

# The Intraday Impact of Macroeconomic News on Price Moves of Financial Instruments

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## Abstract

*This paper studies the impact of major U.S. macroeconomic news releases on price movements of selected instruments in asset classes including equity, foreign exchange, and fixed income over different time spans within a day. The results show that U.S. macroeconomic news surprises affect different asset classes to varying degrees. Price movements of long-term U.S. Treasury bond yield return and news surprises of non-farm payroll, as well as ADP employment change are positively correlated. The impact is also higher within five minutes after release. The results are consistent with earlier research which shows the bond market reacts more to macroeconomic news. Such information can help traders with risk management and alpha generation when trade macroeconomic data. The paper also examines recent news about equity performance on employment data which shows they are not always consistent.*

**Keywords:** macroeconomic news surprise, financial markets, news effect

## 1. Introduction

This paper studies the relationship between price movements of different assets and U.S. macroeconomic news in Table 1 over various time spans in a trading day. Macroeconomic news is scheduled announcements on the economic indicators. U.S. economic indicators are chosen because it is the global financial center and the largest economy; in addition, they are released when liquidity is ample as the European market is open as well. Out of the eight selected indicators, the data that macro traders, the media, and the Federal Reserve pay most attention to would be non-farm payroll, which is scheduled to be released by the Labor Department usually on the first Friday of each month and reflects the state of the economy. It measures the number of employees on business payrolls. Understanding this dynamic can help traders and investors with risk management before entering into trades based on the difference between news releases and expectations.

**Table 1. The U.S. Economic News Announcements from 2008-2020**

Monthly Announcements	No. of observations	Sector
New Home Sales	155	Housing and Real Estate
Existing Home Sales	155	
Building Permit	154	

Non-farm Pay Roll MoM Change	155	Labor Market
ADP Employment Change	155	
Industrial Production MoM Change	155	Industrial Sector
Capacity Utilization	155	
Consumer Credit	155	Personal/Household Sector

The results of the paper are three-fold. Firstly, it shows non-farm payroll, ADP employment change, and new home sales news surprises affect financial markets reflected in price movements of instruments including Standard & Poor 500 Index (S&P 500), DXY index which is the average exchange rates between USD and major world currencies, and long-term Treasury bond more than other indicators in the sample within five minutes of releases.

Secondly, long-term U.S. T-bonds are found to be impacted the most by non-farm payroll surprises, followed by ADP employment change.

Thirdly, recent financial news was examined and evidence shows they sometimes fit into price movements and reporters may find reasons for such movements.

### 1.1. Problem Statement

The U.S. macroeconomic news is undoubtedly one of the major issues of interest for investors globally. This paper aims to study if prices adjust to the news by quantifying the effect of U.S. macroeconomic releases including New Home Sales, Existing Home Sales, Building Permits, Industrial Production, Capacity Utilization, Nonfarm Payroll, Advanced, and Consumer Credit on the Dollar Index (DXY), S&P 500 (SPX Index) and Treasury bonds price movements over the past decade after a time span of 1, 2, 3, 4, 5, 30, and 60 minutes. These selected indicators have comprehensive coverage over labor, housing and real estate, industrial and personal/household sectors which reflect the fundamentals of the U.S. economy. U.S. Treasury bond is also one of the biggest and most actively traded world widely.

### 1.2. Goals and Objectives

The goal is to bridge the gap by studying the effect of macro announcements on the foreign exchange (FX) represented by the DXY index, US equity represented by the S&P 500, and treasury bonds.

The objectives are as follows:

- Collect and collate data of relevant historical news items on Bloomberg as well as price change after 1, 2, 3, 4, 5, 30, and 60 minutes
- Summarize and draw conclusions by analyzing the data

The rest of the paper is organized as follows. Section 2 details the literature review and competitor analysis. Section 3 describes the methodology and section 4 presents empirical results. This is followed by section 5 which discusses the results and lastly, section 6 concludes.

## 2. Theoretic Framework

### 2.1. Literature Review

This section covers peer-reviewed literature from journal articles related to the impact of the macroeconomic news releases on price moves.

Fama's [1] Efficient Market Hypothesis (EMH) states that asset prices fully reflect all available information. The weak form EMH implies that all past information is priced in and neither fundamental nor technical analysis generates alpha in the long-term. The semi-strong form EMH suggests that new information is immediately reflected in securities' prices. The strong-form EMH indicates that both public and private information is priced into securities.

Fedorova, Wallenius, & Collan [2] studied the effect of scheduled euro area macroeconomic releases on certain emerging markets equity market returns and volatilities. Generally, euro area macroeconomic releases impact stock market volatility in the emerging markets and to a certain degree, returns in the selected emerging markets. According to their research, the extent of the impact varies from country to country. Nikkinen, Omran, Sahlström, & Äijö, [3] analyzed the behavior of GARCH volatilities around important scheduled U.S. macroeconomic news releases on local stock markets. They concluded that the G7 countries, the rest of European countries, developed and emerging countries in Asia are closely integrated with respect to the U.S. macroeconomic releases, while Latin America and Transition economies are little impacted. Furthermore, investors can benefit from diversified investments in those segmented emerging economies. Hussainey & Ngoc [4] investigated the effects of macroeconomic indicators including the interest rate and the industrial production on Vietnamese stock prices. They argue that Industrial production has a positive effect on Vietnamese stock prices; the long- and short-term interest rates are not affecting stock prices in the same direction.

Andersen, Bollerslev, Diebold, & Vega, [5] studied if macroeconomic news is reflected in pricing equity, fixed-income, and foreign exchange from 1994-2002. The underlying instruments are GBP/USD, USD/JPY, EUR/USD, S&P 500, long-term U.S. Treasury Bond, British Treasury Bond, German 5-Year Treasury Note, FTSE 100, DJ Euro Stoxx 50. They found that news results in conditional mean jumps; thus, high-frequency equity, fixed-income, and foreign exchange dynamics are connected to macroeconomic conditions. Moreover, bond markets have the most significant reactions to macroeconomic news. They also concluded that a Dollar appreciation is related to the stock market rise abroad, suggesting that the U.S. macro conditions pose a major impact during the releases. Another finding is that U.S. inflation does not appear to impact the foreign exchange rates. In addition, negative macroeconomic announcements have a negative impact on the stock market as expected during contractions, and vice versa during expansions.

Bollerslev, Cai, & Song, [6] studied return volatility in U.S. Treasury bond futures with a sample of five-minute returns from 1994 to 1997. They concluded that the announcement effects contribute the most to bond market volatility. In addition, the most crucial indicators are the Humphrey–Hawkins testimony as well as the employment report; this is followed by the PPI. Nowak, Andritzky, Jobst, & Tamirisa [7] examined how prices and volatility respond to news releases. They found in mature fixed-income markets, surprises about fundamentals in emerging markets impact conditional returns.

To summarize, existing studies such as Kyereboah-Coleman and Agyire-Tettey [8] concur that macroeconomic announcements affect price movements in different assets including equities, bonds, and foreign exchange rates despite varying degrees in different regions. This paper quantifies the effect of 8 macroeconomic indicators on equity and foreign exchange markets price moves represented by S&P 500, DXY index, U.S. 10- and

30-Y treasury bond respectively over time spans of 1, 2, 3, 4, 5, 30, and 60 minutes from 2008 to 2020. Based on the above research, the following hypotheses are formed:

- The macroeconomic news surprises have an impact on the chosen instruments' price moves but to varying degrees
- The impact varies in different time spans

The next section details a competitor analysis.

## **2.2. Competitor Analysis**

Do DXY, SPX Index, and domestic as well as foreign bond market react to U.S. macroeconomic news releases? Does one asset class react more than others? Do the price moves vary with different time spans? These questions help traders and investors better position with respect to news releases. This section identifies where the project will fit into the market by conducting a SWOT analysis.

### **Strengths**

There is existing literature covering the impact of the macroeconomic news releases on stock returns. This paper aims to study the effect on multi-asset classes including foreign exchange represented by DXY index, U.S. equity represented by the S&P 500 index as well as bond represented by long-term treasury over the past decade, which is important as it represents a new regime after the 2008 Great Financial Crisis. It builds on existing literature and verifies the conclusions of earlier work.

### **Weakness**

This paper covers the U.S. market and possible future work includes other developed and emerging markets such as China.

### **Opportunities**

This paper contributes to the earlier literature in two main aspects. Firstly, to my best knowledge, few studies have covered the price moves over different time spans. It aims to bridge a gap, which is the effect of macroeconomic news releases on the price moves over different time spans of 1, 2, 3, 4, 5, 30, and 60 minutes. Secondly, it draws on the latest data over the past decade as previous work focuses on the period before 2008. After 2008, central banks such as the European Central Bank and Federal Reserve started quantitative easing; such paradigm shift may impact the response of asset price changes to macroeconomic news surprises.

### **Threat**

The impact may vary depending on the business cycle. The caveat of the research is data limitation, which limits the scope of this paper to the period after 2008.

## **3. Methodology**

### **3.1 Data Collection Method**

This paper uses secondary data collected from the Economic Surprise (ECSU) function of Bloomberg, which is the most commonly used and reliable data provider. Firstly, the Ljung-Box test will be conducted to test for autocorrelation to ensure the data is suitable for subsequent analysis.

### **3.2 Analysis Method**

The next step is to calculate the correlation coefficient between the reaction of selected instruments and macroeconomic news surprises from linear regression:

$$\Delta y_t^T = \beta_t^T \text{news}_{i,t} + \varepsilon_t^T, \quad (3.1)$$

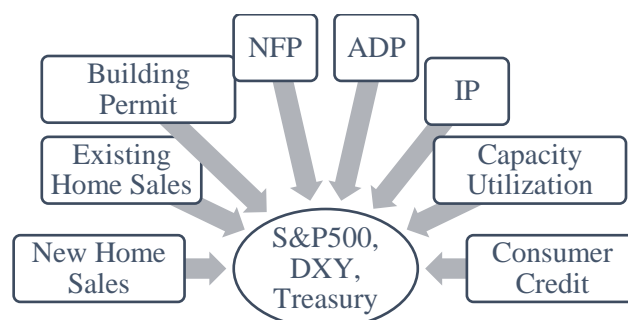
where  $\Delta y_t^T$  denotes return in the underlying instrument at time  $t$  with maturity  $T$  (for bond),  $\beta_t^T$  denotes correlation coefficient and  $\text{news}_{i,t}$  refers to surprise for indicator  $i$  at time  $t$ .

The surprise is defined by the difference between the survey mean and actual data divided by the sample standard deviation. It shows whether the surprise is positive or negative and allows for standardized comparison across indicators as illustrated below:

$$S_{k,t} = (\text{Actual}_{k,t} - \text{Expectation}_{k,t}) / \sigma_k, \quad (3.2)$$

where  $\text{Actual}_{k,t}$  denotes the actual value of the indicator  $k$  release at time  $t$ ,  $\text{Expectation}_{k,t}$  denotes the median from the survey forecast from market analysts from Bloomberg before releases for indicator  $k$  and  $\sigma_k$  refers to the sample standard deviation of the survey. The median forecast is used as a proxy and barometer of the market expectation by economists as well as investors. The number of responses varies and depends on the number of forecasts available from participating firms, which include most large institutions from Wall Street. Standardizing the surprise helps with interpreting the results. For instance, for non-farm payroll data to be released on 8<sup>th</sup> Jan 2021 at 8:30 am, there are 20 estimates from 73 qualified economists at the time of writing.

This is followed by logistic regression analysis; returns are classified as zero and one for negative and positive returns respectively.



**Figure1. Illustration of Variables**

Lastly, a random signal using random generator is added to dataset to test significance.

### 3.3 Desired Outcome

The desired outcome of the project is to determine if and to what extent asset prices respond to selected macroeconomic news surprises as well as any differences over different time spans. The results after adding a random signal should be different ideally.

## 4. Results

In this section, results will be presented.

The results for Ljung-Box show the data does not have autocorrelation except for DXY returns for non-farm payrolls.

### 4.1 Do Macroeconomic News Surprise Impact Price Movements?

Table 2 below shows the correlation, which is the explanatory power, between news surprise and price movements for DXY, S&P 500, and U.S. 10 Year Treasury over different time spans. For the effect on treasury bonds, due to data limitation, available data is from 2013 to 2020.





























Table 2. Correlation

	<i>New Home</i>	<i>Existing Home</i>	<i>Building Permit</i>	<i>NFP</i>	<i>ADP</i>	<i>IP</i>	<i>Capacity Utilization</i>	<i>Consumer Credit</i>
<b><i>DXY</i></b>								
<i>5-min</i>	<b>0.37</b>	0.13	0.14		<b>0.56</b>	0.21	0.09	-0.12
<i>30-min</i>	0.22	0.03	0.14		0.29	0.14	0.09	0.16
<i>60-min</i>	0.13	0	0.06		0.26	0.04	-0.01	-0.05
<b><i>S&amp;P 500</i></b>								
<i>5-min</i>	0.2	0.26	0.1	<b>0.39</b>	0.11	0.02	0.13	0.08
<i>30-min</i>	0.02	0.12	0.04	<b>0.3</b>	0.12	0.14	0.08	-0.13
<i>60-min</i>	-0.03	0.12	0.06	<b>0.31</b>	0.1	0.03	0.13	0.02
<b><i>US 10Y Treasury</i></b>								
<i>5-min</i>	-0.03	0.33	0.08	<b>0.55</b>	<b>0.48</b>	0.06	0.29	0.09
<i>30-min</i>	-0.03	0.02	0.08	<b>0.47</b>	0.24	0.13	0.08	-0.22
<i>60-min</i>	-0.03	-0.12	0.09	<b>0.37</b>	0.2	0.06	-0.02	-0.12

From the results, it is observed in most cases the correlation coefficient, or  $R^2$  estimate of the regression between price movement and news surprise decreases as time increases five to sixty minutes. The correlation coefficients which are higher than 0.3 are highlighted in bold in Table 1. Next, correlation coefficients are found after 1, 2, 3, and 4 minutes after news releases for New Home Sales, Non-farm Payroll, and ADP Employment Change.

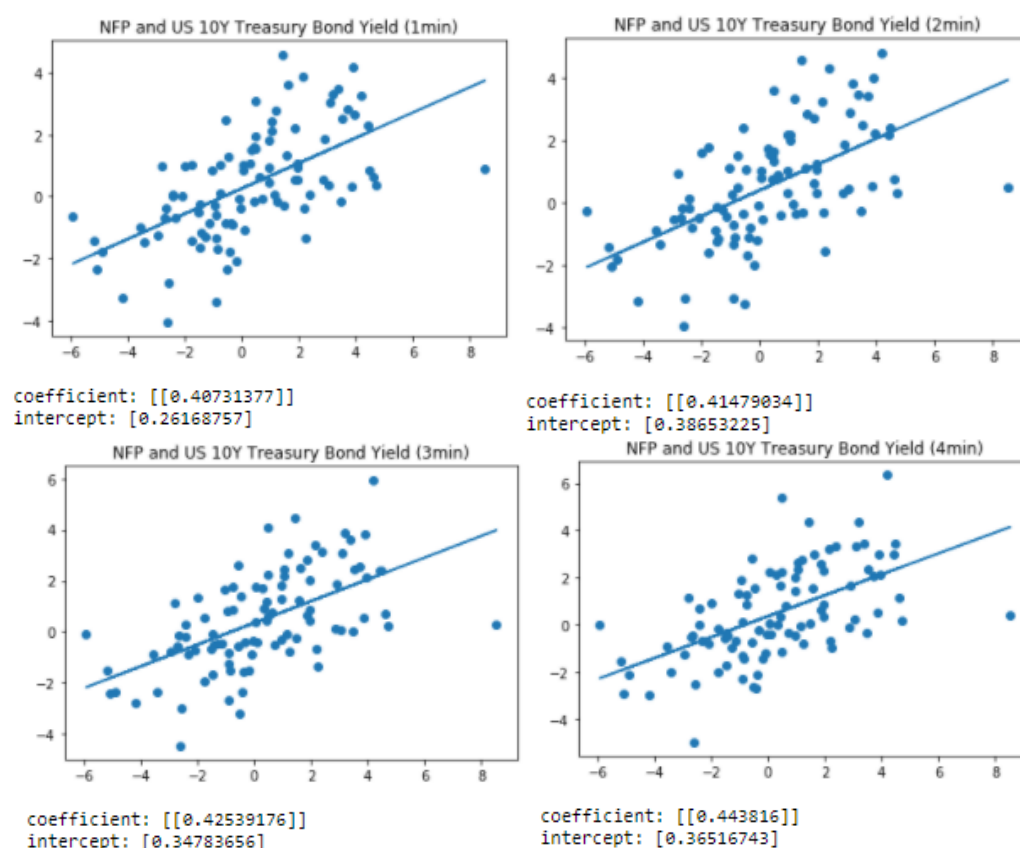
#### 4.2 Does the Impact Vary Across Different Time Spans?

Table 3. Correlations at Different Time

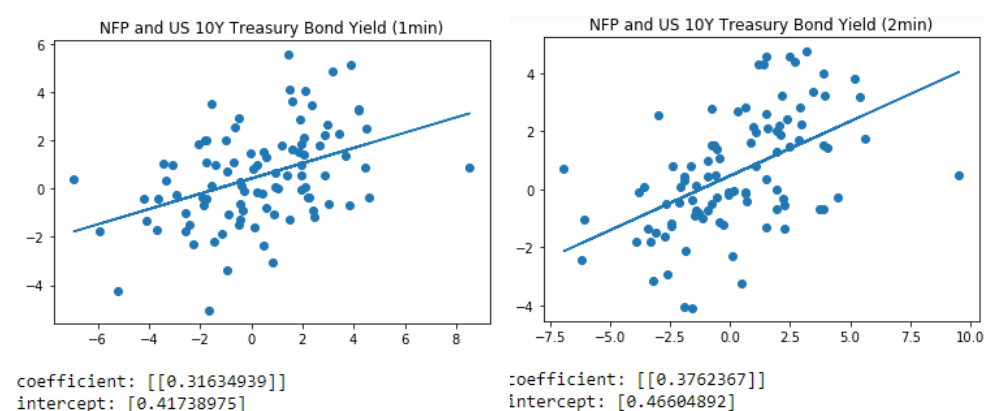
	<i>New Home</i>		<i>NFP</i>		<i>ADP</i>	
<b><i>DXY</i></b>						
<i>1-min</i>	0.41		-		0.47	
<i>2-min</i>	0.41		-		0.45	
<i>3-min</i>	0.36		-		0.48	
<i>4-min</i>	0.32		-		0.53	
<b><i>S&amp;P 500</i></b>						
<i>1-min</i>	-		0.45		-	
<i>2-min</i>	-		0.42		-	
<i>3-min</i>	-		0.41		-	
<i>4-min</i>	-		0.41		-	
<b><i>US 10Y Treasury</i></b>						
<i>1-min</i>	-		<b>0.59</b>		0.52	
<i>2-min</i>	-		<b>0.78</b>		0.53	
<i>3-min</i>	-		<b>0.73</b>		0.34	
<i>4-min</i>	-		<b>0.64</b>		0.25	
<b><i>German 10Y Treasury</i></b>						
<i>1-min</i>	-		0.19		-0.22	
<i>2-min</i>	-		0.11		-0.03	
<i>3-min</i>	-		0.06		0.03	
<i>4-min</i>	-		0.05		0.22	

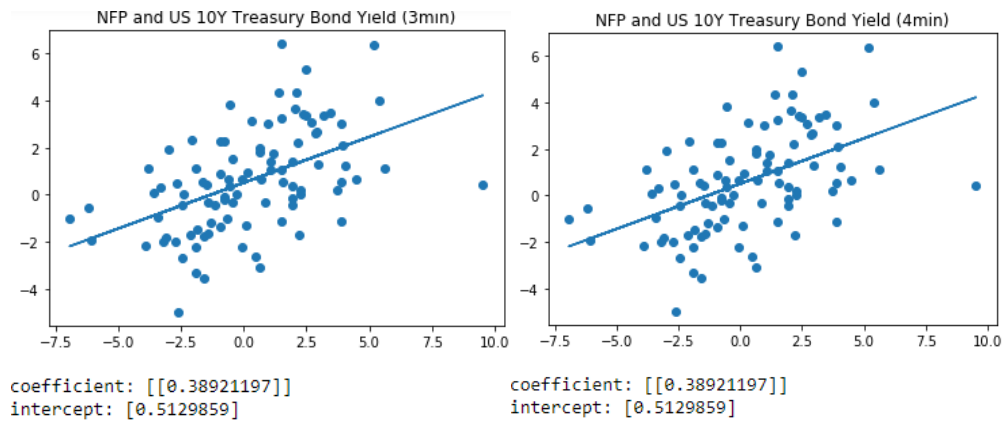
From the results above, the correlation coefficients between price movements of selected instruments and news surprise are greater within five minutes after releases. According to the results from the sample, the U.S. 10Y Treasury yield has the highest positive correlation of 0.59 with non-farm payroll surprise. Positive labor market surprise bodes well for the economy and therefore risky assets, driving investors away from safe-haven assets such as the U.S. Treasury bonds; therefore, yield goes up due to the inverse relationship with the bond price as suggested by the theory. However, the relationship does not hold for the German 10Y government bond from the sample from 2013 to 2020.

Results for linear regression of U.S. 10Y treasury bond yield return on non-farm payrolls over 4 minutes after releases and after adding a random signal are below:



**Figure2. Regression of US 10Y Treasury Bond Yield on NFP Surprises**

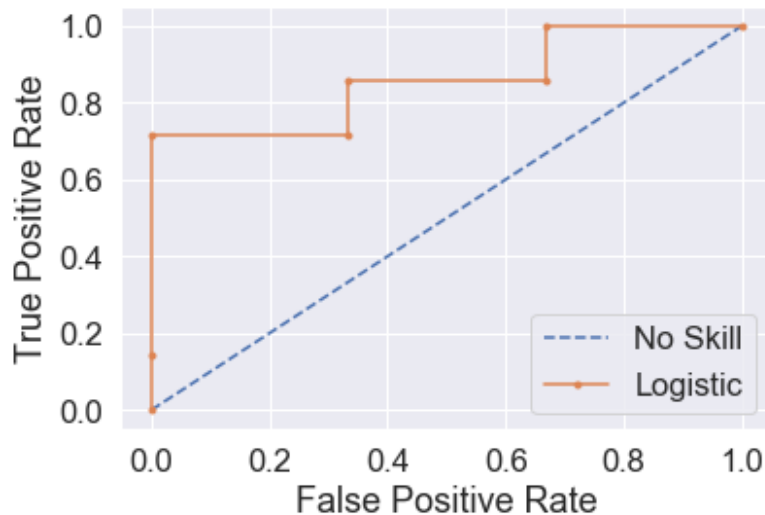




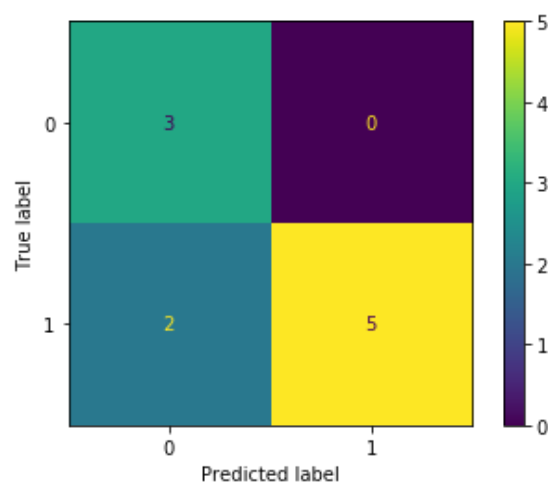
**Figure3. Regression Results after Adding a Random Signal**

After adding a random signal to NFP surprises and US 10Y treasury bond yield changes, the regression results have changed with lower correlation coefficient.

Next, logistic regression is conducted. An accuracy score of 0.8 was obtained and Figure 4 is a graph of the Receiver Operating Curve (ROC) curve. 10% of 96 data points were used for out-of-sample tests and Figure 5 shows a confusion matrix. 8 cases were predicted correctly.



**Figure4. ROC Curve for Logistic Regression**



**Figure5. Confusion Matrix**



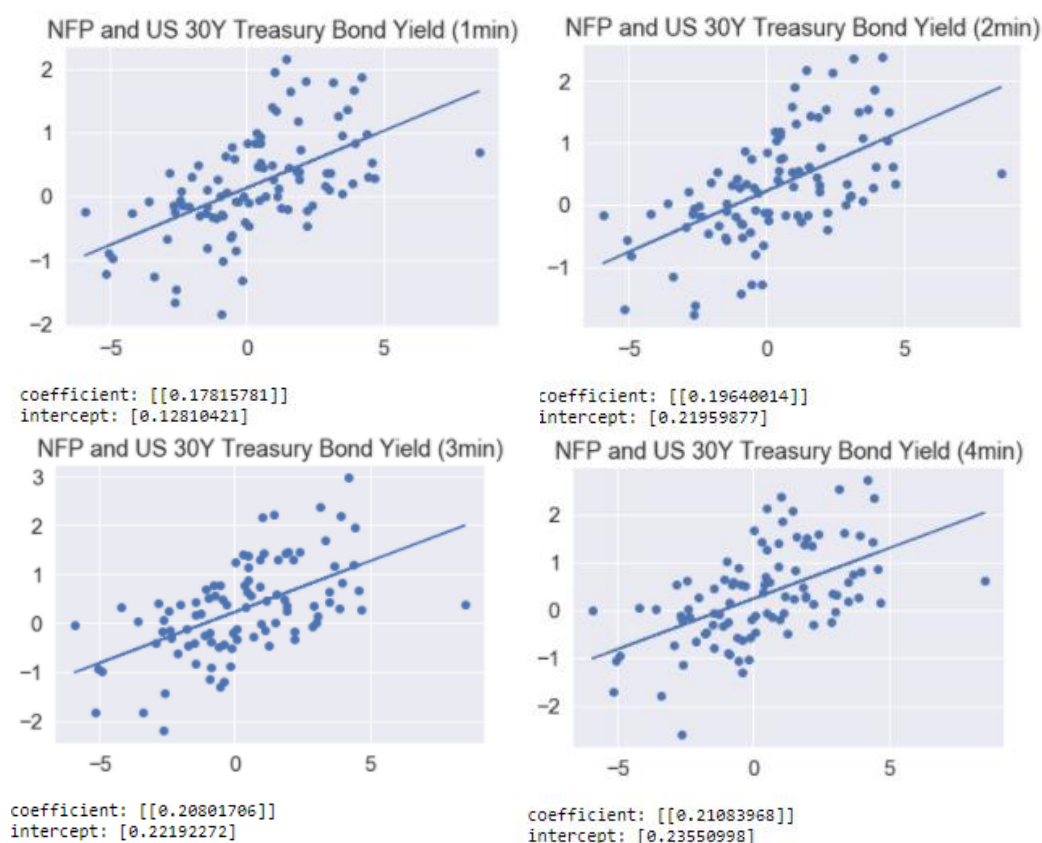
To further study the effect of news surprise on U.S. treasury, U.S. 30Y treasury bond is next analyzed.

#### 4. 3 Does Macroeconomic News Have Greater Impact on U.S. Treasury Bonds?

**Table4. Correlation Between U.S. 30Y Treasury Yield Return and News**

	<i>New Home</i>		<i>NFP</i>		<i>ADP</i>	
<i>US 30Y Treasury</i>						
<i>1-min</i>	0.41	<div></div>	<b>0.56</b>	<div></div>	0.54	<div></div>
<i>2-min</i>	0.35	<div></div>	<b>0.57</b>	<div></div>	0.43	<div></div>
<i>3-min</i>	0.35	<div></div>	<b>0.56</b>	<div></div>	0.39	<div></div>
<i>4-min</i>	0.3	<div></div>	<b>0.55</b>	<div></div>	0.43	<div></div>

The results above indicate that U.S. 30Y treasury price movement has a moderate positive correlation with the selected news surprise especially that of non-farm payroll. Regression results are shown below.

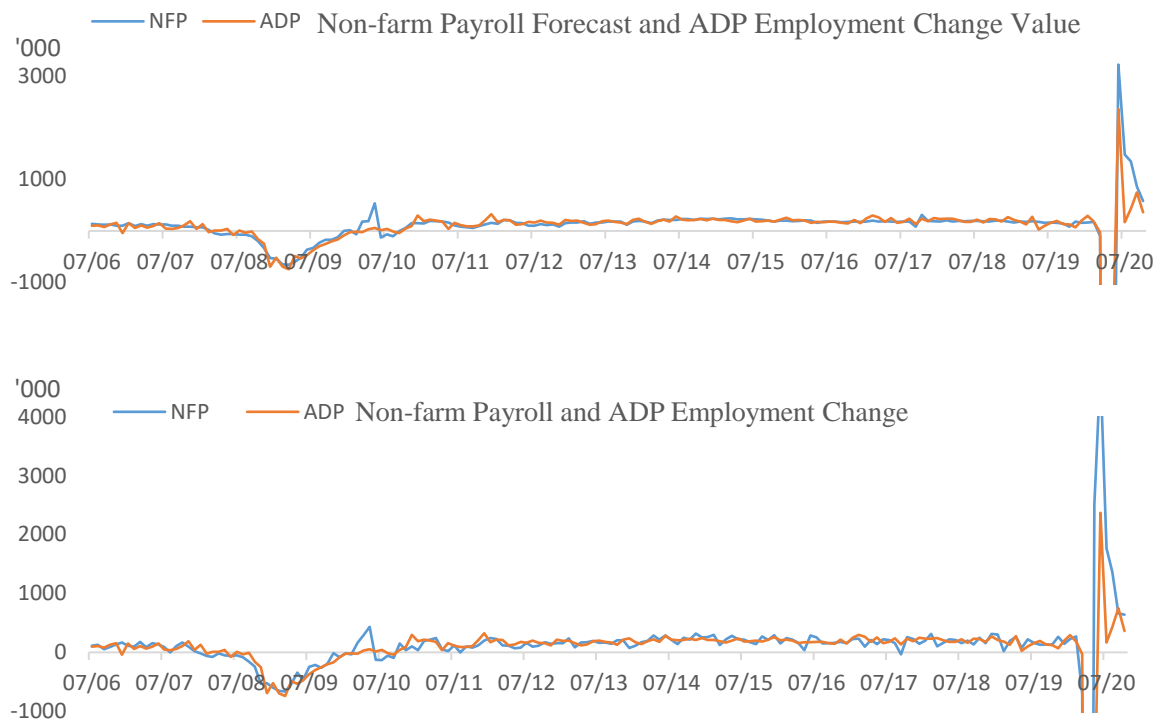


**Figure6. Regression of US 30Y Treasury Bond Yield on NFP Surprises**

#### 4.4 Pairwise Correlation

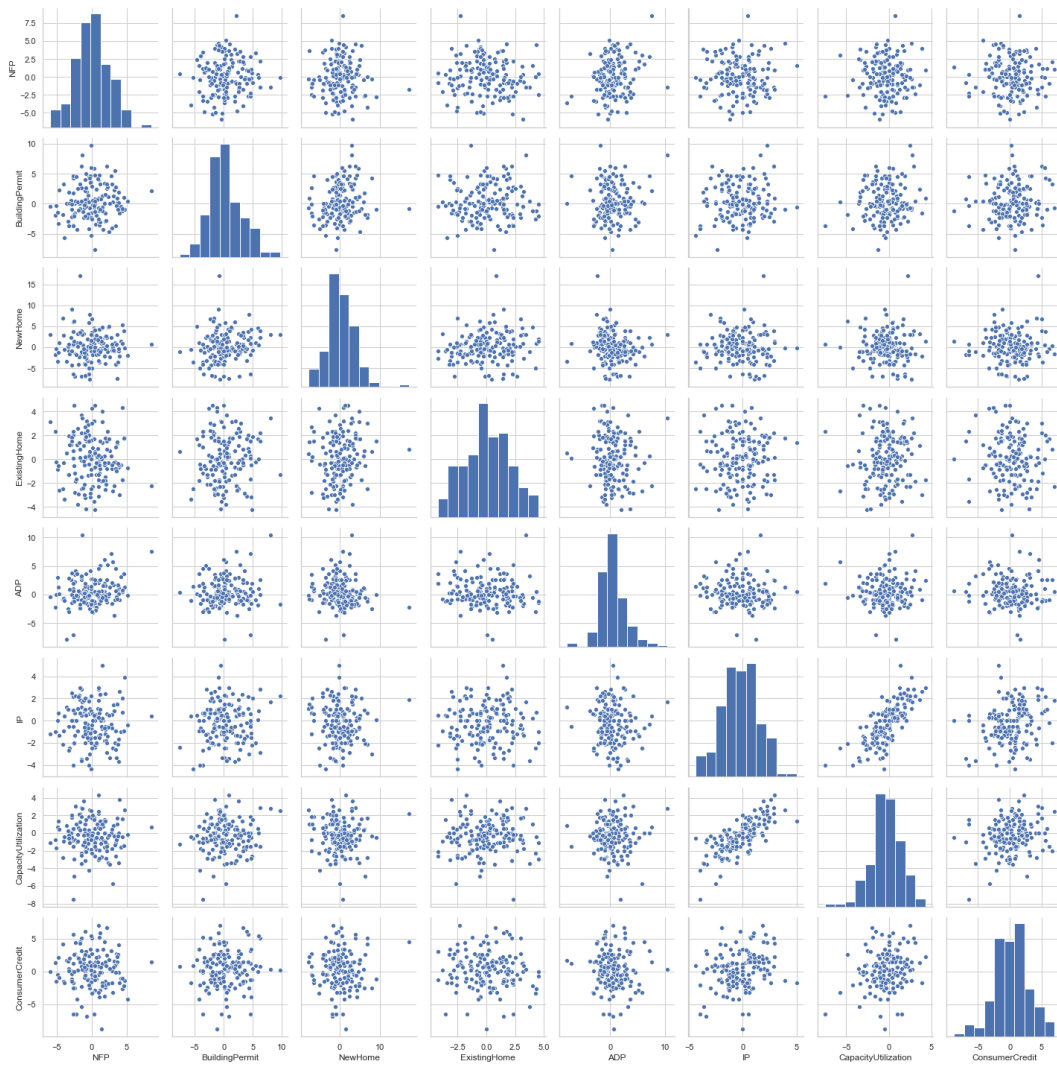
ADP National Employment Report Private Nonfarm Change is based on a subset of aggregated and anonymous payroll data, using about 365,000 of ADP's 500,000 U.S. business clients and 24 million employees working in all 19 of the major North American Industrial Classification private industrial sectors. From regression based on data from 2006 to 2020, ADP employment change realized values and non-farm payroll survey median

have a high correlation coefficient of 0.98. ADP employment change and non-farm payroll realized values also have a high correlation coefficient of 0.96. This implies ADP employment change actual value affect non-farm payroll forecast as a leading indicator.



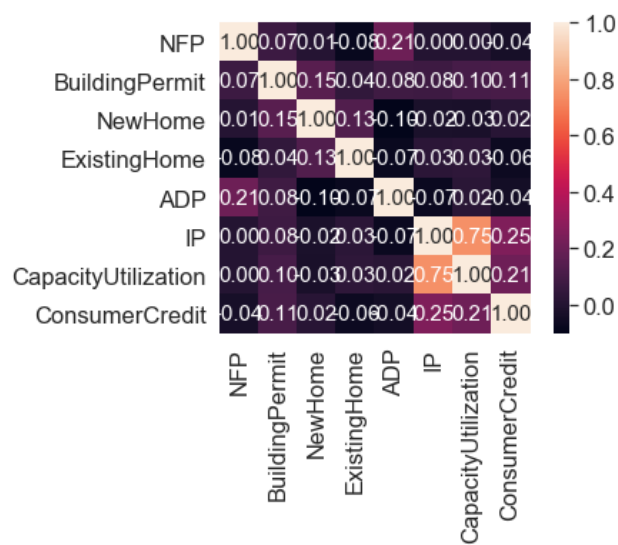
**Figure7. Non-farm Payroll and ADP Employment Change**

Pairwise correlation is plotted below for surprises from non-farm payroll, building permit, new home sales, existing home sales, ADP employment change, industrial production, capacity utilization, and consumer credit.



**Figure8. Pairwise Correlation Between Macroeconomic News Surprises**

As shown in the heat map below, industrial production and consumer utilization surprises have a high correlation of 0.75.



**Figure9. Correlation Matrix Heatmap**

## 5. Discussion

### 5.1 Do Macroeconomic News Surprises Impact Price Movements?

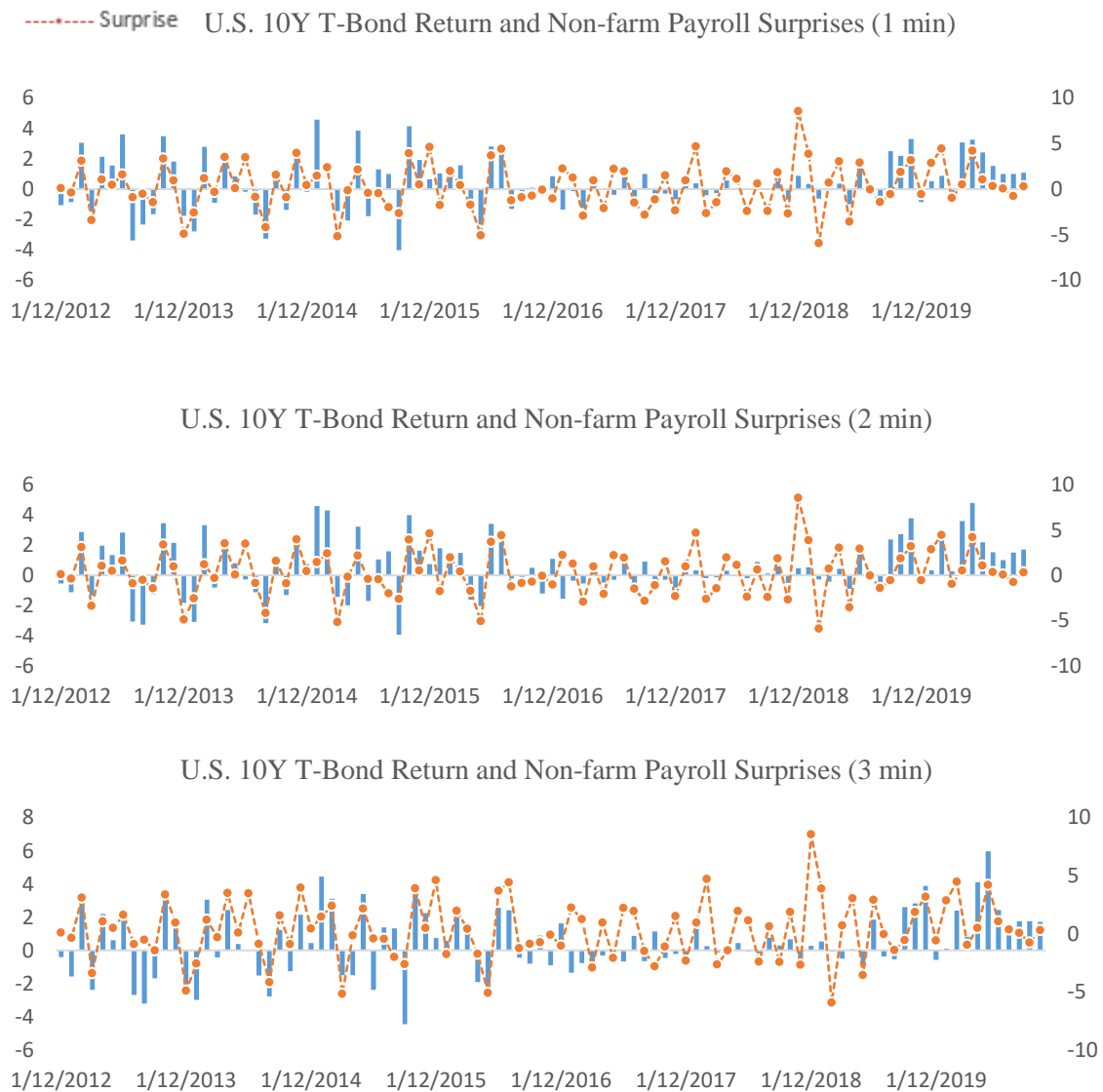
From the results in the previous chapter, the impact of news releases on different instruments differs for each indicator and time span.

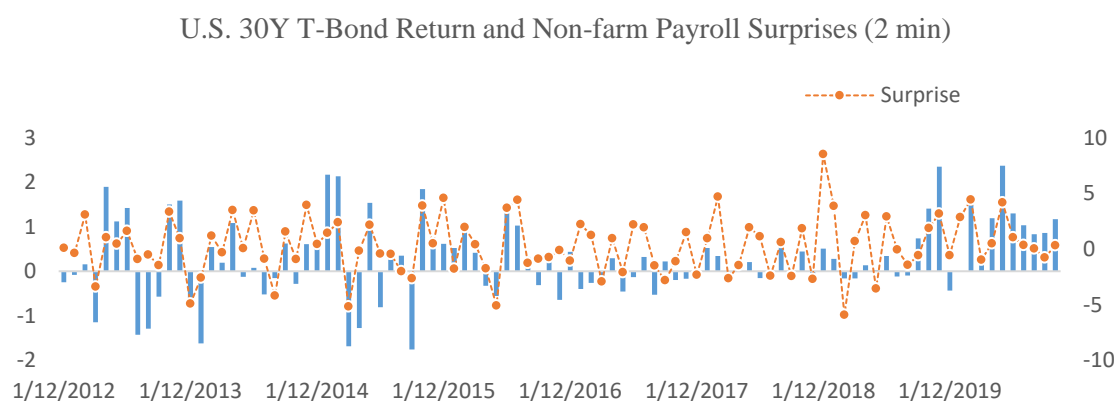
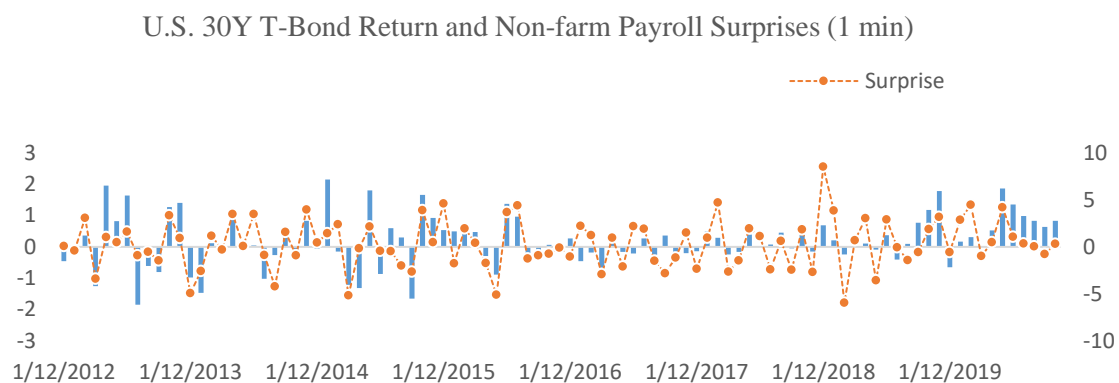
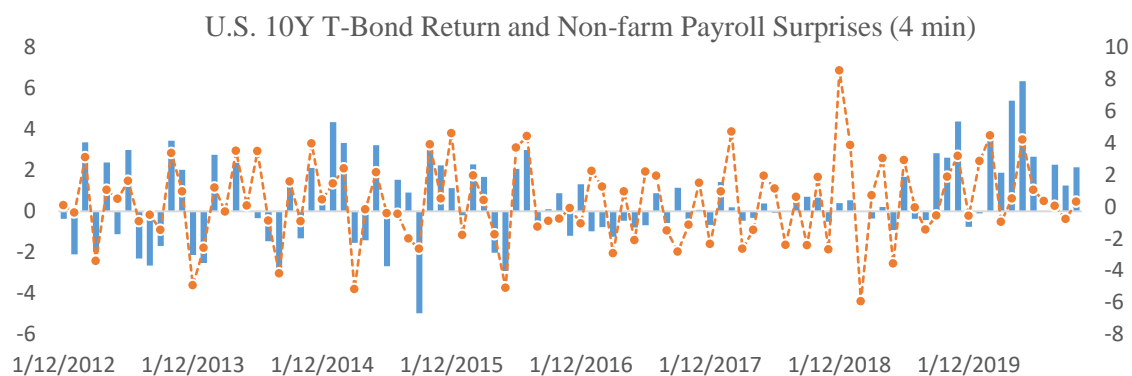
New home sales surprises are positively correlated with DXY returns. The correlation coefficient decreases as time passes by.

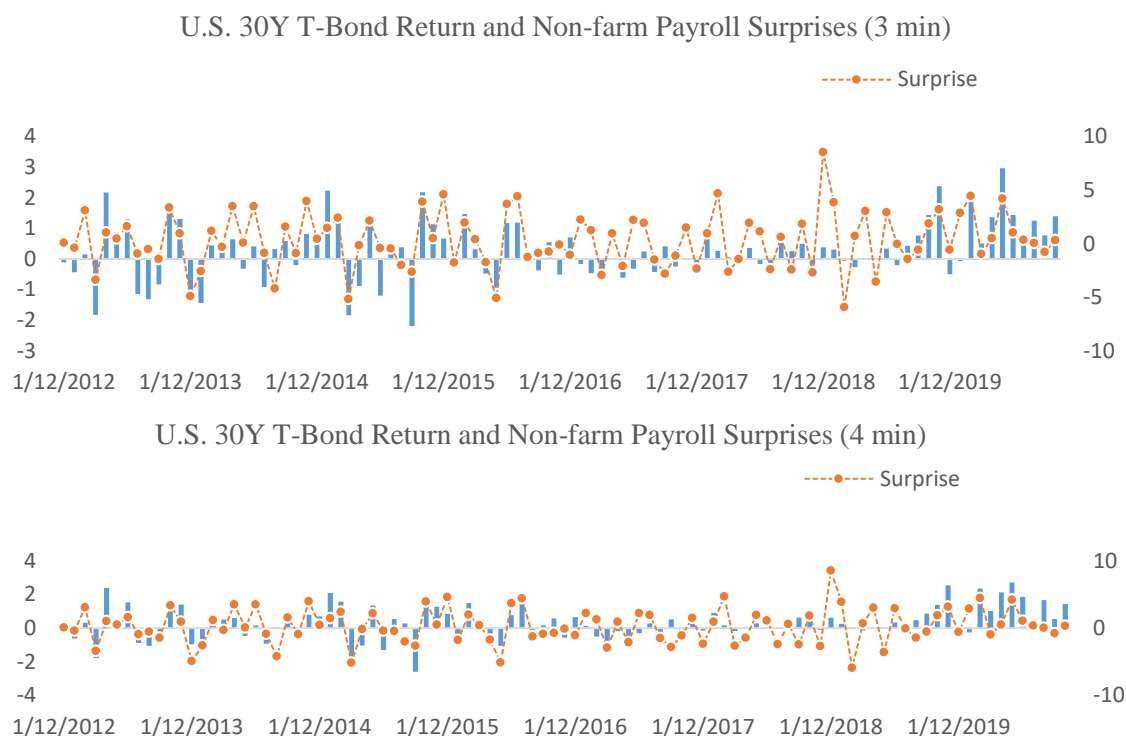
Existing home sales surprises are generally positively correlated with DXY returns and the coefficient decreases as time passes by.

Building permit surprises have a weak correlation with DXY and S&P 500 returns.

Non-farm payroll surprises are positively correlated with S&P 500 and long-term U.S. Treasury bond yield return as shown in Figure 10 below. The explanatory power is higher in Treasury bonds compared to stock returns from the sample. The treasury bond return moves in tandem with payroll surprises; an upside surprises tend to result in a higher bond yield and vice versa. Besides the headline numbers, the market is also paying attention to the details such as hourly earnings figures. This explains why sometimes the market still disappoints despite better-than-expected job growth.







**Figure10. U.S. 10 and 30Y T-Bond Return and NFP Surprises 2013-2020**

ADP has the highest correlation coefficient of 0.56 with DXY return over 5-min and decreases as time passes by. The foreign exchange rate is a function of interest rate and therefore, it is impacted by macroeconomic news which in turn influences central banks' rate decisions.

Industrial production has a moderate positive correlation with DXY return over 5-min.

Consumer credit and capacity utilization do not seem to have a clear relationship with DXY, S&P 500, or long-term U.S. treasury bond yield returns over the specified period. One explanation could be ambiguous interpretations of news and other factors such as business cycles as well as idiosyncratic factors of underlying stocks.

Contrary to Goldberg & Leonard's [10] finding that U.S. economic data has a significant impact on German bond yield using data from 2000 to 2002, results using recent data do not suggest a pronounced relationship with respect to labor market news surprise.

The correlation between price movements and news surprise is generally higher within 5 minutes of releases compared to that after 30 and 60 minutes.

## 5.2 Does News Fit into Price Movements?

Results from the previous section show price movements immediately adjust to certain macroeconomic news surprises including labor market data. Schwager [9] cited two contrasting headlines from the same newspaper on the same day: "Strong economic reports Give a Lift to the dollar" and "Long-term Rates Fall on Reports". Another instance he gave was in 2011 after Federal Reserve Chairman Bernanke's comments, equities were reportedly slid and then bounced by the same media. In this section, news from Reuters with respect to U.S. equity performance on job data this year will be examined to see if they fit into price movements.

Usually, better-than-expected job data would lead to a positive outlook on the economy and therefore outperforming equity. For example, on Jul 2<sup>nd</sup>, U.S. equities were reportedly opened higher, with the Nasdaq hitting a record high, as data suggested the U.S. job growth hit a record high in June, reviving hopes of an economic recovery post-pandemic. On the

same logic, on Dec 2<sup>nd</sup>, “the S&P 500 and the Nasdaq were set to ease...as data showing fewer-than-expected private job additions in November added to concerns about the near-term pressure on the economy.”

However, two days following the ADP employment change data release, on 4<sup>th</sup>, it was reported U.S. equities “rose to all-time highs” despite the slowest job growth in recent half-year due to investors’ expectation of a new relief bill to help with economic recovery. Some would argue that this is a rare occasion when bad news was good news. This was not the case on Aug 7<sup>th</sup> when U.S. equities were reportedly fell as data showed a significant slowdown in U.S. job growth and investors turned their attention toward the probability of another stimulus bill to support the economy from a recession caused by Covid-19. Recent evidence shows financial news reports sometimes fit into price movements whether the market is up or down and are not always consistent.

## 6. Conclusion

The purpose of this paper was to quantify the effect of periodic macroeconomic data releases on U.S. equity represented by S&P 500, foreign exchange represented by DXY index, and fixed-income represented by treasury bonds using data after the 2008 financial crisis. For this purpose, the impact of macroeconomic news surprises arising from differences between actual values and market consensus on price movements of the instruments was examined. The results show that the correlation between price movements of the selected instruments and news surprise is higher within 5 minutes of releases. This implies that price actions are more evident and prices are adjusted to news shortly after releases. As investors rebalance their positions or portfolios, buying and selling of instruments result in their prices changes. This is consistent with the theory of rational expectations which implies that new information that was not predicted will lead to price deviated from expectation. While the market tends to price in macroeconomic announcements based on the expectation, the reaction of different asset classes is heterogeneous. Several announcements a greater impact on assets and prices adjust to surprises of macroeconomic news to varying degrees. Moreover, the correlation coefficients between bond instruments represented by U.S. 10Y and 30Y treasury yield return and labor market news surprise are higher. The bond price is a function of interest rate and macroeconomic news is the key source of public information reflecting economic conditions that impact central banks’ interest rate decisions. The impact of other macroeconomic news surprises on S&P 500 and DXY index is variable. This is in line with existing research including Bollerslev, Cai, & Song’s finding [6] as well as Andersen, Bollerslev, Diebold, & Vega’s [5] conclusion. Even after the 2008 financial crisis, this is still valid. Such important information can provide investors and traders with insight into risk management and decision-making in generating alpha. This paper also provides evidence that media are sometimes found to interpret financial news differently to fit into price actions.

This paper contributes to existing literature in several dimensions. Firstly, the impact on asset prices over different time spans was studied. Secondly, it draws data from 2008 to 2020 which confirmed that the relationship between macroeconomic news surprises and assets especially U.S. treasury bond still holds, showing macroeconomic news is a crucial source of information. Some macroeconomic indicators are correlated as well. ADP employment change is a leading indicator of non-farm payroll data. Industrial production and capacity utilization surprises are also found to be highly correlated. Another intriguing finding is that the relationship between U.S. macroeconomic news surprises and German bond yield that existed twenty years ago does not seem to be significant according to recent data. Further areas of research include news on emerging markets outside of the United States such as China, which has attracted significant foreign investments, especially in fixed income space this year. The recent rapid growth of China’s economy also makes its macroeconomic data closely monitored by participants in the financial markets.

## Disclaimer

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## Appendix

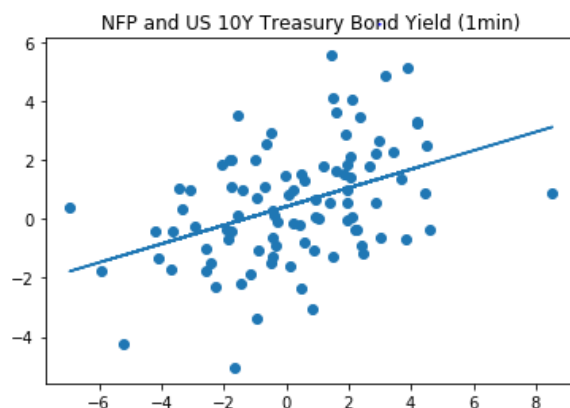
### 1. Python Source Code

Link to the online code repository: <https://github.com/a0114301/macroeconomic-news>

```
lb=acorr_ljungbox(df['sur'], lags=10) #Ljung-Box test will be conducted to test for autocorrelation
print (lb[1])
lb=acorr_ljungbox(df['five'], lags=10)
print (lb[1])
lb=acorr_ljungbox(df['thirty'], lags=10)
print (lb[1])
lb=acorr_ljungbox(df['sixty'], lags=10)
print (lb[1])
lb=acorr_ljungbox(df['Efive'], lags=10)
print (lb[1])
lb=acorr_ljungbox(df['Ethirty'], lags=10)
print (lb[1])
lb=acorr_ljungbox(df['Esixty'], lags=10)
print (lb[1])
```

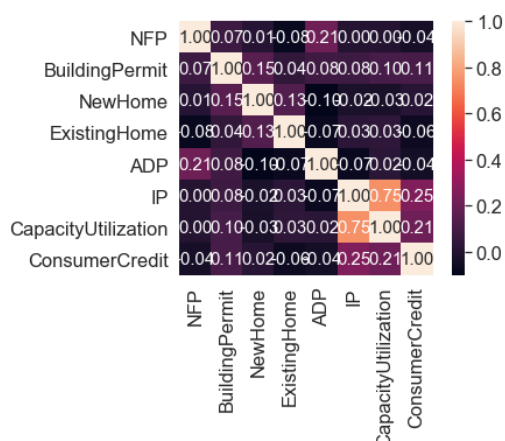
```
[0.22324554 0.15845536 0.29517675 0.39117163 0.3813517 0.44094868
0.46333776 0.55262767 0.53655366 0.38679751]
[0.02795369 0.08462711 0.0168823 0.03443477 0.03692375 0.06323283
0.0557158 0.03015613 0.04874279 0.07418267]
[2.92137951e-02 3.02474164e-02 1.48641558e-02 9.03125561e-03
4.60840808e-03 8.80533399e-03 7.88257205e-04 8.68486380e-05
1.53409914e-04 2.03478572e-04]
[7.51996139e-02 9.16979256e-02 3.16814532e-03 2.52516489e-03
7.13297773e-04 1.61913952e-03 5.01112596e-05 8.66573257e-07
2.04435668e-06 3.23624615e-06]
[0.12111387 0.22616087 0.37789335 0.35689675 0.13437618 0.16008626
0.01433794 0.01326938 0.02099744 0.0142671 ]
[0.26350143 0.03691087 0.04233213 0.03342955 0.0442484 0.05591693
0.01157966 0.02050357 0.02978153 0.01774046]
[0.99542088 0.02013188 0.03839718 0.07755826 0.07058121 0.10724303
0.04871968 0.07316201 0.1046978 0.03407599]
```

```
#regression results after adding a random signal
x=np.array(train_data['surR']).reshape(-1,1)
y=np.array(train_data['BoneR']).reshape(-1,1)
regr=linear_model.LinearRegression()
regr.fit(x,y)
a=regr.coef_
b=regr.intercept_
Y=a*x+b
plt.scatter(x,y)
plt.plot(x,Y)
plt.title('NFP and US 10Y Treasury Bond Yield (1min)')
plt.show()
print('coefficient:', regr.coef_)
print('intercept:',regr.intercept_)
```



```
import seaborn as sns
#Plot pairwise correlation between macroeconomic releases
sns.set(style='whitegrid',context='notebook')
df=pd.read_excel(r'C:\Users\SS\Downloads\data.xlsx',sheet_name='pairwise')
cols=['NFP','BuildingPermit','NewHome','ExistingHome','ADP','IP','CapacityUtilization','ConsumerCredit']
sns.pairplot(df[cols],size=2.5)
plt.tight_layout()
plt.show()

#plot a correlation heat map
cm=np.corrcoef(df[cols].values.T)
sns.set(font_scale=1.5)
hm=sns.heatmap(cm,cbar=True,annot=True,square=True,fmt='.2f',annot_kws={'size':15},yticklabels=cols,xticklabels=cols)
plt.show()
```



```
from sklearn.linear_model import LogisticRegression
from sklearn import linear_model
import matplotlib.pyplot as plt
#LogisticRegression on NFP surprises and one-minute US 10Y treasury bond yield changes
train_data=pd.read_excel(r'C:\Users\SS\Downloads\data.xlsx',sheet_name='NFP')
train_x=train_data['sur']
train_y=train_data['One']
train_x=np.array(train_x).reshape(-1,1)
train_y=np.array(train_y).reshape(-1,1)
```

```
model=LogisticRegression(solver='liblinear')
```

```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test=train_test_split(train_x,train_y,test_size=0.1,random_state=0)
model.fit(X_train,y_train)
```

C:\Users\SS\anaconda3\lib\site-packages\sklearn\utils\validation.py:760: DataConversionWarning: A 1d array was expected. Please change the shape of y to (n\_samples, ), for example using `y = column_or_1d(y, warn=True)`

```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                    intercept_scaling=1, l1_ratio=None, max_iter=100,
                    multi_class='auto', n_jobs=None, penalty='l2',
                    random_state=None, solver='liblinear', tol=0.0001, verbose=0,
                    warm_start=False)
```

```
model.predict(X_test)
model.score(X_test,y_test)
```

0.8

```

from sklearn.metrics import roc_curve
from matplotlib import pyplot
from sklearn.metrics import roc_auc_score
ns_probs = [0 for _ in range(len(y_test))]
# fit a model
# predict probabilities
lr_probs = model.predict_proba(X_test)
# keep probabilities for the positive outcome only
lr_probs = lr_probs[:, 1]
# calculate scores
ns_auc = roc_auc_score(y_test, ns_probs)
lr_auc = roc_auc_score(y_test, lr_probs)
# summarize scores
print('No Skill: ROC AUC=%.3f' % (ns_auc))
print('Logistic: ROC AUC=%.3f' % (lr_auc))
# calculate roc curves
ns_fpr, ns_tpr, _ = roc_curve(y_test, ns_probs)
lr_fpr, lr_tpr, _ = roc_curve(y_test, lr_probs)
# plot the roc curve for the model
pyplot.plot(ns_fpr, ns_tpr, linestyle='--', label='No Skill')
pyplot.plot(lr_fpr, lr_tpr, marker='.', label='Logistic')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')

```

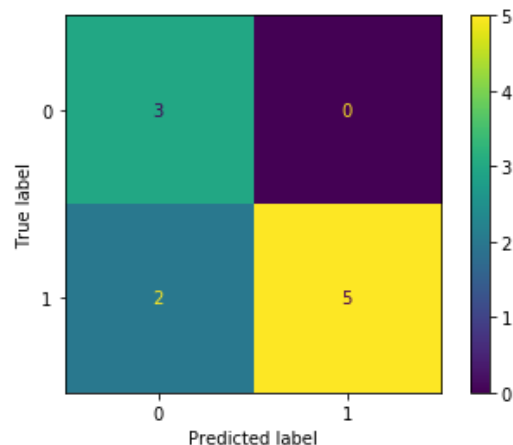
No Skill: ROC AUC=0.500

Logistic: ROC AUC=0.857

```

from sklearn.metrics import plot_confusion_matrix
#plot confusion matrix which shows number of correct and incorrect predictions
plot_confusion_matrix(model, X_test, y_test)
plt.show()

```



```

ns_probs = [0 for _ in range(len(y_test))]
# fit a model
# predict probabilities
lr_probs = model.predict_proba(X_test)
# keep probabilities for the positive outcome only
lr_probs = lr_probs[:, 1]
# calculate scores
ns_auc = roc_auc_score(y_test, ns_probs)
lr_auc = roc_auc_score(y_test, lr_probs)
# summarize scores
print('No Skill: ROC AUC=%.3f' % (ns_auc))
print('Logistic: ROC AUC=%.3f' % (lr_auc))
# calculate roc curves
ns_fpr, ns_tpr, _ = roc_curve(y_test, ns_probs)
lr_fpr, lr_tpr, _ = roc_curve(y_test, lr_probs)
# plot the roc curve for the model
pyplot.plot(ns_fpr, ns_tpr, linestyle='--', label='No Skill')
pyplot.plot(lr_fpr, lr_tpr, marker='.', label='Logistic')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
pyplot.legend()
pyplot.show()

```

No Skill: ROC AUC=0.500  
 Logistic: ROC AUC=0.857

## 2. A snapshot of dataset:

	zur	five	thirty	sixty	Etive	Etthirty	Etixty	Etano	Etua	Etthree	Etfour	Etano	Etua	Etthree	Etfour	
31/10/2020	0.31016	0.06493	-0.0921	0.0325	-0.3204	-0.5535	-0.1038	-0.0886	-0.1254	-0.2976	-0.3668	1.0741	1.719	1.719	2.1491	
30/9/2020	-0.7704	0.0181	0.1227	0.1579	-0.0192	0.3753	0.6535	-0.2438	-0.1677	-0.1473	-0.1471	1.0057	1.5088	1.7605	1.2573	
31/8/2020	0.04762	0.0194	0.2942	0.3503	0.6162	-0.5316	-1.7495	0.2481	0.3489	0.5279	0.6191	1.0058	1.0058	1.7607	2.2641	
31/7/2020	0.34512	-0.0129	-0.0751	0.3489	0.038	0.147	0.0862	-0.0518	0.0102	0.0165	0.0186	1.5275	1.5275	0.9163	0	
30/6/2020	1.05157	-0.0526	0.1062	0.1248	0.5414	0.6257	0.041	0.2847	0.383	0.4571	0.5169	2.4253	2.1826	2.4253	2.6681	
31/5/2020	4.19841	0.2182	0.2834	0.0952	0.3679	0.3736	0.5041	0.3603	0.3085	0.3037	0.3423	3.2655	4.8055	5.9619	6.3476	
30/4/2020	0.49966	0.1756	0.1716	0.2298	0.0512	0.1306	0.2104	0.121	0.1117	0.0908	0.0124	3.0797	3.5935	4.1075	5.3933	
31/3/2020	-0.9601	0.1222	0.1699	0.0119	0.3268	0.4529	-0.229	0.0302	0.0604	0.2732	0.2644	-0.2685	0.2686	0.8058	1.8807	
29/2/2020	4.45455	0.1158	0.0688	-0.1054	-0.7037	-0.7389	0.304	-0.6039	-0.7119	-0.4583	-0.3801	0.867	2.3857	2.3857	3.4714	
31/1/2020	2.85714	-0.0396	0.0365	0.0416	-0.259	-0.1991	-0.0051	-0.1142	-0.0336	-0.0821	-0.2096	0.5335	0.32	0.1067	-0.1066	
31/12/2019	-0.5769	-0.1435	-0.0308	-0.04	-0.1383	-0.0466	-0.0649	-0.0192	-0.0518	-0.0719	-0.099	-0.8538	-0.3796	-0.5693	-0.759	
30/11/2019	3.18519	0.2412	0.1847	0.2114	0.2153	0.3056	0.3075	0.1649	0.163	0.1384	0.216	3.3017	3.7889	3.8864	4.3741	
31/10/2019	1.86957	0.1511	0.1799	0.0267	0.078	0.175	0.3475	0.1141	0.1351	0.1046	0.0757	2.1965	2.7206	2.8255	2.6158	
30/9/2019	-0.5625	0.1589	0.1407	0.0779	0.2272	0.4043	0.2964	0.0466	0.2762	0.2433	0.2015	2.4893	2.3759	2.6027	2.8295	
31/8/2019	-1.4286	-0.001	-0.0965	-0.1819	-0.1456	-0.0916	0.0611	-0.0349	-0.0423	-0.0846	-0.0601	-1.1719	-1.1719	-0.5329	-0.4264	
31/7/2019	-0.0455	-0.0377	0.1171	0.0774	-0.0645	-0.3281	-0.5	-0.0632	-0.0985	0.0054	-0.0622	-0.3659	-0.0915	-0.3659	-0.3659	
30/6/2019	2.90909	0.1507	0.2466	0.3457	-0.134	-0.3036	-0.3917	-0.0231	-0.0349	-0.1089	-0.0972	1.8512	1.8512	1.8512	1.6746	
31/5/2019	-3.5714	-0.304	-0.3998	-0.3813	0.1511	0.5191	0.6281	0.0733	0.0911	0.1283	0.1083	-0.9863	-0.9042	-0.9042	-0.9042	
30/4/2019	3.04167	0.0602	-0.0796	-0.0766	0.1601	0.1775	0.1161	0.0789	0.0864	0.1707	0.1813	0.3538	0.4246	0.0707	0.2123	
31/3/2019	0.7037	-0.0596	-0.0298	0.0699	0.0704	0.1543	0.1824	0.0766	0.111	0.1456	0.0843	-0.0708	-0.4247	-0.4955	-0.354	
28/2/2019	-5.9259	-0.0103	-0.0626	-0.0575	-0.2582	-0.1146	-0.063	-0.1901	-0.1417	-0.1219	-0.1827	-0.6157	-0.2738	-0.0685	0	
31/1/2019	3.86111	0.1152	-0.0168	0.0084	0.1258	0.0559	0.467	0.1018	0.1351	0.1021	0.0988	0.3386	0.542	0.542	0.542	
31/12/2018	8.53333	0.1237	0.1974	0.3117	0.3431	0.974	1.6978	0.2861	0.2587	0.2675	0.4005	0.8793	0.4732	0.2703	0.4056	
30/11/2018	-2.6875	-0.3488	-0.2002	-0.1517	0.1174	0.3437	-0.4414	0.0516	0.0108	0.0825	0.0227	-0.6843	-0.4978	-0.56	-0.4978	
31/10/2018	1.85185	0.0967	0.1539	0.206	0.173	0.1053	-0.3799	0.0994	0.0947	0.157	0.1566	0.541	0.6012	0.6614	0.6614	
30/9/2018	-2.4286	0.023	-0.1869	-0.19	0.0813	-0.0427	0.0613	0.051	0.0534	-0.0238	0.02	0.0592	0.1184	0.296	0.7109	
31/8/2018	0.61111	0.2264	0.3781	0.3486	-0.0115	0.2322	0.3117	-0.0286	-0.0289	-0.137	-0.0781	0.6322	0.8854	0.7588	0.8221	
31/7/2018	-2.4	-0.0767	-0.0631	0.0715	-0.0007	-0.0117	0.176	-0.052	-0.0198	0.0424	0.0488	0	-0.1876	-0.1876	0	
30/6/2018	1.125	-0.1824	-0.1846	-0.3012	-0.076	0.2119	0.2981	-0.0683	-0.0468	-0.149	-0.126	0.0646	-0.0646	-0.0646	-0.0646	
31/5/2018	1.94118	0.0478	0.1232	-0.0149	0.2064	0.3274	0.3619	0.107	0.1589	0.16	0.174	0.5656	0.3141	0.4398	0.3769	
30/4/2018	-1.45	-0.1426	-0.0616	0.2819	-0.1385	0.2861	0.7439	-0.1121	-0.0496	-0.0557	-0.1869	-0.2548	-0.1274	-0.0637	-0.3185	
31/3/2018	-2.6452	-0.1923	-0.158	-0.3338	-0.0416	0.2642	0.0658	-0.178	-0.1085	-0.0567	-0.0609	-0.3905	-0.1953	-0.1302	-0.4556	
28/2/2018	4.69565	-0.1318	-0.0864	-0.1196	-0.0036	0.1591	0.3404	0.13	0.1228	0.057	0.0069	0.3825	0.3187	0.2549	0.1912	
31/1/2018	0.95238	0.2792	0.3951	0.3175	-0.1876	-0.3813	-0.3948	-0.0876	-0.1609	-0.1442	-0.1598	0.9476	1.0154	1.2866	1.4223	
31/12/2017	-2.3333	-0.2455	-0.1315	0.0163	-0.0333	-0.0103	-0.0663	0.0677	0.0688	0.0589	0.0253	-0.664	-0.8115	-0.8851	-0.664	
30/11/2017	1.5	0.05	-0.1128	-0.0979	0.0582	0.0351	-0.0064	0.0162	0.0159	0.0355	0.0733	-0.3006	-0.3006	-0.2255	0.0752	
31/10/2017	-1.1304	-0.2461	-0.038	-0.0243	-0.0732	-0.1294	-0.1348	-0.0248	-0.0209	-0.0356	-0.0771	-0.8475	-0.4625	-0.4625	-0.6935	
30/9/2017	-2.825	0.1734	0.1308	0.1053	-0.0381	0.0275	0.0726	-0.0259	-0.0063	0.022	0.0035	0.9908	0.9145	1.1435	1.1435	
31/8/2017	-1.5	-0.2317	0.223	0.2187	0.1107	0.0776	0.0828	0.0966	0.1107	0.101	0.1128	-0.4924	-0.9024	-0.6564	-0.5744	
31/7/2017	1.93333	0.2694	0.4062	0.3146	0.0057	-0.0908	0.0182	0.0355	0.004	-0.0157	-0.0024	0.9571	1.037	0.8773	0.8773	
30/6/2017	2.2	-0.3112	-0.0385	-0.0489	0.1135	0.2258	0.1649	0.1309	0.1396	0.1119	0.0945	-0.3755	-0.3005	-0.6757	-0.6757	
31/5/2017	-2.0952	-0.2297	-0.2863	-0.2729	0.0518	-0.0946	0.0066	-0.028	0.0214	-0.0214	-0.0247	0	-0.4764	-0.7145	-0.7938	
30/4/2017	0.95455	-0.1869	-0.2152	-0.1899	0.0635	-0.069	-0.0535	0.0878	0.0894	0.0656	0.0656	0.4603	0.3068	-0.3066	-0.4598	
31/3/2017	-2.9286	-0.0696	0.2484	0.2683	-0.0857	-0.219	0.0479	-0.0416	-0.017	-0.0488	-0.0564	-1.2378	-0.542	-0.774	-1.2378	
28/2/2017	1.25	-0.1766	-0.3827	-0.2649	0.0691	0.1572	0.0468	0.1066	0.1273	0.105	0.1045	-0.1403	-0.3507	-0.7711	-0.7711	
31/1/2017	0.33333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	