significantly important, because it might be possible that some sectors react differently to aforementioned factors than the others.

The main purpose of this study is to explore whether or not there is a relationship between stock returns for different sectors and macroeconomic factors in the period of 21 years (1995-2016). In addition, this study aims to discover whether or not these relationships are significant over the period of this study. Linear regression will be used as main analysis tool to explore the possible relationship.

III. Sectors

This study investigated the relation between stock returns and inflation rates, real economic activity and interest rates for 10 sectors of the S&P 500. Nominal stock returns are the first difference of logarithm of monthly price Index.

1. **Consumer discretionary (SPCD)**: This sector contains 12.9% of total market weight of the S&P 500 index with about USD 28 billion market capitalization. There are variety businesses included in this sector such as: This sector includes businesses related to 1) Auto components 2) Automobiles 3) Distributers 4) Diversified consumer services 5) Hotels, restaurants and leisure 6) Internet and catalog retail 7) Leisure products 8) Media 9) Multiline retail 10) Specialty retail 11) Textile, apparel and luxury goods (Fidelity, 2016).
2. **Consumer staples (SPCS)**: This sector contains 10.04% of total market weight of the S&P 500 index with USD approximate 3.75 trillion market capitalization. There are variety of business included in this sector such as: 1) Beverages 2) Food and staples retailing 3) Food products 4) Household products 5) Personal products 6) Tobacco (Fidelity, 2016).
3. **Energy (SPE)**: This sector contains 7.09% of the total market weight of the S&P 500 with approximate USD 3.29 trillion market capitalization. There are variety of businesses included in this sector, which some of them are: 1) Energy equipment and services 2) Oil, gas and consumable fuels (Fidelity, 2016).
4. **Financial (SPF)**: This sector contains 16.05% market weight of the S&P 500 with approximate USD 5.87 trillion market capitalization. There are variety of businesses included in this sector, which some of the main ones are: 1) Banks 2) Capital markets 3) Diversified financial services 4) Insurance 5) Mortgage real estate investment trusts 6) Thrifts and mortgage finance 7) Consumer finance (Fidelity, 2016).
5. **Health care (SPHC)**: This sector contains 14.7% of the total market weight of the S&P 500 with approximate 4.53 trillion market capitalization. There are variety of business included in this sector, which the main ones are: 1) Biotechnology 2) Health care equipment and suppliers 3) Health care providers and services 4) Health care technology 5) life science tools and services 6) Pharmaceuticals (Fidelity, 2016).
6. **Industrial (SPI)**: This sector contains 9.97% weight of the S&P 500 with approximate USD 3.39 trillion market capitalization. There are variety of business included in this sector, which the main ones are:1) Aerospace and defense 2) Air freight and logistics 3) Airlines 4) Building products 5) Commercial services and suppliers 6) Construction and engineering 7) Electrical equipment 8) Industrial conglomerates 9) Machinery 10) Marine 11) Professional services 12) Road and rail 13) Trading companies and distributers 14) Transportation infrastructures (Fidelity, 2016).
7. **Information technology (SPIT)**: This sector contains 21.03% of the total market share of the S&P 500 with approximate USD 6.41 trillion market capitalization. There are variety of business included in this sector, which the main ones are: 1) Communication equipment 2) Electronic equipment, instruments and components 3) Internet software and services 4) IT services 5) Semiconductors and semiconductor equipment 6) Software 7) Technology hardware, storage and peripherals (Fidelity, 2016).
8. **Materials (SPM)**: This sector has a market capitalization of approximate USD 1.65 trillion and contains 2.93% of the total share of the S&P 500. There are variety of business included in this sector, which the main ones are: 1) Chemicals 2) Construction materials 3) Containers and packaging 4) Metals and mining 5) Paper and forest products (Fidelity, 2016).
9. **Telecommunication services (SPTS)**: This sector contains 2.65% of the total market share of the S&P 500 index with 100 billion market capitalization. There are variety of business included in this sector, which the main ones are: 1) Diversified telecommunication services 2) Wireless telecommunication services (Fidelity, 2016).
10. **Utilities (SPU)**: This sector contains a market capitalization of approximate USD 1.16 trillion and contained 3.24% of the total share of the S&P 500. There are variety of business included in this sector, which the man ones are: 1) Electric utilities 2) Gas utilities 3) Independent power and

renewable electricity products 4) Multi-utilities 5) Water utilities (Fidelity, 2016).

I. Data Analysis

As Koop (2006) stated that it is necessary to determine whether or not a time series it is "stationary". To deal with this issue, the ADF unit root test was conducted for different time series of the models. Since, the time series data are not stationary at level, the first difference of the time series were used in linear regression models.

A linear regression was employed as main analysis too in order to explore the possible relationships between variables over the period of study (1995-2016). In addition, this test is conducted between current stock returns and lagged values of others. The analysis of each sectors will be discussed below.

A. Consumer discretionary

The estimations were corrected for autocorrelation and heteroscedasticity within the models through the application of the Newey-West method. As can be observed in table 1, there is no significant relationship between the contemporaneous inflation rate and stock returns of consumer discretionary sector. By adding more lags, the third test shows that the second lag of real activity had a positive relationship with expected stock returns. The size of the coefficient (1.43) denotes that a 1% increase in real activity implies an increase in the expected return by 1.43%.

The fifth test indicates that there is a negative relationship between current stock returns and inflation rate at time (t-4). The negative coefficient indicates that 1% increase in inflation rate implies a decline in the expected stock returns by 5.17%. The R^2 (coefficient of determination) within the fourth model reveals that only 16% of the variations are explained by four lagged values of each explanatory variable. It can be concluded that based on the test results, there is no relationship between variables.

Table 1: Consumer discretionary results

$$\boldsymbol{SPCD = 0.007[1.26] + (-0.420)\, INF[-0.18]}$$

$\boldsymbol{R^2 = 0.007}$, S.E = 0.051 , SSR = 0.697, D.W = 1.80, F – statistic = 0.716

$$\boldsymbol{SPCD = 0.006[1.46] + (-0.580)INF_{-1}[-0.59] + 1.241\, IP_{-1}[1.48] + 0.367\, IR_{-1}[0.22]}$$

$\boldsymbol{R^2 = 0.026}$, S.E = 0.051 , SSR = 0.697, D.W = 1.86, F – statistic = $\boldsymbol{2.301}^{***}$

$$\boldsymbol{SPCD = 0.003[0.65] + (-0.966)INF_{-1}[-0.92] + 1.205\, INF_{-2}[0.96] + 0.899\, IP_{-1}[1.10] + 1.435^{**}\, IP_{-2}[1.97] + (-0.212)IR_{-1}[-0.15] + (-1.060)IR_{-2}[-0.59]}$$

$\boldsymbol{R^2 = 0.061}$, S.E = 0.051 , SSR = 0.654, D.W = 1.80, F – statistic = $\boldsymbol{2.727}^{**}$

$$\boldsymbol{SPCD = 0.006[1.42] + (-0.962)INF_{-1}[-0.74] + 1.982\, INF_{-2}[1.32] + (-2.367)INF_{-3}[-1.65] + 1.136\, IP_{-1}[1.58] + 1.778^{*}\, IP_{-2}[2.41] + (-0.952)IP_{-3}[-1.12] + (-0.808)IR_{-1}[-0.56] + (-0.757)IR_{-2}[-0.43] + 0.726\, IR_{-3}[0.402]}$$

$\boldsymbol{R^2 = 0.087}$, S.E = 0.050 , SSR = 0.635, D.W = 1.87, F – statistic = $\boldsymbol{2.626}^{*}$

$$\boldsymbol{SPCD = 0.013^{*}[2.95] + (-0.670)INF_{-1}[-0.54] + 1.060\, INF_{-2}[0.79] + (-0.219)INF_{-3}[-0.16] + (-5.178^{*})INF_{-4}[-3.31] + 1.486^{**}\, IP_{-1}[2.32] + 1.948^{*}\, IP_{-2}[3.303] + (-0.454)IP_{-3}[-0.78] + (-1.011)IP_{-4}[-1.85] + (-0.959)IR_{-1}[-0.71] + (-2.584)IR_{-2}[-1.47] + 1.300\, IR_{-3}[0.77] + 1.818\, IR_{-4}[1.10]}$$

$\boldsymbol{R^2 = 0.160}$, S.E = 0.049 , SSR = 0.584, D.W = 1.87, F – statistic = $\boldsymbol{3.864}^{*}$

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

(*) $\boldsymbol{significance\ at\ 1\%}$ *; (**)* $\boldsymbol{significance\ at\ 5\%}$; (***) $\boldsymbol{significance\ at\ 10\%}$, [t-statistic]

B. Consumer staples

In table 2, it is obvious that there is no significant relationship between inflation rates and contemporaneous stock returns and it is concluded based on low coefficient of determination. The results show that the first and second lags of real economic activity had a positive relationship with expected stock returns. On the other hand, by including two lagged values for interest rates, it can be seen that the first lag of interest rate was negatively related to expected stock returns at a 10% significance level. The last test shows that the lags of both inflation rate and interest rate had

negative and industrial production positive relationships with the expected stock returns. The coefficient of INF_{-4} indicates that a 1% increase in inflation rate implies a decrease in the expected rate of return by 1.72%.

Table 2: Consumer staples results

$\boldsymbol{SPCS = 0.006^{*}[2.40] + 0.055\ INF[0.06]}$
$\boldsymbol{R^2 = .00001}$, S.E = 0.036 , SSR = 0.344, D.W = 1.85, F – statistic = 0.004
$\boldsymbol{SPCS = 0.003[1.40] + 0.481\ INF_{-1}[0.59] + 1.122^{*}\ IP_{-1}[3.28] + (-1.634)\ IR_{-1}[-1.44]}$
$\boldsymbol{R^2 = 0.045}$, S.E = 0.035 , SSR = 0.329, D.W = 1.86, F – statistic = $\boldsymbol{4.021^{*}}$
$\boldsymbol{SPCS = 0.002\ [0.70] + 0.183\ INF_{-1}[0.20] + 0.737\ INF_{-2}[0.82] + 0.915^{**}\ IP_{-1}[2.56] + 0.772^{**}\ IP_{-2}[2.21] + (-2.059^{***})IR_{-1}[-1.78] + (-0.107)IR_{-2}[-0.09]}$
$\boldsymbol{R^2 = 0.066}$, S.E = 0.044 , SSR = 0.321, D.W = 1.87, F – statistic = $\boldsymbol{2.99^{*}}$
$\boldsymbol{SPCS = 0.003[1.04] + 0.313\ INF_{-1}[0.33] + 0.577\ INF_{-2}[0.56] + (-0.270)INF_{-3}[-0.28] + 0.970^{*}\ IP_{-1}[2.60] + 0.833^{**}\ IP_{-2}[2.29] + (-0.515)IP_{-3}[-1.38] + (-2.417^{***})IR_{-1}[-1.96] + (-0.221)IR_{-2}[-0.18] + 1.882\ IR_{-3}[1.55]}$
$\boldsymbol{R^2 = 0.082}$, S.E = 0.035 , SSR = 0.315, D.W = 1.90, F – statistic = $\boldsymbol{2.477^{**}}$
$\boldsymbol{SPCS = 0.005[1.69] + 0.506\ INF_{-1}[0.54] + 0.409\ INF_{-2}[0.38] + 0.29\ INF_{-3}[0.28] + (-1.729)^{***}\ INF_{-4}[-1.82] + 1.201^{*}\ IP_{-1}[3.14] + 0.987^{*}\ IP_{-2}[2.64] + (-0.324)IP_{-3}[-0.85] + (-0.788)IP_{-4}[-1.38] + (-2.396^{***})IR_{-1}[-1.95] + (-0.793)IR_{-2}[-0.63] + 1.974\ IR_{-3}[1.63] + 0.869\ IR_{-4}[0.72]}$
$\boldsymbol{R^2 = 0.11}$, S.E = 0.035, SSR = 0.304, D.W = 1.90, F – statistic = $\boldsymbol{2.593^{*}}$
Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.
*(*) significance at 1% ; (**) significance at 5% ; (***) significance at 10% ;* [t-statistic]

C. Energy

The results from table 3 shows a significant positive relationship between stock returns and inflation. However, the coefficient of determination (2.2%) is relatively low, which means that stock returns are not affected by this variable. By adding four lags to the model, it was found that inflation has a significant relationship with the expected rate of return. In this regard, a 1% increase in inflation rate denotes a decrease by 2.78% within the expected stock returns. In general, it can be concluded that fourth lag of real activity had a negative effect on stock return within this sector with probability of 90%, and on the other hand, there is no Significant evidence to prove this relationship.

Table 3: Energy results

$\boldsymbol{SPE = 0.0008[0.21] + 2.968^{**}\ INF[2.42]}$
$\boldsymbol{R^2 = 0.022}$, S.E = 0.055 , SSR = 0.783, D.W = 2.10, F – statistic = $\boldsymbol{5.85^{**}}$
$\boldsymbol{SPE = 0.005[1.47] + (-1.864)\ INF_{-1}[-1.55] + 2.322^{*}\ IP_{-1}[4.54] + (-2.061)\ IR_{-1}[-1.21]}$
$\boldsymbol{R^2 = 0.081}$, S.E = 0.053 , SSR = 0.735, D.W = 2.01, F – statistic = $\boldsymbol{7.568^{*}}$
$\boldsymbol{SPE = 0.007[1.6] + (-1.741)INF_{-1}[-1.30] + (-0.949)INF_{-2}[-0.70] + 2.219^{*}\ IP_{-1}[4.13] + 0.576\ IP_{-2}[1.09] + (-2.686)IR_{-1}[-1.54] + 2.071\ IR_{-2}[1.18]}$
$\boldsymbol{R^2 = 0.094}$, S.E = 0.053 , SSR = 0.724, D.W = 2.002, F – statistic = $\boldsymbol{4.389^{*}}$
$\boldsymbol{SPE = 0.004[0.93] + (-1.330)INF_{-1}[-0.93] + (-1.860)INF_{-2}[-1.20] + 1.882\ INF_{-3}[1.30] + 2.235^{*}\ IP_{-1}[3.97] + 0.403\ IP_{-2}[0.73] + 0.039\ IP_{-3}[0.07] + (-1.974)IR_{-1}[-1.06] + 1.721\ IR_{-2}[0.96] + (-0.480)\ IR_{-3}[-0.26]}$
$\boldsymbol{R^2 = 0.101}$, S.E = 0.053 , SSR = 0.717, D.W = 1.99, F – statistic = $\boldsymbol{3.105^{**}}$
$\boldsymbol{SPE = 0.007[1.56] + (-1.11)INF_{-1}[-0.78] + (-2.153)INF_{-2}[-1.34] + 2.915\ INF_{-3}[1.81] + (-2.785)^{***}\ INF_{-4}[-1.94] + 2.550^{*}\ IP_{-1}[4.42] + 0.630\ IP_{-2}[1.11] + 0.346\ IP_{-3}[0.60] + (-1.017)^{***}IP_{-4}[-1.77] + (-1.924)IR_{-1}[-1.03] + 0.957\ IR_{-2}[0.51] + (-0.262)\ IR_{-3}[-0.14] + 0.525\ IR_{-4}[0.28]}$

$R^2 = 0.128$, S.E = 0.085, SSR = 0.695, D.W = 2.003, F – statistic = 2.994^{*}

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

*(*) significance at 1% ; (**) significance at 5% ; (***) significance at 10% ; [t-statistic]*

D. Financial

The estimates were corrected for autocorrelation and heteroscedasticity within the models through the application of the Newey-West method. As demonstrated in table 4, the contemporaneous inflation rate has no significant relationship with stock returns. The second test shows that a one-period past rate of industrial production was positively related to the expected return. The third test demonstrated that the second lag of inflation rate had a positive relationship with the expected return on stocks.

Table 4: Financial results

$$SPF = 0.001[0.26] + 1.573\ INF[0.60]$$

$R^2 = 0.004$, S.E = 0.064 , SSR = 1.07, D.W = 1.77, F – statistic = 0.275

$$SPF = (-0.0004)[-0.07] + 1.237\ INF_{-1}[0.62] + 2.099^{***}\ IP_{-1}[1.81] + 0.986\ IR_{-1}[0.36]$$

$R^2 = 0.054$, S.E = 0.063 , SSR = 1.021, D.W =1.88, F – statistic = 4.889^{*}

$$SPF = (-0.005)[-0.86] + (-0.603)INF_{-1}[-0.38] + 4.043^{**}\ INF_{-2}[2.10] + 1.359\ IP_{-1}[1.39] + 1.697^{***}\ IP_{-2}[1.77] + (-0.294)IR_{-1}[-0.10] + 1.844\ IR_{-2}[0.88]$$

$R^2 = 0.112$, S.E = 0.061 , SSR = 0.957, D.W = 1.80, F – statistic = 5.283^{*}

$$SPF = (-0.002)[0.74] + (-0.340)INF_{-1}[-0.19] + 4.249^{**}\ INF_{-2}[2.23] + (-1.593)\ INF_{-3}[-0.78] + 1.586^{***}\ IP_{-1}[1.66] + 1.981^{**}\ IP_{-2}[2.11] + (-1.295)\ IP_{-3}[-1.51] + (-0.99)IR_{-1}[-0.36] + 2.09\ IR_{-2}[0.98] + 2.41\ IR_{-3}[0.90]$$

$R^2 = 0.134$, S.E = 0.061 , SSR = 0.932, D.W = 1.87, F – statistic = 4.275^{**}

$$SPF = 0.006[0.82] + 0.127\ INF_{-1}[0.07] + 3.079^{**}\ INF_{-2}[1.83] + 0.804\ INF_{-3}[0.42] + (-6.094^{*})INF_{-4}[-2.89] + 2.027^{*}\ IP_{-1}[2.73] + 2.160^{**}\ IP_{-2}[2.41] + (-0.736)IP_{-3}[-0.95] + (-1.322)IP_{-4}[-1.57] + (-1.196)IR_{-1}[-0.49] + (-0.360)\ IR_{-2}[-0.17] + 2.799\ IR_{-3}[1.22] + 3.702^{**}\ IR_{-4}[1.90]$$

$R^2 = 0.208$, S.E = 0.059, SSR = 0.852, D.W = 1.90, F – statistic = 5.338^{*}

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

*(*) significance at 1% ; (**) significance at 5% ; (***) significance at 10% ; [t-statistic]*

In the fifth test, the coefficient of determination was relatively high at 20.8%. In this test, inflation at time (t-2) was positively related with expected stock returns, while a 1% rise in INF_{-4} implies a decrease by 6.09% in the expected rate of return. In addition, it appears that both the first and second lags of economic activity maintained a positive relation with expected return. On the other hand, only the fourth lag of interest rate appears to display a significant effect on the expected rate of return. In other words, a 1% rise in the fourth lag of interest rate implies a rise in the expected return by 3.7%.

E. Health care

The results demonstrate that there is no significant evidence which displays a relationship between the stated variables. As demonstrated in table 5, even by including lagged values of inflation rates within the model, any significant relationship between inflation and expected stock returns was not found. Similarly, the results did not provide evidence that indicates effects of previous interest rates on expected rates of return within this sector.

Table 5: Health care results

$$SPHC = 0.007^{**}[2.41] + 0.248\ INF[0.25]$$

$R^2 = 0.0002$, S.E = 0.043 , SSR = 0.482, D.W = 2.08, F – statistic = 0.066

$$SPHC = 0.006^{**}[2.09] + (-0.397)\ INF_{-1}[-0.41] + 1.323^{*}\ IP_{-1}[3.27] + (-0.824)\ IR_{-1}[-0.61]$$

$R^2 = 0.040$, S.E = 0.042 , SSR = 0.460, D.W =2.13, F – statistic = 3.591^{**}

$$SPHC = 0.006^{***}[1.88] + (-0.458)INF_{-1}[-0.43] + (-0.292)\ INF_{-2}[-0.27] + 1.112^{*}\ IP_{-1}[2.63] + 0.949^{**}\ IP_{-2}[2.30] + (-1.452)IR_{-1}[-1.65] + 1.406\ IR_{-2}[1.02]$$

$R^2 = 0.067$, S.E = 0.042 , SSR = 0.447, D.W = 2.12, F – statistic = 3.007^{*}

$$SPHC = 0.007^{*}[2.06] + (-0.407)INF_{-1}[-0.36] + (-0.281)\ INF_{-2}[-0.23] + (-0.477)\ INF_{-3}[-0.42] + 1.161^{*}\ IP_{-1}[2.62] + 1.024^{**}\ IP_{-2}[2.37] + (-0.404)\ IP_{-3}[-0.91] + (-1.791)IR_{-1}[-1.22] + 1.360\ IR_{-2}[0.97] + 1.380\ IR_{-3}[0.96]$$

$R^2 = 0.074$, S.E = 0.042 , SSR = 0.443, D.W = 2.14, F – statistic = 2.195^{**}

$$SPHC = 0.009^{*}[2.46] + (-0.28)INF_{-1}[-0.25] + (-0.431)INF_{-2}[-0.34] + 0.197\ INF_{-3}[0.15] + (-1.798)INF_{-4}[-1.59] + 1.374^{*}\ IP_{-1}[3.01] + 1.193^{*}\ IP_{-2}[2.67] + (-0.196)\ IP_{-3}[-0.43] + (-0.689)IP_{-4}[-1.51] + (-1.732)IR_{-1}[-1.18] + 0.953\ IR_{-2}[0.64] + 1.543\ IR_{-3}[1.06] + (-0.002)\ IR_{-4}[-0.001]$$

$R^2 = 0.093$, S.E = 0.042, SSR = 0.434, D.W = 2.11, F – statistic = 2.093^{**}

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

*(*) significance at 1% ; (**) significance at 5% ; (***) significance at 10% ;* [t-statistic]

However, the second test provided evidence that a 1% rise in industrial production implies a rise by 1.32% in expected returns. Yet, the coefficient of determination indicates that only 4% of variation in expected stock returns is explained by these variables. Moreover, the positive relations for the first and second lags of industrial production also appeared in the results.

F. Industrials

The estimates for the following tests were corrected for autocorrelation and heteroscedasticity within the models through the application of the Newey-West method. As demonstrated in table 6, the contemporaneous inflation rates and stock returns are not significantly related. The second test demonstrated that a rise in the one-period past rate of industrial production signaled an increase in current stock returns.

Table 6: Industrial results

$$SPI = 0.005[0.97] + 0.254\ INF[0.12]$$

$R^2 = 0.0001$, S.E = 0.051 , SSR = 0.688, D.W = 1.83, F – statistic =0.048

$$SPI = 0.003[0.69] + 0.152\ INF_{-1}[0.17] + 1.995^{**}\ IP_{-1}[2.36] + (-0.569)\ IR_{-1}[-0.40]$$

$R^2 = 0.064$, S.E = 0.050 , SSR = 0.643, D.W =1.94, F – statistic = 5.890^{*}

$$SPI = (-0.0004)[-0.10] + (-0.604)\ INF_{-1}[-0.60] + 1.778\ INF_{-2}[1.15] + 1.556^{***}\ IP_{-1}[1.90] + 1.466^{**}\ IP_{-2}[2.36] + (-1.435)IR_{-1}[-1.04] + 0.178\ IR_{-2}[0.10]$$

$R^2 = 0.106$, S.E = 0.049 , SSR = 0.613, D.W = 1.89, F – statistic = 4.984^{*}

$$SPI = 0.007[0.15] + (-0.143)\ INF_{-1}[-0.12] + 1.518\ INF_{-2}[1.02] + (-0.327)INF_{-3}[-0.20] + 1.785^{**}\ IP_{-1}[2.31] + 1.622^{**}\ IP_{-2}[2.52] + (-1.013)IP_{-3}[-1.29] + (-1.447)IR_{-1}[-1.05] + 0.222\ IR_{-2}[0.13] + 0.936\ IR_{-3}[0.512]$$

$R^2 = 0.121$, S.E = 0.049 , SSR = 0.601, D.W = 1.93, F – statistic = 3.810^{**}

$$SPI = 0.006[1.45] + 0.133\ INF_{-1}[0.12] + 0.662\ INF_{-2}[0.48] + 1.696\ INF_{-3}[1.06] + (-4.899)^{*}INF_{-4}[-3.18] + 2.130^{*}\ IP_{-1}[3.02] + 1.810^{*}\ IP_{-2}[3.43] + (-0.540)\ IP_{-3}[-0.95] + (-0.978)IP_{-4}[-1.53] + (-1.528)IR_{-1}[-1.10] + (-1.424)\ IR_{-2}[-0.74] + 1.334\ IR_{-3}[0.79] + 1.522\ IR_{-4}[0.84]$$

$R^2 = 0.188$, S.E = 0.047, SSR = 0.555, D.W = 1.90, F – statistic = 4.702^{*}

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

(*) $\boldsymbol{significance\ at\ 1\%}$; (**) $\boldsymbol{significance\ at\ 5\%}$; (***) $\boldsymbol{significance\ at\ 10\%}$; [t-statistic]

The fifth test with a relatively high coefficient of determination (18.8%) revealed that current stock returns are influenced by inflation rates at time (t-4). The size of the coefficient indicated that a rise in inflation rates implies a decline by 4.89% in the expected return. Moreover, it was found that changes in both the first and second lags of industrial production imply that the stock returns moved in the same direction.

However, there is no evidence that current stock returns are significantly influenced by the past values of interest rates.

G. Information technology

The estimates of the second, third and fourth tests were corrected for autocorrelation and heteroscedasticity within the models through the application of the Newey-West method.

Table 7: Information technology results

$$\boldsymbol{SPIT = 0.005[0.98] + 1.273\ INF[0.74]}$$

$\boldsymbol{R^2 = 0.002}$, *S.E = 0.076 , SSR = 1.515, D.W = 2.03, F – statistic =0.557*

$$\boldsymbol{SPIT = 0.007[1.30] + (-0.634)\ INF_{-1}[-0.47] + 1.490^{***}\ IP_{-1}[1.75] + 1.786\ IR_{-1}[0.55]}$$

$\boldsymbol{R^2 = 0.020}$, *S.E = 0.076 , SSR = 1.486, D.W = 2.06, F – statistic =* $\boldsymbol{1.811}$

$$\boldsymbol{SPIT = 0.006[1.02] + 0.044\ INF_{-1}[0.02] + (-1.432) INF_{-2}[-0.84] + 1.344\ IP_{-1}[1.50] + 1.662^{***}\ IP_{-2}[1.92] + 1.167\ IR_{-1}[0.38] + (-1.369)\ IR_{-2}[-0.48]}$$

$\boldsymbol{R^2 = 0.041}$, *S.E = 0.076 , SSR = 1.451, D.W = 2.05, F – statistic =* $\boldsymbol{1.829^{***}}$

$$\boldsymbol{SPIT = 0.009^{***}[1.68] + 0.223\ INF_{-1}[0.12] + (-0.572) INF_{-2}[-0.25] + (-2.567) INF_{-3}[-1.23] + 1.716^{**}\ IP_{-1}[2.12] + 2.085^{**}\ IP_{-2}[2.56] + (-1.179) IP_{-3}[-1.28] + 0.93\ IR_{-1}[0.25] + (-0.961)\ IR_{-2}[-0.34] + (-0.702)\ IR_{-3}[-0.24]}$$

$\boldsymbol{R^2 = 0.059}$, *S.E = 0.075 , SSR =1.423, D.W = 2.08, F – statistic =* $\boldsymbol{1.726^{***}}$

$$\boldsymbol{SPIT = 0.012[1.77] + 0.292\ INF_{-1}[0.14] + (-1.196) INF_{-2}[-0.53] + (-0.838) INF_{-3}[-0.36] + (-3.787)^{**} INF_{-4}[-1.87] + 1.937^{**}\ IP_{-1}[2.37] + 2.278^{*}\ IP_{-2}[2.86] + (-0.796)\ IP_{-3}[-0.98] + (-0.465) IP_{-4}[-0.57] + 1.046\ IR_{-1}[0.39] + (-1.752)\ IR_{-2}[-0.66] + (-0.579)\ IR_{-3}[-0.22] + (-0.839)\ IR_{-4}[-0.32]}$$

$\boldsymbol{R^2 = 0.077}$, *S.E = 0.075, SSR = 1.388, D.W = 2.10, F – statistic =* $\boldsymbol{1.692^{***}}$

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

(*) $\boldsymbol{significance\ at\ 1\%}$; (**) $\boldsymbol{significance\ at\ 5\%}$; (***) $\boldsymbol{significance\ at\ 10\%}$; [t-statistic]

The test between current stock returns and inflation did not exhibit a significant relationship between the stated variables. The second test demonstrated a positive relation between the first lag of industrial production and stock returns. By adding more lags, it was found that the first and second lags of industrial production have positive effects on expected return. Afterwards, the fifth test provided evidence that a rise in inflation rate implies a decline by 3.78% in the current stock returns. On the other hand, no evidence was found that indicated that interest rates have a significant effect on the current stock returns.

H. Materials

The estimates were corrected for autocorrelation and heteroscedasticity through the application of the Newey-West method. As demonstrated, current inflation was not related to stock returns.

Table 8: Materials results

$$\boldsymbol{SPM = 0.001[0.21] + 1.558\ INF[0.67]}$$

$\boldsymbol{R^2 = 0.005}$, S.E = 0.060 , SSR = 0.934 , D.W = 2.01, F – statistic = 1.354

$$\boldsymbol{SPM = 0.002[0.52] + (-0.428) INF_{-1}[-0.33] + 1.683^{***}\ IP_{-1}[1.81] + (-1.876)\ IR_{-1}[-1.04]}$$

$\boldsymbol{R^2 = 0.034}$, S.E = 0.059, SSR = 0.904, D.W = 1.98, F – statistic = $\boldsymbol{3.038^{**}}$

$$\boldsymbol{SPM = 0.001[0.34] + (-0.534) INF_{-1}[-0.35] + 0.067\ INF_{-2}[0.04] + 1.547\ IP_{-1}[1.57] + 0.623\ IP_{-2}[0.78] + (-2.418) IR_{-1}[-1.34] + 0.474\ IR_{-2}[0.24]}$$

$R^2 = 0.040$, S.E = 0.059 , SSR = 0.896, D.W = 1.97, F – statistic = 1.758

$$SPM = 0.003[0.56] + (-0.234)INF_{-1}[-0.14] + 0.176\ INF_{-2}[0.10] + (-0.975)INF_{-3}[-0.53] + 1.787^{***}\ IP_{-1}[1.81] + 0.836\ IP_{-2}[1.03] + (-0.916)IP_{-3}[-1.28] + (-2.512)IR_{-1}[-1.36] + 0.549\ IR_{-2}[0.27] + 0.421\ IR_{-3}[0.21]$$

$R^2 = 0.051$, S.E = 0.059 , SSR = 0.883, D.W = 2.03, F – statistic = 1.477

$$SPM = 0.011^{**}[2.11] + 0.108\ INF_{-1}[0.06] + (-0.725)INF_{-2}[-0.43] + 1.683\ INF_{-3}[1.02] + (-6.496)^{*}INF_{-4}[-3.57] + 2.333^{*}\ IP_{-1}[2.60] + 1.208\ IP_{-2}[1.63] + (-0.235)\ IP_{-3}[-0.39] + (-1.637)IP_{-4}[-2.90] + (-2.515)IR_{-1}[-1.60] + (-1.280)IR_{-2}[-0.76] + 1.131\ IR_{-3}[0.62] + 0.710\ IR_{-4}[0.36]$$

$R^2 = 0.146$, S.E = 0.057, SSR = 0.795, D.W = 2.02, F – statistic = 3.463^{*}

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

*(*) significance at* 1% *; (**) significance at* 5% ; (***) *significance at* 10% ; [t-statistic]

The relation between past rates of inflation and the current rate of return was only found within the model with four lags of variables. The coefficient of determination for the fifth test revealed that 14.6% of variations in stock returns are explained by these variables. As can be observed, a rise in INF_{-4} implies a decline by 6.49% in expected return. Moreover, this test indicated that the first lag of industrial production had a positive relation with expected returns. On the other hand, there is no evidence which revealed a relationship between interest rate and stock returns.

I. Telecommunication services

As demonstrated in table 9, there is no relationship between current stock returns and neither contemporaneous nor past values of inflation rates.

Table 9: Telecommunication service results

$$SPTS = 0.004[1.05] + (-1.316)\ INF[-1.03]$$

$R^2 = 0.004$, S.E = 0.057 , SSR = 0.840 , D.W = 1.98 , F – statistic = 1.07

$$SPTS = 0.002[0.56] + (-1.069)INF_{-1}[-0.84] + 1.190^{**}\ IP_{-1}[2.20] + 0.949\ IR_{-1}[0.52]$$

$R^2 = 0.023$, S.E = 0.056, SSR = 0.822, D.W = 2.02, F – statistic = 2.029

$$SPTS = 0.001[0.22] + (-1.310)INF_{-1}[-0.92] + 0.668\ INF_{-2}[0.46] + 1.04^{***}\ IP_{-1}[1.82] + 0.531\ IP_{-2}[0.95] + 0.736\ IR_{-1}[0.39] + (-0.287)\ IR_{-2}[-0.15]$$

$R^2 = 0.027$, S.E = 0.057 , SSR = 0.818, D.W = 2.00, F – statistic = 1.192

$$SPTS = 0.005[1.32] + (-1.731)INF_{-1}[-1.46] + 1.563\ INF_{-2}[0.92] + (-2.417)INF_{-3}[-1.52] + 1.046^{***}\ IP_{-1}[1.75] + 0.767\ IP_{-2}[1.32] + (-0.434)\ IP_{-3}[-0.73] + (-0.490)IR_{-1}[-0.24] + (-0.151)\ IR_{-2}[-0.08] + 2.653\ IR_{-3}[1.37]$$

$R^2 = 0.046$, S.E = 0.057 , SSR = 0.803, D.W = 2.00, F – statistic = 1.334

$$SPTS = 0.006[1.25] + (-2.00)INF_{-1}[-1.33] + 0.830\ INF_{-2}[0.49] + (-0.852)INF_{-3}[-0.50] + (-2.41)INF_{-4}[-1.59] + 0.872\ IP_{-1}[1.42] + 0.655\ IP_{-2}[1.09] + (-0.241)\ IP_{-3}[-0.39] + 0.983\ IP_{-4}[1.61] + (-0.552)IR_{-1}[-0.28] + (-0.563)IR_{-2}[-0.28] + 3.026\ IR_{-3}[1.55] + (-2.099)\ IR_{-4}[-1.08]$$

$R^2 = 0.069$, S.E = 0.056, SSR = 0.783, D.W = 2.00, F – statistic = 1.505

Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.

*(*) significance at* 1% *; (**) significance at* 5% ; (***) *significance at* 10% ; [t-statistic]

There is also no evidence which revealed a relationship between lagged values of interest rates and expected rate of return. On the other hand, it can be inferred that a 1 % rise in the first lag of industrial production implies a rise of around 1% in expected returns. However, the coefficient of determination was relatively low for all of the tests, suggesting that there are other factors influencing this sector's stock returns.

J. Utilities

As demonstrated in table 10, there was no relationship found between stock returns and contemporaneous inflation rates.

Table 10: Utilities results

$\boldsymbol{SPU = 0.003[1.09] + (-0.106)\ INF[-0.10]}$
$\boldsymbol{R^2 = 0.00004}$, S.E = 0.045 , SSR = 0.538 , D.W = 1.87 , F – statistic = 0.010
$\boldsymbol{SPU = 0.001[0.50] + (-0.016)INF_{-1}[-0.01] + 1.359^{*}\ IP_{-1}[3.18] + 1.218\ IR_{-1}[0.86]}$
$\boldsymbol{R^2 = 0.045}$, S.E = 0.044, SSR = 0.511, D.W = 1.96, F – statistic = $\boldsymbol{4.081^{*}}$
$\boldsymbol{SPU = 0.001[0.49] + (-0.222)INF_{-1}[-0.19] + 0.094\ INF_{-2}[0.08] + 1.221^{*}\ IP_{-1}[2.71] + 0.387\ IP_{-2}[0.88] + 0.851\ IR_{-1}[0.58] + (-1.454)\ IR_{-2}[0.99]}$
$\boldsymbol{R^2 = 0.053}$, S.E = 0.044 , SSR = 0.507, D.W = 1.95, F – statistic = $\boldsymbol{2.366^{**}}$
$\boldsymbol{SPU = 0.002[0.57] + (-0.229)INF_{-1}[-0.19] + 0.237\ INF_{-2}[0.18] + (-0.322)INF_{-3}[-0.26] + 1.243^{*}\ IP_{-1}[2.63] + 0.433\ IP_{-2}[0.94] + (-0.101)\ IP_{-3}[-0.21] + 0.781\ IR_{-1}[0.50] + 1.615\ IR_{-2}[1.08] + (-0.104)IR_{-3}[-0.06]}$
$\boldsymbol{R^2 = 0.054}$, S.E = 0.045 , SSR = 0.506, D.W = 1.95, F – statistic = $\boldsymbol{1.575}$
$\boldsymbol{SPU = 0.003[1.11] + (-0.067)INF_{-1}[-0.05] + 0.100\ INF_{-2}[0.07] + 0.011\ INF_{-3}[0.007] + (-1.126)INF_{-4}[-1.13] + 1.401^{*}\ IP_{-1}[2.05] + 0.526\ IP_{-2}[1.42] + 0.0139\ IP_{-3}[0.03] + (-0.545)IP_{-4}[-0.99] + 0.788\ IR_{-1}[0.55] + 1.154\ IR_{-2}[0.73] + (-0.136)IR_{-3}[-0.10] + 1.019\ IR_{-4}[0.71]}$
$\boldsymbol{R^2 = 0.064}$, S.E = 0.045, SSR = 0.499, D.W = 1.95, F – statistic = 1.397
Note: D.W. = Durbin-Watson; S.E= Standard error of estimate; SSR= Sum of squared residuals.
*(*)* $\boldsymbol{significance\ at\ 1\%}$ *; (**)* $\boldsymbol{significance\ at\ 5\%}$; (***) $\boldsymbol{significance\ at\ 10\%}$; [t-statistic]

According to the tests, past values of inflation did not have a significant relationship with expected rate of return. Similarly, lagged values of interest rate were not significantly related to current stock returns. On the other hand, it appears that a one-period past value of industrial production had a significant effect upon the expected stock returns. To illustrate, the fifth test with indicated that a 1% rise in IP_{-1} implies an increase by 1.4% in expected return.

II. Findings and Conclusion

A linear regression was used as main analysis tool in this study in order to explore any possible relationship between aforementioned variables. Author was expecting different responses to variables in all 10 sectors. As an example, a 1% increase in inflation rate implies a decrease by 4.8% in the expected returns of the industrial sector, while a 1% rise in inflation increases the expected rate of return of the financial sectors by 4.2%. This means that not only they are different, but also one of them is decrease and the other one is increase. There some sectors that have no statistical relationship with inflation rate, such as utilities and health care.

One possible reason could be the nature of these industries. Industries that provide products and not services are more vulnerable to inflation fluctuation. When inflation rate increase, cost of production will increase too, which this could lower profit margin of companies, so in general, it has adverse effects of them. Investors are trying to invest in sectors that have higher margins, therefore, they move their investments from lower margin sectors.

For those sectors that inflation rate did not have any effects on the, it can be concluded that these sectors are relatively price inelastic, which means that quantity of demands do not have any influence on the price of end goods. Therefore, earning of the firms will be stable and unchanged.

Furthermore, the results show that industrial production (as a proxy for real economic activity) has a positive relationship with all sectors of the S&P 500 which is similar to the Fama's (1981) proxy hypothesis. It is a result of an increase in industrial production which act as economic growth index of a country. Consequently, investors are willing to invest in these companies because of possible higher earnings and profitability.

The results of this study show that majority of sectors do not have significant relationship with interest rates. Therefore, it denotes that these sectors are affected more by real economic activity than monetary policies.

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